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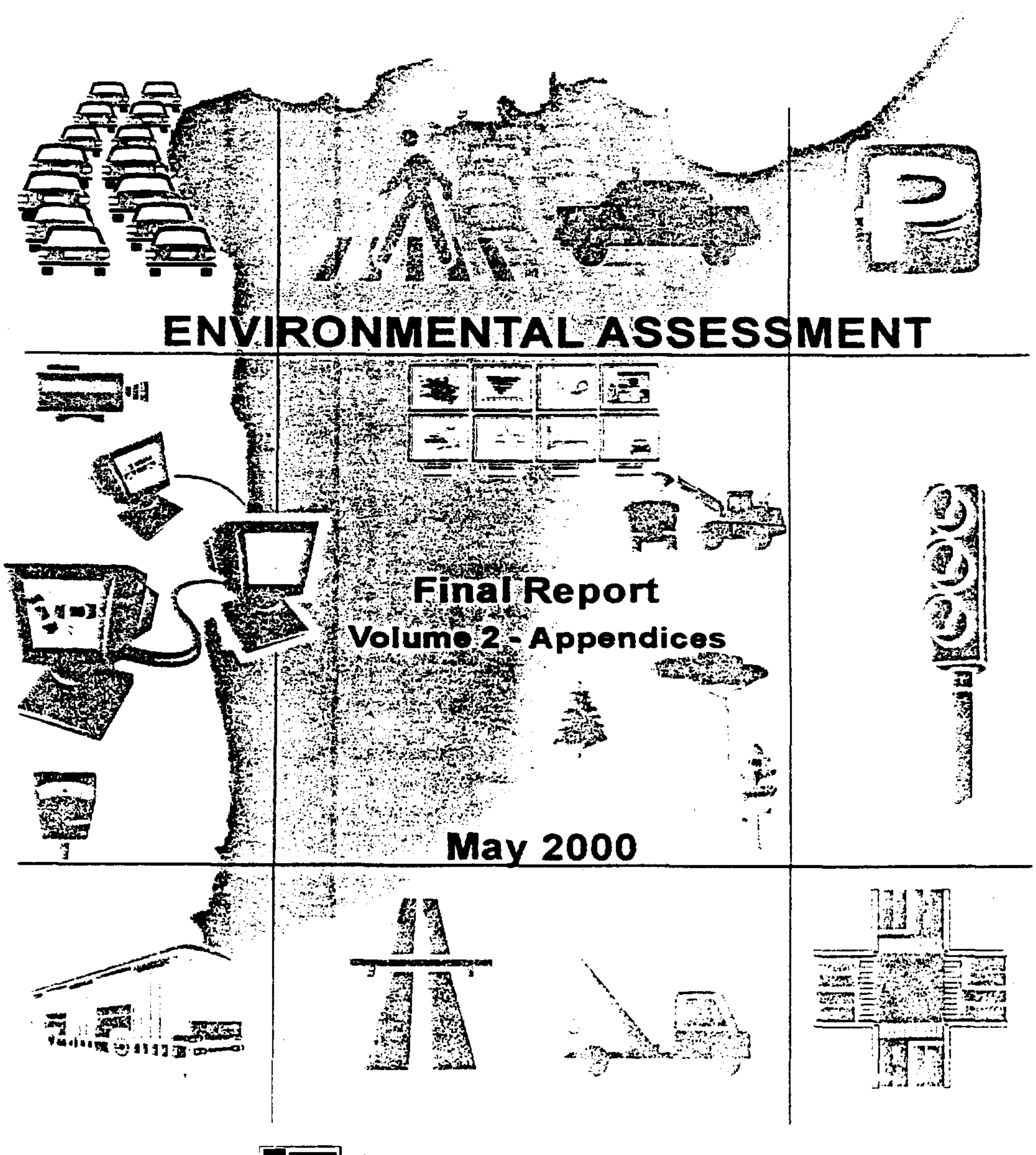
VOL. 3

LEBANESE REPUBLIC

COUNCIL FOR DEVELOPMENT AND RECONSTRUCTION

BEIRUT URBAN TRANSPORT PROJECT



ENVIRONMENTAL ASSESSMENT

Final Report

Volume 2 - Appendices

May 2000

team INTERNATIONAL
engineering & management consultants
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The Beirut Urban Transport Project (BUTP) Preparatory Study has been carried out for the Council for Development and Reconstruction (CDR) by the consulting firm TEAM International, and has been financed by the Lebanese Government.

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ACKNOWLEDGEMENTS

The authors wish to express their sincere gratitude to the office of the Board of the Council of Development and Reconstruction and the World Bank staff for their assistance during the preparation of this Environmental Assessment.

INTRODUCTION

The metropolitan area of Beirut, usually referred to as Greater Beirut Area (GBA) is the core of the service-based economy of Lebanon with one third of the population and contributes in excess of two thirds of the total value added in the economy. The city and its metropolitan area, however, suffer severe traffic congestion, a result of an extremely deficient transportation system. This implies high economic losses and deteriorating air quality. As sustained growth of the service-oriented economy is underpinned by efficient infrastructure, Beirut needs to improve the operational and economic efficiency of its urban transport system.

In its heyday, Beirut had an extensive urban transport system including a well-developed bus system and even a trolley-bus system. Due to the prolonged period of conflict this infrastructure deteriorated. Also, over the last two decades major changes have occurred in Lebanon's demography due to urbanization and displacement of residents from the South and relocation of businesses from Beirut to various locations along the coast. These have resulted in important changes in traffic patterns throughout the Greater Beirut Area (GBA), which, in turn, generates severe congestion both in and around Beirut and particularly at the connections with the coastal highway to the north and south. The problem of congestion is exacerbated by a heavy reliance on the use of private cars, which amounts to approximately 300,000 cars for a population of some 1.2 million in the GBA (about 250 cars per 1000 inhabitants). Over 70 percent of total motorized person trips, more than half of which are home-to-work, are made by private car. Shared taxis account for nearly 20 percent of all trips, while just 10 percent of the population is served by privately and publicly operated bus services. In addition, latent travel demand is high and would materialize with improving supply of transport capacity.

For Beirut to develop as a competitive regional center for finance, trade, services and tourism, it should have an efficient transport system. To this end, the Government prepared a comprehensive Greater Beirut Area Transportation Plan (GBATP) which addresses the most serious urban transport issues, analyzes needed investments through the year 2015, and recommends a large phased investment program. The prioritization and phasing of this program, which will be the largest single investment need in Lebanon over the next ten years, will require a significant planning, consensus building, and resource mobilization effort.

The Beirut Urban Transport Project (BUTP) is an element of the GBATP. Other projects are anticipated to be implemented to address the issues related to public transportation as described below in the GBATP background and summary section. The BUTP has been proposed to provide the fundamental urban transport apparatus needed to address part of the extremely diverse and complex transport issues the city faces. The project consists of establishing a traffic management organization; constructing of grade separations at highly congested intersections; and parking provision and controls.

Financial support for the proposed project is being sought through a loan from the World Bank. Loan provisions dictate the preparation of an environmental assessment for the project. The present report (Volume 2) contains the technical appendices that are an integral part of the overall Environmental Assessment report (Volume 1).

GBATP BACKGROUND AND SUMMARY

Seventeen years of war sustained by Lebanon has had grave negative consequences on the economic frame of the country: destruction of buildings and infrastructure networks. accumulated delay of public investments, and lack of town planning control.

In the absence of public transport, which nearly disappeared during the war, private cars and taxi services provide today the (quasi) only traveling means for Beirut inhabitants. The road network is congested by bottlenecks that can paralyze some vital thoroughfares of the city for hours. Chaotic parking in central areas reduces the capacity of the street network and makes pedestrian trips especially onerous. For Greater Beirut inhabitants, traveling in the city is a costly experience in time as well as money. Bad traffic conditions form a stumbling hurdle against developing interaction and they seriously handicap the restarting of the economy.

Urgent measures should be taken to reestablish acceptable traffic conditions in Beirut in order not to annihilate the first benefits of the reconstruction works. They should be completed by a long-term policy that will enable Greater Beirut to meet future needs.

Greater Beirut in 1994

Collecting recent and reliable data about Greater Beirut population and urban economy is a prerequisite task of any planning activity. Preparation of the transportation plan has necessitated the execution of numerous surveys of traffic, trips, and land use in the Metropolitan Region. A large-scale socio-economic survey has thus been carried out. comprising a sample of 4300 households.

The study area included the territories spreading from Nahr El Damour to the South to Nahr el Kalb to the North, below an average 400 m altitude. It covers 23 000 ha. The GBA was populated by 1,165,00 inhabitants in 1994, with some 400,000 of them within Municipal Beirut. Due to the destruction of Beirut Downtown and to war years insecurity, new business and commercial centers have developed outside the City, and suburban areas have been intensely urbanized.

Few and Polarized Trips

With 1,500,000 motorized person trips executed every day in Greater Beirut area (900,000 of which by inhabitants of the Region), Greater Beirut is a metropolitan area where people did not travel much in 1994 (0.79 daily motorized trips per inhabitant of Beirut City compared to 1.21 twenty five years earlier), and mainly for work (55% are work trips). Car ownership in Greater Beirut is quite high reaching 250 per 1000 population, resulting in a strong reliance on the automobile. Less than 1% of the trips were served in 1994 by the Public Transport Company. Automobile use is prominent, with 90% share of the total trips (71% for private cars and 19% for taxi-services). Traffic volumes along a number of road axes are very high. reaching 200.000 per day.

AN IMMEDIATE ACTION PLAN (IAP) TO RESPOND TO URGENT NEEDS

The emergency measures proposed in the Immediate Action Plan (IAP) aim at restoring tolerable traffic conditions in Greater Beirut Area without additional costly infrastructure works nor extra right-of-way.

The First Fold: Traffic System Management

Greater Beirut road network suffers from many insufficiencies: lack of network hierarchy, traffic lanes invaded by chaotic parking and intersections without signals. If better managed. the network can cope with much higher traffic volumes than it accommodates today.

The methodology used to prepare the Immediate Action Plan has relied on a functional analysis of the network and on a set of network simulations allowing the testing of various alternatives. It has led to optimum network utilization ensuring the best efficient use of the existing network.

Emergency measures are concentrated on a limited number of corridors that accommodate the main part of the traffic. The basic network candidate for traffic management measures is 200 Km long (107 Km in Municipal Beirut, 93 Km in suburbs). A clear hierarchy will be established among the various streets according to their role (through traffic versus local access). The circulation plan will be reviewed to increase network capacity.

The main intersections of the built-up area will be signal controlled. Parking will be prohibited along a number of major axes and systematically banned in the vicinity of intersections. A signing plan will guide drivers and facilitate traffic management. Spot improvements (grade-separations for instance) will be executed on a limited number of intersections whose level-of-service cannot be sufficiently improved relying on less drastic measures.

The investment cost of the traffic management scheme proposed in the IAP reaches about US$ 20 million.

Proposed traffic improvement measures integrate the proposals made for restructuring the bus network. Bus Transport will directly benefit from the new street organization.

A large public information campaign will be launched, since an active participation of users is one of the main conditions to make the Immediate Action Plan a success. It will be followed. by strict enforcement of the traffic code.

The present scattering of responsibilities is a serious handicap to successful implementation of an overall traffic policy. A close coordination of responsible governmental and municipal departments will have to be ensured. Municipal technical departments in charge of traffic management will be established.

The Second Fold: Restarting A Public Transport System

Traffic improvement in Greeter Beirut Area cannot be obtained without setting up an efficient public transport system. Many users have no cars. and taxi-services cannot answer mass transit needs. Reliance on the automobile solely will progressively increase congestion.

The transport supply provided by the Public Transport Company (OCFTC) was reduced in 1994 to nearly nothing. Many buses have been damaged during the war and a part of the depots are the same. Only 25 buses carrying every day less than 20,000 passengers were operating in 1994. A number of privately operated buses provided transport services, but without any coordinated planning or any system coherence.

More expensive and a source of permanent congestion due to their anarchical and uncontrolled operation, taxi services (traditional jitney service in Beirut) have quickly grown in number. They provide the main supply for public transport. Captive users of public transport are today confronted with a quite restricted transport supply and this can partially explain the low level trips per person observed in Greater Beirut.

Restarting a modern mass transit system necessitates institutional and technical measures:

Only a Metropolitan Transport Authority is able to plan, organize, and control a public transport system: Selecting the lines to serve, the level of service to ensure, and the operators. Controlling the quality of service is undoubtedly under the responsibility of public authorities, and a specialized body should be instituted to assume this role. Conversely, network operation itself should be largely open to competition. But this is not contradictory with the maintaining and the upgrading of a public transport company. The target should be to provide users with a good service at the lowest cost.

Future public transport network should be designed as a coherent system including trunk bus lines (13 of which are proposed in the Immediate Action Plan along the heaviest demand corridors), complementary feeder bus lines and taxi services lines. Taxi-services will continue to play an important role in the short-term to meet transport needs, but they should be strictly organized and controlled (stations and lines).

The implementation action of a trunk bus network in Greater Beirut will necessitate purchase of about 400 buses, to equip 3 depot-garages and to set up complementary facilities. The total investment cost of this program has been estimated at US$ 100 million, with an estimated annual patronage of 80 million passengers.

A LONG TERM PLAN TO ANSWER FUTURE NEEDS

Challenges of the Future

Beirut revival as a large international metropolis necessitates to plan a transportation system well suited to this ambition. In 2015 (retained study horizon) Greater Beirut will be populated with about 2 million inhabitants who will enjoy an income level and a vehicle ownership rate much higher than today. Beirut Central District (BCD) would have been rebuilt and it would have recovered its former role of largest service and business center of Greater Beirut Area. Other secondary centers would have been developed in the outskirts of Beirut, allowing to reorganize and restructure Beirut suburbs.

The division of the city into two parts would have disappeared. Exchanges would have been re-established with all neighboring countries, creating intense goods and people flows.

Trips by Greater Beirut residents shall grow by more than twice during the next 20 years and reach an average value of 1.75 daily motorized trips per person in 2015. Combining all these trends, trip demand should reach nearly 5 million daily motorized person trips in Greater Beirut by 2015, that is more than 3 times the present value.

Options for the Future

Facing the huge future needs, Greater Beirut possesses a number of characteristics liable to orient decisions regarding transport systems, notably the choice between road and mass transit.

- Beirut urban agglomeration is very dense in the city itself, as well as in its suburbs. Residential densities exceed 500 inhabitants/ha in some neighborhoods. This high density may present difficulties in searching for road alignments and liberating the necessary right-of-way, but it also satisfies a prerequisite for setting up a rapid mass transit system.
- Greater Beirut area owns an urban and natural heritage comparable to that of many large world cities. Mountains are at the door of the built up area. Network alignments would have to integrate this constraint and be respectful to the environment.

Two Contrasted Scenarios

In order to highlight possible network structure alternatives and assess their performance, two contrasted scenarios have been constructed, the first privileges road network development, the second integrates the construction of a rapid mass transit system in dense areas.

These scenarios have been tested and operation simulations have been carried out, highlighting peak hour traffic on road network, load on mass transit lines, and average access time by each to the poles of the Metropolitan Region. Construction cost of proposed networks has been estimated. An optimal scenario has been defined, based on both technical and financial considerations, in a manner which allows to maximize the respective advantages of the two tested scenarios.

Mass Transit, a Necessity of the Future

Computer simulations demonstrate that, in the absence of a modern mass transit system, meeting future needs will remain an illusion. Devoted to serve the dense areas of the Metropolitan Region, in the first place, a rapid mass transit network is necessary to solve future trip problems of Greater Beirut Area.

LONG TERM MASS TRANSIT NETWORK

Targets

The long term mass transit network should provide all inhabitants of the dense agglomeration with a mass transit line on its own right-of-way less than 1 Km from home. It will thus supply an attractive alternative to the automobile, and public transport will ensure an easy access to the large development poles of this area (BCD, Airport). The proposed network should enable mass transit (taxi services excluded) to capture about 26% of total daily motorized trip market.

Components

The long term mass transit network include:

- A regional commuter service line that will use the rehabilitated railway line Saida-Beirut Tripoli, from Damour to Jounieh (38 Km).
- Two modern metro lines ensuring the basic backbone of mass transit, servicing the interior of the dense Beirut urban agglomeration.
  - an East-West line (MA) linking Ras Beirut to NBT station, via Hamra and BCD, and extended to the South (Hazmieh) and to the East (Nahr El Mott). It will be 17 Km long.
  - a North-South line (MB) from the Lebanese University and Airport to St. Michel Terminal (15KM), via south suburbs and BCD.
- Three bus lines on their own right-of-way ensuring the secondary servicing of the urban agglomeration and totaling 28 Km.
- A complementary bus network.
- Multimodal exchange stations located along the boundaries of the urban agglomeration, close to the Beirut Peripherique Boulevard (Nahr El Mott, Laylake).

With all its components fully integrated with each other and the street network, future mass transit network would allow to carry nearly 500 million passengers per year, with line loads compatible with the selected technologies (15.000 passengers per direction at peak hour on metro lines for instance). Mass transit investment cost has been estimated at US$ 2.5 billion, with US$ 1.7 billion of which for the two metro lines.

Implementing such a network over a 20-year period, will necessitate both an institutional reorganization (strengthening of the Metropolitan Transport Authority proposed in the Immediate Action Plan) and resort to new financing sources. The private sector could notably be invited to participate in the building and operation of the metropolitan network, as practiced in many large world metropolises.

LONG TERM ROAD NETWORK

Targets

Complementary to mass transit, the long-term road network has three main targets:

- ensure the connection between Greater Beirut and its national and international surroundings
- open up and improve the Beirut suburbs
- serve the large development poles of Greater Beirut Area (BCD, Airport, Port...)

Components

The long term road network is a hierarchical and meshed network composed of motorway, expressways and urban boulevards. It is organized around a major axis : Beirut Peripherique Boulevard (BPB). The basic future road network is 248 Km long. It includes:

- Boulevard Peripherique, located along the limits of the urban agglomeration, extending from Khalde to Antelias (18 Km)
- Five long distance motorways linking Beirut to the rest of the country : two to the North (A1,A2), one to the east (Damascus Motorway), two to the South, existing coastal motorway (A3) and a new mountain highway linking Choueiffate to Damour.
- Seven urban penetrators ensuring the primary linking of the urban agglomeration with BPB
- A network of expressways (23 Km) and urban boulevards (122 Km) ensuring the secondary servicing of Greater Beirut area.

Half of the proposed road network is composed of already existing roads or an upgrade of existing ones, while the other half includes entirely new roads whose right-of-way was previously reserved in most other cases.

The investment cost of the long-term road network has been evaluated at US$ 4 billion, 75% of which will be devoted to motorways. Land expropriation will be quite costly: it will represent more than half of the total cost of the program.

The Parking Master Plan

The current parking conditions in most parts of GBA, and especially in Municipal Beirut, are over congested. This over congestion of parking is the main reason for traffic problems, and has downgraded the quality of urban life. The current parking space deficit is estimated at 60,000.

The causes of this serious problem were diagnosed to include:

- Deficient urban panning and building code regulations.
- Absence of mass transit and heavy reliance on the automobile.

- Low cost of vehicle operation (including parking) perceived by users.
- Deficient enforcement

Various scenarios for dealing with the parking problem were considered, simulating various levels of tolerance to congestion and ability to pay for additional parking. The proposed master plan has a first short term target to reduce the level of parking congestion and a second longer term target of bringing the parking to a normal condition by the horizon of the study. To achieve these targets, the parking master plan proposes four types of intervention:

- Organizing on-street parking, timing the use and making it for-a-fee in business areas
- Building dedicated parking structures at specified locations
- Encouraging providing public parking as part of new buildings
- Applying stricter parking requirements for all buildings and especially for commercial and office uses.

The parking Master Plan is a long term coordinated effort with well- defined roles for the state and the private sector. The enabling role of government is essential and when properly exercised will turn over the financing and cost recovery responsibilities entirely to the private sector

LIST OF APPENDICES

Appendix

APPENDIX 1

METEOROLOGICAL PARAMETERS

American University of Beirut Weather Station, 1996

Table A1.1. Average monthly wind speeds

Month	Minimum Wind Speed m/s	Wind direction	Maximum Wind Speed m/s	Wind direction	Average Wind Speed m/s
January	0.2	151.3	18.7	278.9	5.16
February	0.5	172.5	15.6	41.9	5.19
March	0.1	139.1	17.2	125.5	4.29
April	0.5	210.6	16	30	4.46
May	0.6	265.2	11.2	232.6	4.35
June	0.1	150.4	13.2	97.4	4.35
July	0.2	185.6	10.4	238.7	4.31
August	0.2	203.2	8.6	238.2	4.11
September	0.1	105.2	10.5	29.4	4.15
October	0.2	90.2	22	51.9	4.16
November	0.2	108.8	15	282.9	3.45
December	0.5	173.3	11.6	267.6	3.66

Table A1.2. Average monthly rainfall

Month	Average Rainfall (cm)
January	377.5
February	171.5
March	240
April	194.2
May	32
June	4
July	3.05
August	2.1
September	4.5
October	170.5
November	28.8
December	160

Table A1.3. Average monthly temperatures

Month	Minimum Temperature (°C)	Maximum Temperature (°C)	Average Temperature (°C)
January	4.1	17.7	12.3
February	4.3	21.3	11.4
March	7.6	27.2	14.7
April	13.4	33.5	18.2
May	16.2	28.6	20.6
June	19.4	29.3	24.3
July	22.3	30.8	26.6
August	23.9	31.5	28.0
September	20.4	33.5	26.8
October	17.3	29.5	24.5
November	9.3	30.8	20.2
December	6.2	19.1	16.8
Yearly Average	**13.7**	**27.7**	**20.4**

Table A1.4. Average monthly humidity

Month	Humidity (%)
January	74.6
February	71.3
March	69.1
April	65.1
May	56.9
June	53.0
July	60.4
August	62.6
September	65.7
October	71.5
November	69.7
December	74.9
Yearly Average	**66.2**

APPENDIX 2

ARCHEOLOGICAL ASSESSMENT

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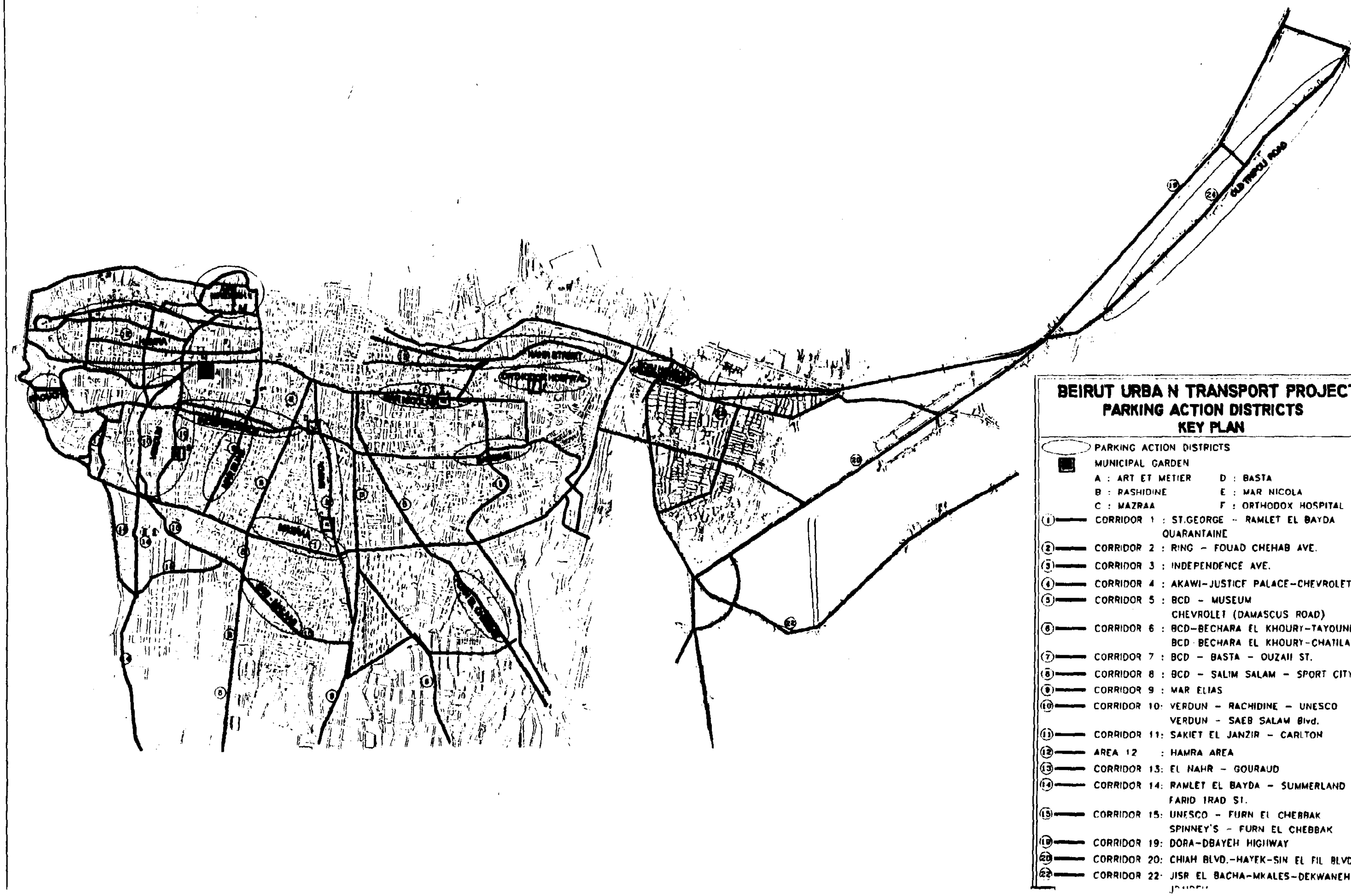
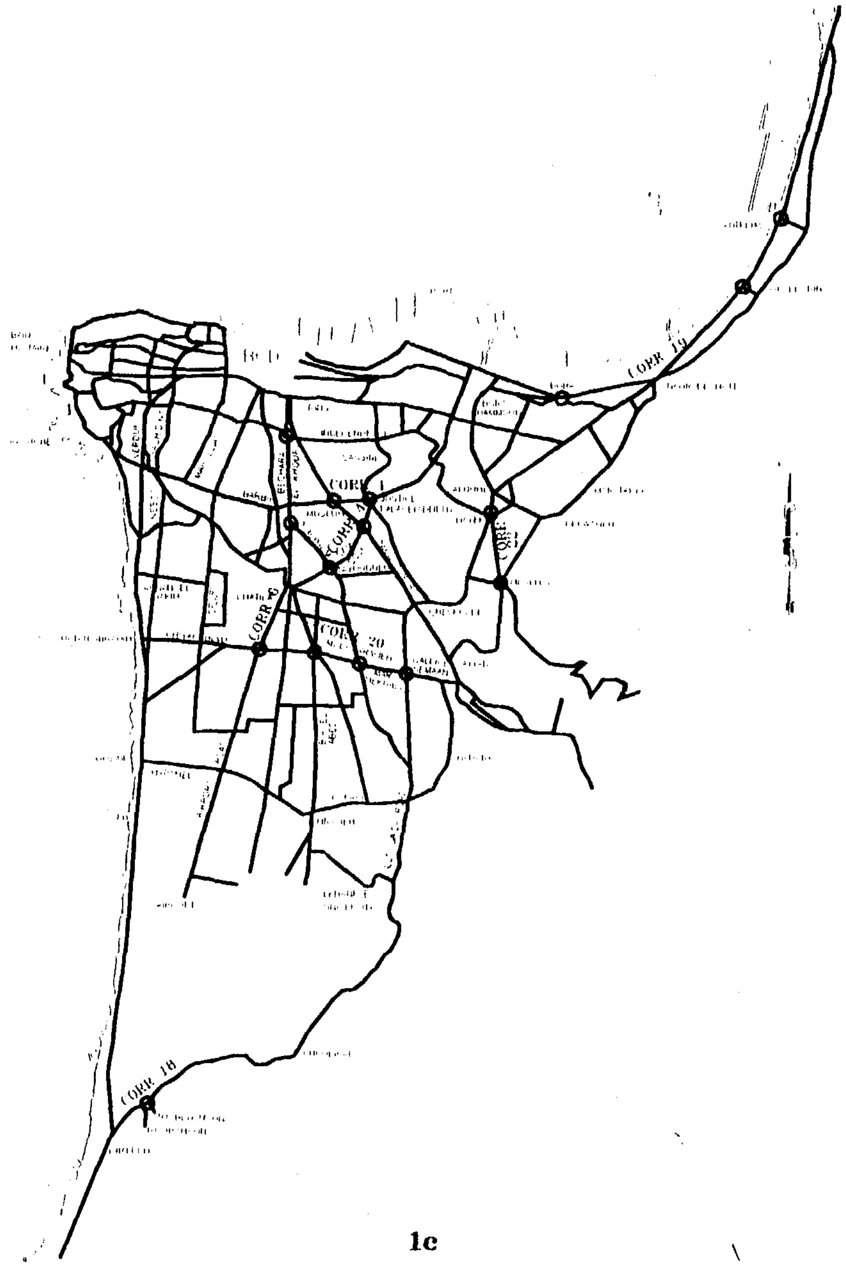
1. INTRODUCTION

This document is an Archaeological Assessment commissioned by Team International engineering and management consultants. After giving some preliminary background to the report and the methods used in its compilation, it addresses all the sites proposed for ground works in the Beirut area (Figures 1-1, 1-2) while outlining their known historical development. It also specifies the types of archaeological material that may be found on each site and suggests the most prudent mitigation strategy. The report gives some wider background history for several wider areas that may be affected by the proposed development and assesses the likely level of preservation of archaeological remains in these areas as well as likely nature, date and relative significance. The concluding sections deal with visible archaeological trends present in the data and also the recommended mitigation strategies along with possible options of work for each site. Two appendices are also attached of the individual site reports, their references, and figures which characterise and outline the archaeological significance of each area based on the survey. The archaeological component of this study is dictated by what is currently taken as best practice according to *Management of Archaeological Projects* (English Heritage 1991) and must be seen as the preliminary, (Desktop based) research prior to any potentially archaeologically damaging interventions. The background research was conducted by a team of five experienced professional archaeologists, Ms. Joanna Abdallah M.A. (American University of Beirut/Archaeological Collaboration for Research and Excavation AUB/ACRE) Ms. Amelie Beyhum M.A. (AUB/ACRE), Ms. Nadine Boksmati, (AUB Post Graduate Student and employee of the Directorate General of Antiquities for Lebanon (DGA)) Ms. Rana Mikati (AUB/ACRE and undergraduate student with extensive excavation and surveying experience) and Ms. Rima Mikati M.A. (AUB/ACRE). These project team members prepared the reports contained within Appendix 1 and were managed by the project manager and principal author Mr. Reuben Thorpe B.A. (Hons) Sheffield. Except for Ms. Boksmati, all the project team members are employed on the AUB/ACRE post excavation project of sites BEY 006, 007 and 045 which is also managed by the principal author. All the project team members have in excess of four years archaeological experience on sites of an urban character, and/or experience with managing and executing studies of material culture. The project manager has 15 years experience of contractor and curatorial archaeology, is a former field archaeologist for the Central Archaeology Service of English Heritage and is a freelance consultant for them.


OLD TRIPOLI ROAD
BEIRUT URBA N TRANSPORT PROJECT
PARKING ACTION DISTRICTS
KEY PLAN
PARKING ACTION DISTRICTS
MUNICIPAL GARDEN
A : ART ET METIER
B : RASHIDINE
C : MAZRAA
D : BASTA
E : MAR NICOLA
F : ORTHODOX HOSPITAL
CORRIDOR 1 : ST.GEORGE - RAMLET EL BAYDA QUARANTAINE
CORRIDOR 2 : RING - FOUAD CHEHAB AVE.
CORRIDOR 3 : INDEPENDENCE AVE.
CORRIDOR 4 : AKAWI-JUSTICF PALACE-CHEVROLET
CORRIDOR 5 : BCD - MUSEUM CHEVROLET (DAMASCUS ROAD)
CORRIDOR 6 : BCD-BECHARA EL KHOURY-TAYOUNE BCD BECHARA EL KHOURY-CHATILA
CORRIDOR 7 : BCD - BASTA - OUZAII ST.
CORRIDOR 8 : BCD - SALIM SALAM - SPORT CITY
CORRIDOR 9 : MAR ELIAS
CORRIDOR 10: VERDUN - RACHIDINE - UNESCO VERDUN - SAEB SALAM Blvd.
CORRIDOR 11: SAKIET EL JANZIR - CARLTON
AREA 12 : HAMRA AREA
CORRIDOR 13: EL NAHR - GOURAUD
CORRIDOR 14: RAMLET EL BAYDA - SUMMERLAND FARID IRAD ST.
CORRIDOR 15: UNESCO - FURN EL CHEBBAK SPINNEY'S - FURN EL CHEBBAK
CORRIDOR 19: DORA-DBAYEH HIGHWAY
CORRIDOR 20: CHIAH BLVD.-HAYEK-SIN EL FIL BLVD.
CORRIDOR 22: JISR EL BACHA-MKALES-DEKWANEH



Notes :

FIGURE 1-2

LOCATION OF JUNCTIONS CANDIDATE FOR GRADE SEPARATION

2. BACKGROUND

This archaeological assessment was commissioned by Team International engineering and management consultants on behalf of the C.D.R (Council for Development and Reconstruction) Republic of Lebanon. It is intended to form part of an integrated Environmental Assessment (E.A) as part of the project feasibility study of the Beirut Urban Transport project and as a pre-requisite of World Bank funding.

The assessment covers Greater Beirut (outside the B.C.D-Beirut Central District) it encompasses 17 general areas, 16 areas of proposed traffic improvement necessitating ground works of some kind and the proposed locations of 5 underground car parks shown in Figures 1-1, 1-2 and in Table 2-1 below.

This report will deal with outlining the historical and archaeological evidence from each of these general areas first, and then proceed to deal with the individual sites from east to west of the study area.

Table 2-1: Area Descriptions, Areas and Sites Covered in this Study

AREA DESCRIPTION	AREA
General areas (Parking Action Districts. Figure 1-1)	THE EASTERN APPROACHES TO BEIRUT (Section 3.1. below) Old Tripoli Road; Borj Hammoud; Nahr Street; Mar Nicholas; Orthodox Hospital; Sassine. THE SOUTHERN APPROACHES TO BEIRUT (Section 3.2. below) Mazraa; Basta; Furn El Chebbak; Bau Malaab. THE WESTERN AND SOUTHWESTERN APPROACHES TO BEIRUT (Section 3.3. below) Ain Mreiseh; Hamra; Verdun; Raouche; Mar Elias; Independence; Corniche.
Traffic Improvement Requiring Ground work (Grade Separation Locations. Figure 1-2)	Antélias; Jal El-Dib; Dora; Saloume; Mkalles; Sodeco; Omar Beyhum; Tayouneh; Galerie Semaan; Mar Mekhael; Haret Hreik; Chiyah Boulevard; Khaldehh; National Museum; Palace of Justice; Damascus road-Justice Palace to Chatila junction.
Underground Parking	Orthodox Hospital; Mar Nicholas; Verdun; Basta; Hamra area.

2.1 Objectives

The objectives of this study are four fold.

- To collate, examine and interpret all the relevant literature relevant to the sites in the study areas.
- To mute the likely presence or absence of archaeological and historic material within the separate study areas.
- To suggest the likely periods of the archaeological deposits that may be present on the sites.
- To recommend the mitigation strategy most suited to the conditions of each site.

2.2 Methods

Initially members of the American University of Beirut (after referred to as A.UB) project team conducted a literary search which encompassed sources from the Jafet Library in AUB and the Library at IFAPO (Institut Français de l'Archéologie du Proche Orient). Maps from the British Admiralty, articles referring to the archaeology of the study area in the local and national press and sources on the Internet were also consulted as were lecturers and archaeologists from the AUB and Directorate General of Antiquities of Lebanon. Following from this literature search a series of visits were made to the individual sites of proposed ground-works to try and assess the local topography, current settlement morphology, depth of soil cover, its likely nature, and the visual presence of historic remains in the area (presence of ceramics within any recent ground-works, old buildings etc).

The areas of proposed groundwork are not susceptible to more traditional methods of survey as they are in essence of an urban character or have been subject to urban site formation processes. This typically renders almost all sub-surface feature detection equipment. such as flux-gate gradiometers or resistively meters as useless due to the superimposed and intrinsically complex nature of urban archaeological deposits. The most successful remote sensing device known to the author for evaluating urban stratigraphy is Ground Scanning Radar, however these resources and the finances to employ them were unavailable at the time of the survey. Results from ground scanning radar are still the subject of contentious debate within the discipline. Topographic survey in such a setting where the urban landscape has been altered by the redeposition of material and also the re-working and truncation of material in this instance would have proven fruitless.

Finally an assessment report with figures was produced for each area (Appendix 1) which was then checked and edited by the main author. A summary of the main points of each report is presented in section 4 below. This report is the fruition of this study, while it synthesises the results of the area studies it also collates this data attempts to draw out trends in the archaeological data present and suggests the appropriate strategies to be employed. The study has examined and collated sources referring to the archaeology of the Palaeolithic (10,000 BP before present) to the end of the Ottoman Empire (1918).

3. AREA REPORTS

3.1 The Eastern Approaches To Beirut

The coastal strip between the sea and the mountains governing the eastern approaches to Beirut, witnesses several periods of archaeological activity. The earliest known occupation is demonstrated by the discovery of Palaeolithic remains in the vicinity of Antélias in the cave of Ksra Akil which date to 13,000 years before present (B.P.). Palaeolithic rock shelters and caves have also been found in this area (Magharet Wara' and Magharet Al-Ballaneh) as well as Early Stone Age remains on the banks of the Nahr Beirut (Moufarrej 1969: 19-20; 39).

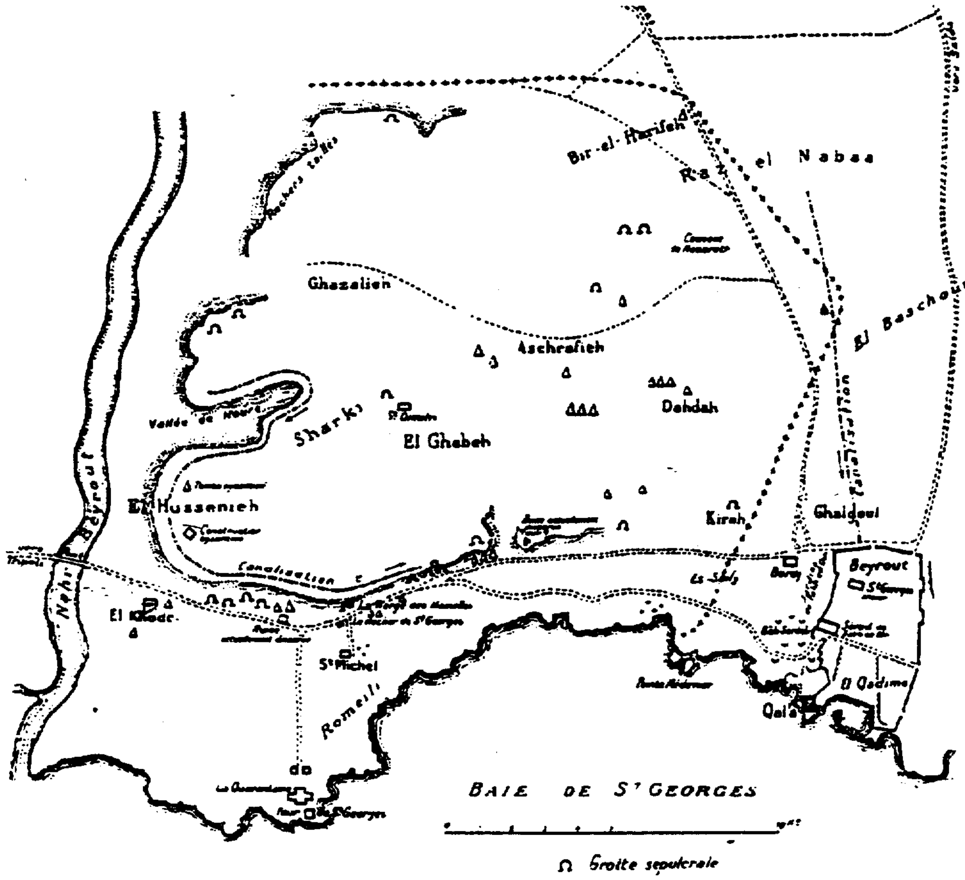
Later archaeological activity is not confined solely to this area but also encompasses the eastern hill of Beirut, Achrafieh. Despite the evidence of Palaeolithic activity Beirut has certainly been a seaport and settlement for at least 4000 years. Archaeologists know from recent excavations, that the Phoenician city lay in part near the former Byblos building in Downtown Beirut, and that the portion exposed for preservation retains a city gate in its fabric.

Evidence of the line of the Roman road into Beirut is more easily accessed. The Roman road between Antioch and Acre which passed through Beirut was built in 56 AD by Caius Ummidius Durmis a legate of the Emperor Nero. This road was subsequently repaired by different Emperors up to the reign of Constantine I. Improvements to the road at Nahr El-Kolb were also made during the reign of Caracalla (Goodchild 1949: 112-113; 115; 127). A milestone dating to the reign of Caracalla has been found at Nahr El-Kolb. Traces of a Roman road were also found near the Railway station along the eastern edge of this area early in the century (Goodchild 1949: 108). A milestone (N° 228) found near the Tram Depot possibly demonstrates the eastern approach to the city after crossing the Beirut River on a seven-arched Roman bridge (Goodchild 1949: 100, Maundrell 1697, reprinted 1963: 50).

Traditionally the necropolis (city of the dead) of Roman cities were aligned along their major approach roads, it is almost certain that this was also the case with Roman and Byzantine Beirut. The Achrafieh hill is known to be the site of a Roman necropolis and several sarcophagi have been found on the northern, eastern and western facing slopes Figure 3-1 and in the region of Mar-Nicolas and Nahr Street. In addition a Romano-Byzantine burial complex with associated grave goods was found on Sursock Street during ground-works in the gardens of the Sursock Museum (Jidejian 1993: 90). Roman sarcophagi have also been found on the western side of this hill near the Nazareth convent (Mouterde 1929: 241).

There is limited evidence that occupation continued or grew up in the area after the fall of Beirut in 650 A.D. The Maronites built a fortress (now below a monastery) Figure 3-2 in Antélias after settling in the 7th C A.D. (Moufarrej 1969: 19-21). A tower (Born) was built in the area of Borj Hammoud by the Banu Hammoud from Morocco while in Lebanon fighting the Crusaders. A later Borj was also built next to the residence of Moussa Sursock, known as Borj Karkouti. This tower was demolished in 1953 to make way for the Italian Embassy. (Al-Nimr 1994: 104).

Figure 3-1: Plan of Beirut by Robert du Mesnil du Buisson. Triangle marks sarcophagi findspot. Omega marks Sepulchral caves

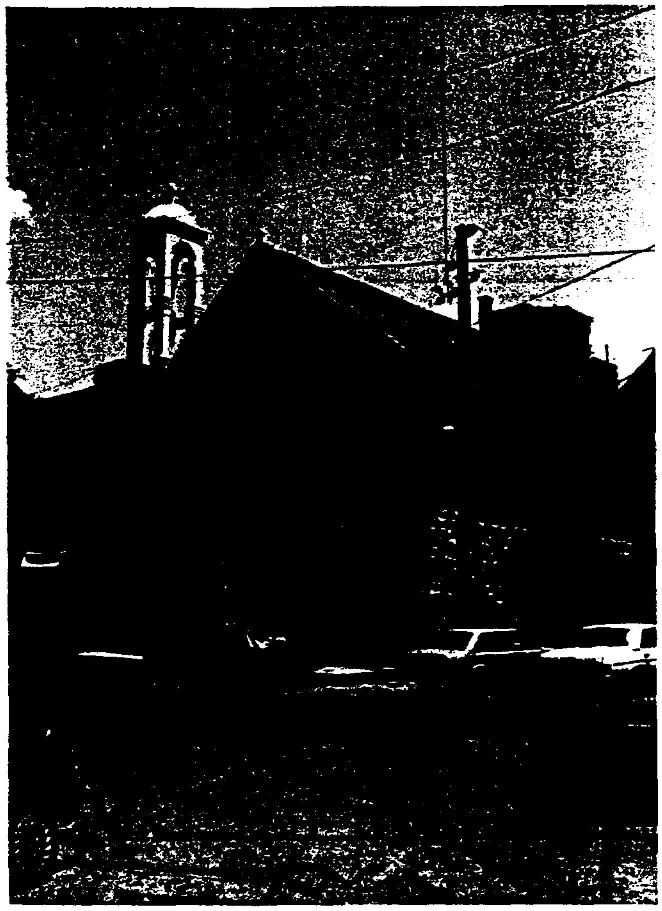


3.1.1 Summary of Periods Represented

The eastern approaches to Beirut are geographically prime sites for historical and archaeological deposits and remains to have occurred. The antiquity of the coastal approach to Beirut from the east along the coastal plain west of the Dog River cannot be doubted and it is known to have been a road since 56 A.D. It is unlikely that this road was an independent creation and it likely that the road followed the one taken by Alexander the Great in his conquest of the Levant. If this is the case then it is highly likely that the Old Tripoli road follows the line of all the previous north-eastern roads/track ways to and from Beirut.

Though little has been reported found in area of Phoenician or Hellenistic origin the absence of material could be due to a number of circumstances. The social, political and economic circumstances of Lebanon over the past 25 years have done little to ensure that chance finds of archaeological material are reported to the National Museum. The character of the archaeological deposits themselves may have made them difficult to recognise. Earth fast burials are notoriously difficult to spot when ground clearance is done with bulldozers, as are wooden structures, and all but the most solid of masonry buildings. Rather than being absent, pre-Roman and medieval archaeological deposits may be present in this area but have until now remained unobserved.

Figure 3-2: Antélias Church said to be built over a 7th Cent. Fortress



3.1.1.1 Prehistoric Period

The presence of Palaeolithic occupation on the coastal strip is wall attested and dates back to the earliest occupation of this area by Homo Sapien Sapien. It is unlikely that this occupation is isolated, there is therefore a possibility that deposits dating to the Palaeolithic and the Mesolithic (Mesolithic, Middle Stone Age as opposed to the Palaeolithic, Old Stone Age) are present along the coastal strip immediately to the east of Beirut.

3.1.1.2 Classical Period

Classical occupation in the area of the eastern approaches to Beirut can be characterised from the literary and cartographic sources alone into three types.

3.1.1.2.1 *Roadside 'ribbon' development.*

It was usual during the Roman period for 'ribbon' development to occur adjacent to Roman roads, artisan's workshops, emporia, Inns etc. Some low level residential occupation would often follow Roman roads outside the confines of the city walls as well as the growth of small towns based on providing service industries for the cities, these small towns often formed suburbs often leading to the organic growth of the town. (see Western Approaches to Beirut below). The full extent of Roman and Byzantine Beirut is still unknown and the location of the Roman Amphitheatre of Beirut has been muted to lay somewhere on its western approaches.

The location of a large Roman bridge in the vicinity of Borj Hammoud suggests that there would have been some occupation in its vicinity. The bridge would have acted as a nodal point. Any traveller, merchant or army wishing to approach Beirut from the northeast, or following the road to Acre would have to pass over this bridge, and it is especially likely that some form of ribbon development would have occurred at this location.

3.1.1.2.2 *Roadside Cemeteries*

The Romano-Byzantine proclivity for burying their dead along the sides of the cities major roads is well attested from the excavation of countless Roman cities e.g. Tyre. Roman funerary practice for the wealthy and the urban middle classes tended toward the monumental. Inhumation either complete or after partial cremation usually took place in stone sarcophagi buried in a tomb carved out of the natural rock. Usually a tombstone or Stele accompanied the burial, if not a monument of some kind. It is known from previous finds of sarcophagi that not only was there a roadside cemetery lining the old Roman road in the vicinity of Nahr Street, but that the north, east and west facing slopes of the Achrafieh hill were also used for burying Roman and Byzantine dead. Little is known of Hellenistic burial practice around Beirut, though it is also likely that there may be burials dating to the 1st – 3rd centuries B.C in the vicinity.

3.1.1.2.3 *Patterns of land-use*

It is certain that the eastern approaches to Beirut up to the Nahr Beirut were encompassed in the original Roman survey of the Hellenistic city prior to it being granted *colonia* status by Augustus. The course of one of the aqueducts into the city runs along the contour of the northern and western face of the Achrafieh hill. The field pattern shown on Figure 3-4 is strongly reminiscent of Roman centuriation, the division of land into large units (variations on the size of a city block) that could then be sub-divided into fields. This regular field patterning reflected on the Löytved map is probably an echo of Roman rather than later Islamic land division. In no way do these field patterns reflect those of Feudal Europe and an origin for them between the 11th and late 13th century A.D can probably be discounted. Given that this system of fields was probably established between the 1st cent. B.C and the 7th A.D, then it is of interest and importance to try and elucidate the history of land division and settlement/land use patterns prior to and after the delineation of these fields. In situ sub-soil and topsoil buried under later upcast may also provide crucial information as to the environmental regime of this part of Beirut at this time as well as economic evidence of plant and faunal life in the area.

However, though it may seem from the literary evidence alone that the Achrafieh hill saw little intense occupation in terms of habitation until the late 19th century when it become a fashionable area for the bourgeois of Beirut. (Davie 1996:63) (see Figure 3-4). It would be foolish to suppose that utilisation of this hill dated only to this time. Topographically the Achrafieh hill dominates the eastern approach to Beirut, and as a prominent place it would have provided a likely location for a temple and/or a fortification or signal station. It would therefore be unwise to assume that only the Romans first utilised the Achrafieh hill.

3.1.1.3 Post Roman Period

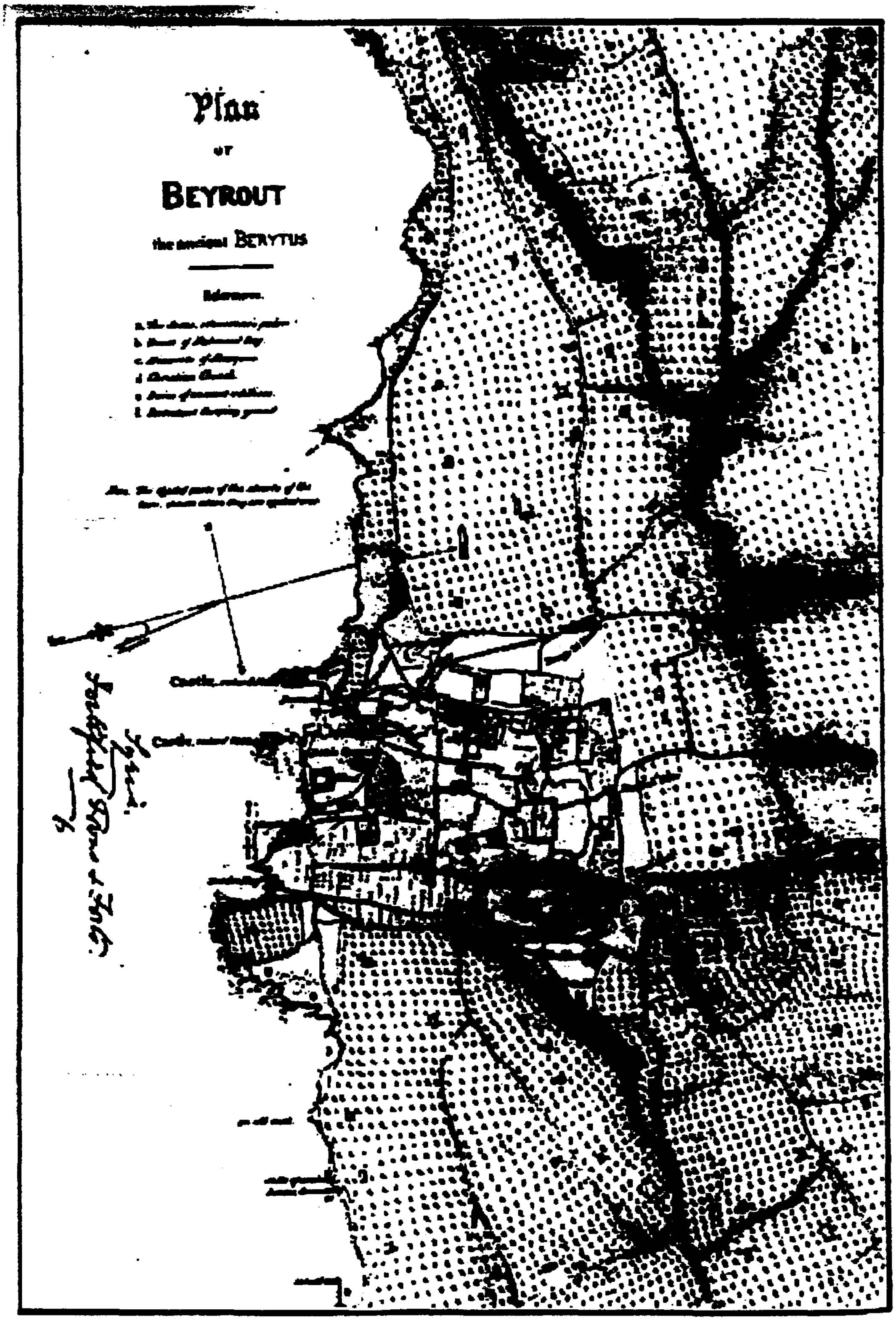
Evidence covering the period from the rise of Islam (650 A.D) to the fall of the Ottoman Empire in 1918 is not as obvious in the records from this area as is the evidence for the Romano-Byzantine period. However, the Löytved plan of 1876 clearly shows that the eastern road from Beirut crossed the Beirut River by the Roman bridge which was still standing into the 1920's (Figure 3-3). It therefore seems likely that the old Roman road continued in use as a carriageway and the main coast road until the 1930's, its use in the Post-Medieval period is mentioned by contemporary sources (Maundrell 1697; reprinted 1963: 50).

Mensil du Buisson (1924-25: 85, Figure 1) marks the find spots of several *'Grotte sepulcrale'* some of which may in fact date from the 7th cent. to the 13th cent. A.D. Beirut is known to have been a resting point for Pilgrims on their way to and from Jerusalem and given that the medieval Tripoli road followed that of the earlier Roman road, it is unsurprising to find small Christian cave Chapels along its side. The presence of defensive towers, or Burj's is also to be expected in this area for a number of reasons. The upkeep of the highways in Crusader society was not a matter of civic pride, nor were the Crusader Overlords ignorant of the revenue to be gained from charging a toll for the use of the roads. Militarily control of the coast road was crucial to the Crusader States. It is also possible that some of the medieval and late medieval towers were also to act as signal towers. It is known that a Burj stood on the east bank of the Nahr Beirut and the ruined circular foundations on the foreground of (Figure 3-3) may also be of a Burj. Mesnil du Buisson's map (1924-25) shows the Mosque of El Khodr on the west bank of the Nahr Beirut. This is known to be the site of a Crusader Chapel constructed before 1395 to commemorate the victory of St George over the serpent, and was also a place of pilgrimage for healing from fever by touching the marble column in front of the altar.

Interestingly the Löytved plan shows a large building within a ruined and possibly fortified enclosure wall on the south-western slope of the Achrafieh hill. The Tour du St-George and its associated buildings 'La Quarantaine' are also shown standing within a ruined enclosure wall to the north of the east Beirut road. The literary and cartographic evidence may seem to indicate that occupation was sparse in this area of Beirut up to the late 19th century, however it is not an empty landscape, and it would be rash to dismiss the presence of religious monuments, chapels and military towers as indicating sporadic post Roman occupation in this area. The medieval and Islamic periods of occupation in Beirut are extremely poorly represented and understood so far from the archaeological record, largely because they have been hitherto ignored.

Figure 3-3: Possible Ruined foundations of a Burj on the West Bank of the Nahr Beirut

Figure 3-4: Plan of Beirut by Julius Löytved (1876). Note field subdivisions in East and West



6. Beyrouth en 1841.

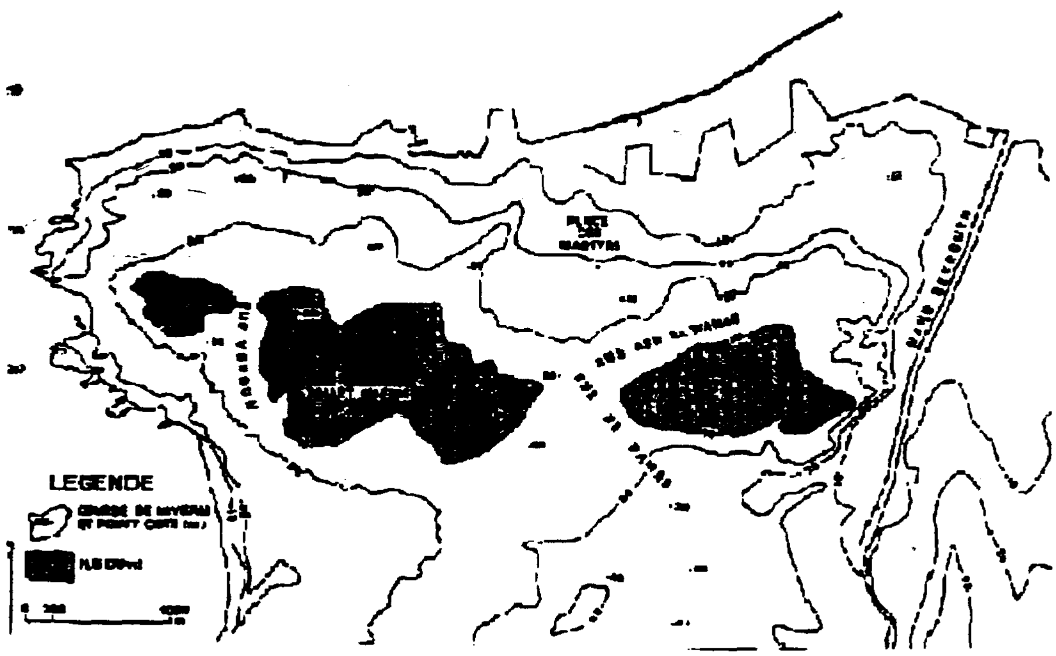
(Source : Public Record Office, Londres)

3.2 THE SOUTHERN APPROACHES TO BEIRUT

(Basta, Mazraa, Bau- Malaab, Furn El Chebbak)

Topographically the southern approaches to Beirut are dominated by the hills of Achrafieh to the east and Ras Beirut to the west. This effectively creates a corridor about 3km wide to the south of the city through which the roads from Sidon and Damascus had to approach (Davie 1989: 146) Figure 3-5. The southern approach corridor is comprised of fertile colluviums washed from the surrounding hillsides, which is well watered by several springs that then flow down toward the coast in Beirut.

Figure 3-5: Relief Map of the Southern Approaches to Beirut. Note the plain between Achrafieh and Ras Beirut hills



The earliest known occupation of the area dates to the Palaeolithic (Old stone Age). An open air campsite was identified in the area of Furn El Chebbak which yielded a modest assemblage of Lower and Middle Acheulean lithics, (Khalieh 1997: 293; Jidejian 1993: 21) however this site has since been built upon. Upper and Middle Palaeolithic assemblages are known from the area of Bir-Hassan and some Neolithic (New Stone Age, 10,000 B.P.–8,000 B.P.) material has also been found there (Copeland and Wescomb 1966). Archaeological deposits dating to the Palaeolithic have been found in the southern approaches to Beirut at Tell-Aux-Scies (East Saint Simon), Tell-Aux-Crochets, Haret Hreik and in the vicinity of the Galerie Semaan intersection. Neolithic material is present at Tell Arslan (now below Beirut International Airport) and in the vicinity of the Mar Mekhael intersection in the Hadath area. A series of Middle Bronze Age tombs were also discovered and partially excavated in 1964 a little to the east of Galerie Semaan (Saida 1964).

There is little evidence in the literary sources of Iron Age and Hellenistic deposits in the area, a surprising anomaly given the antiquity of the Beirut-Sidon and Beirut Damascus roads. However there is a plethora of literary and archaeological evidence relating to later classical occupation of this fertile corridor. Several maps pre-dating the British Ordnance Survey of 1840 clearly show fallen columns outside the later medieval walls, suggesting that the Roman city spread southwards as a series of suburbs along the Damascus and Sidon roads. Nasir-I-Khusrau, a Persian traveller journeying thorough Syria and Palestine in 1047 noted that the plain surrounding Beirut was covered with columns and capitals of marble and granite (Nasir-I-Khusrau reprinted in PPTS IV 1983: 9-11; Jidejian 1973: 3). These archaeological remnants were still visible at the close of the 17th century when Maundrell recounted that "..the south side. (of) the town-wall is still entire, but built out of the ruins of the Old City.......a little without this wall. we see many granite pillars, and remnants of mosaic floors, and in a heap of rubbish several pieces of polished marbles, fragments of statues, and other poor relics of this City's ancient magnificence." (Reprinted 1769; 38.). Chance finds of monumental Roman masonry have also been made along the course of the Beirut Sidon road in the vicinity of the modern Basta road (Lauffray 1944-45: 75). A large marble torso, possibly of a Roman Emperor was found in the Borj el-Barajneh area south of Haret Hreik in 1887 (Mouterde 1907: 337) and two milestones (along the Beirut - Sidon or Antioch-Ptolemais road) were also found in the vicinity. Milestone 233 bore four inscriptions ranging in date from the Emperor Vespasian to Constantine I while milestone 234 bore two inscriptions dating to Nero and Vespasian respectively.

There is some circumstantial evidence that a Roman theatre was located to the west of the Sidon road in the Mazraa area. Several terracotta 'actors masks' have been found in the locale (Jidejian 1973: plates 155–158) though Jidejian is particularly un-forthcoming about the circumstances of their discovery, their specific find location or possible artefactual association.

The Roman custom of burying their dead along the major roads outside the city has been described above. The discovery of sarcophagi on the western slopes of the Achrafieh hill may in fact be part of the Beirut –Damascus road necropolis. an observation which may have some support in the fact that sarcophagi and cave burials are somewhat poorly reported in the area of Furn El Chebbak. Roman burials have also been reported along the line of the Beirut–Sidon road. Local reports of skeletal remains associated with finds of Iron and Bronze objects. ceramics and 'seashell plates' are recounted by Khuri (1975: 21-22) as coming from Chiyah.

There is unequivocal archaeological evidence of suburban 'ribbon' development along the southern corridor to Beirut. Several Roman Villas have been excavated in Jnah dating between the 3rd and 6th centuries A.D. and Jidejian (1997: 95) claims that "important (Roman) suburbs developed between Jnah and Ouzaii." Archaeological excavation has also demonstrated the presence of Roman. Hellenistic and earlier domestic occupation at Khaldehh. While the people of Hadath reported an abundance of Roman finds during construction works in the village (Merhej 1971: 194).

It is not surprising given the comparative wealth of archaeological evidence from the area that later periods should also be relatively well represented in the literary and cartographic sources. Though there is little evidence relating to the early Islamic and medieval periods for this part of the study area there is better evidence concerning the area after the Crusades and into the Ottoman period. It would appear that much of the fertile southern corridor was given over to Mulberry plantation following the revival of the Beirut silk industry. The Löytved plan still depicts. in 1876, large tracts of land to the east of the Damascus road lined with mulberry plantations as well as the Sidon road up to the southern Pine forest.

As many as 19 Khans are located on the Damascus road in the southern hinterland of Beirut. Unfortunately the maps showing their location are somewhat inaccurate and unreliable (Chevalier 1972: 6). However two Khans are evident in the vicinity of Beirut's present day race course as well as the Khan Berajou on the northern fringe of Furn El Chebbak. Another Khan was situated on the Hazmiyeh hill while another is located to the south of a Borj, on the summit of a hill (possibly Borj Abi-Haidar) in the Nouairi sector. A large building resembling a Khan with a central court is also located in Furn El Chebbak, and is named as 'tahwhetah' (Davie 1984; 56). The location of this building corresponds with Tahouita which signifies an enclosure and is actually a sector in Furn El Chebbak. Though still extant in the late 19th century it is possible that in some cases these Khans had antecedents dating to the Mamluk or earlier periods, as is the case in some instances within Beirut itself (Thorpe in press). The frequency of Khans along the Damascus road serves as a contrast to those on the Sidon road located on Beirut's southern corridor. The cartographic sources show a single Khan at what is the present day crossroad of the Basta and Mazraa roads (Davie 1984: 69-70) while a Khan is also shown at Bir-Hassan (Ibid 56, 68). The fact that Borj-el-Barajneh was occupied during the early Ottoman period is attested by the contemporary historian Saleh Bin Yahya who chronicles a rebellion in the village against Fakhr-Eddine in the 16th century. Similarly Ouzaii is known to have existed as a village during the Umayyad period (600-750 A.D) when it was known as Hantouss. The burial there of the Imam Abdul-Rahman al-Ouzaii (707-773 A.D.) and the respect and reverence that he was accorded resulted in the subsequent change of the villages name. Medieval and later Islamic occupation is also known at Haret Hreik (Merhej 1971: 115).

3.2.1 Summary of Periods Represented

The southern approach corridor to Beirut is geographically and topographically a prime site for historic occupation. It was both fertile, and well watered and constituted the most easily navigable and traversed strip of land if travelling along the coastal plain of the Levant. It is unsurprising therefore that of all the areas covered in this study it is this area which appears to be most densely occupied throughout time as well as the best represented in the cartographic and literary sources.

3.2.1.1 Prehistoric Period

Given the concentration of Palaeolithic sites around Beirut (see 3.1.1.1 above and 3.3.1.1 below) it is no surprise that prehistoric activity is archaeologically most visible on the least marginal, most fertile and best watered land. It must be assumed that the encroachment of the sand to the southwest and to the west has served merely to hide further evidence of Beirut's Palaeolithic and Neolithic environs. It would be surprising if Mesolithic material were absent from this area, and this paucity may reflect problems in site identification as well as archaeological clarity and research/sample biases. The concentration of Palaeolithic sites in this area makes, and the potential they pose for understanding economic practices, seasonal landscape utilisation and possibly social organisation through patterned discard is of regional, national and international importance.

Use of this constrained landscape during later prehistory is less evident however. The location of Neolithic material at Tell Arslan and near the Mar Mekhael intersection in the Hadath area is tantalising though there is too little evidence to begin to try and establish models of pre-urbanisation landuse. It is a matter of some speculation as to whether Beirut did in fact have a Neolithic precursor. Investigation and recognition of possibly associated settlements within such a relatively small landscape and the establishment of a chronology of occupation between sites should be a wider research aim when examining the environs of Beirut.

The relative absence of Bronze Age material is somewhat suspicious and leads the author to wonder if the Bronze Age sites are either absent, already developed, buried under the sand dunes or have not yet been recognised. It is very possible that the establishment of the city state of Beirut may have resulted in a certain contraction of the population in Beirut's hinterland as people began to live in the urban centre. However the presence of Bronze Age funerary deposits near to Galerie Semaan and the Damascus road is interesting and may illustrate the antiquity of that particular pathway. However, the fact that these tombs were only partially excavated means that their discovery is of use only in demonstrating the presence of Bronze Age activity in the landscape.

Almost no Phoenician (Iron Age) archaeological deposits are represented in the literary sources addressing Beirut's southern approaches. Phoenician burials have been excavated at Khaldeh. however excepting these. the landscape seems devoid of Phoenician occupation to the south outside Beirut. Again this may be due to archaeological intelligibility the state of preservation or the fact that Phoenician deposits may lie under the sand to the west and southwest of the area awaiting discovery.

3.2.1.2 Classical Period

Archaeological deposits relating to the Hellenistic period are curiously absent from the literary sources concerning this part of Beirut's hinterland, though they are present at Khaldeh, this may be a reflection however of the limited number of excavations that took place in this area both before and since the civil war.

Roman occupation of the area on the other hand is well attested over most of the area and takes several forms.

3.2.1.2.1 *Extra Mural Settlement*

Excavations of Roman villas at Ouzi'i. Jnah. Khan Khaldeh and chance finds made in Hadath may also demonstrate the existence of extramural settlements outside Beirut. It is possible that the antecedents of Borj-al-Barajneh lie in the Roman period. The Roman road to Sidon passes through it and the origins of the place name may lie in the Roman Burgarii which means 'quartered in the Burgi' or tower (Chevallier 1976: 189). The successive inundation of sand to the west and south west may have effectively sealed parts of any Roman 'ribbon' development, satellite or extra-mural settlement. This would indeed seem likely given the accounts of medieval and 17th century travellers who described the fallen remains outside the city walls. When one bears in mind that the depth of sand in some areas can be in excess of 9m and then takes into account the speed with which beach rock can form it is more than likely that relatively recent (2000 B.P. as opposed to 20.000 B.P.) anthropogenic material could be sealed by geological formation processes. that to all intents and purposes looks like natural bedrock.

3.2.1.2.2 *Roadside Cemeteries*

The fact that the Basta road (where it extends south to the Pine forest and then joins corridor 6) Figure 1-1. follows the line of the earlier Roman road makes it almost certain that at some point not far from Beirut there will be a necropolis present. This is also true of the Damascus road.

3.2.1.2.3 *Public/Monumental Buildings*

There is the possibility that archaeological deposits relating to a Roman Theatre survive beneath the sand in Mazraa. Though citing the discovery of ceramic 'actors masks' without reference to how they were procured and what their associations were makes Jidejians association between artefact and context far from empirically justifiable. However. its location in the southeast lea of the Ras Beirut hill. and its position outside the main city on two main access roads. does make Mazraa a credible candidate for the location of the Roman theatre of Berytus.

3.2.1.3 Post Roman Period

The depopulation of Beirut after 650 A.D. (a process which had begun after the earthquake of 551) would appear to have affected Beirut's hinterland, which seems to have been either abandoned (hence the further inundation of sand to the west and southwest of the area) or turned over to mulberry plantation. The presence of the Khans attested on the Damascus road from 19th century cartographic sources seems to imply that some sort of service industry associated in a way with ribbon development continued. The relatively fewer number of Khans on this part of the Sidon road is somewhat bewildering, their absence from the cartographic record may mean only that the early pre 1840 maps were inaccurate and not really representational in their depiction.

It is difficult to elucidate the settlement pattern of the area from the literary sources alone, and the origin of place names has proven unreliable as an indicator of the date of settlement inception. The area is known however, to have been turned over largely to mulberry plantation by the end of the 16th Cent. and only became urbanised in the latter half of the 20th century.

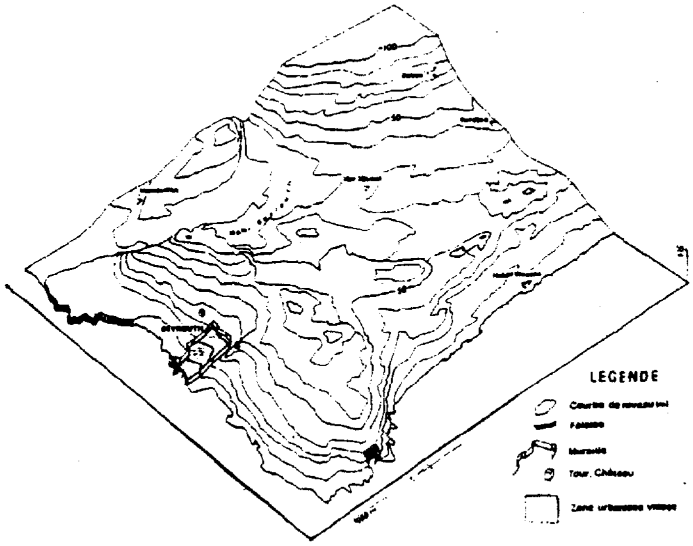
3.3 THE WESTERN AND SOUTH-WESTERN APPROACHES TO BEIRUT

The hill of Ras Beirut forms the western edge of the ancient corridor (Davie 1987) to Beirut from the south. The summit of this hill is some 35m lower than that of Achrafieh standing at 65m O.D. Figure 3-5. Ras Beirut was originally an island separate from the Beirut peninsula and it was not until the middle Palaeolithic that this part of Beirut became joined to the mainland (Cheikho 1993: 18). The accumulation of windblown sand from the south-west and its subsequent formation into 'beach rock' created a land bridge with the mainland between 120,000 B.C and 40,000 B.C. However, the rocky promontories of the island had been covered in sand dunes dating to the early Palaeolithic (1 million years B.C –120,000 B.C.) (Jidejian 1993: 21).

Ras Beirut is known for its prehistoric finds and no fewer than twelve sites have so far been identified occurring on a series of marine terraces which are now on dry land. The earliest known occupation comes from four sites in Ras Beirut (one of which is just east of the 'Shell Building') and corresponds with the 45m O.D. marine terrace. These sites in the Raouche area contained stratified lower Palaeolithic industries, or evidence of flint tool manufacture. The 35m marine terrace which extends to the Ras Beirut coast and is particularly evident in the Manara and Pigeon Rock area has produced the earliest known Mousterian (flint tools made of flakes struck from a core and later re-sharpened or re-touched) assemblage from the Near East. (Saidah 1970: 4-6). These assemblages are usually considered the work of Neanderthal man dating to 120,000 – 40,000 B.C. A Palaeolithic rock shelter of unknown date has also been found within the grounds of the American University of Beirut.

Chalcolithic or copper age (7,000 B.C. – 3000 B.C.) occupation is also known from west Beirut. The site, Minet ed-Dalieh is on the second headland south of Pigeon Rocks, and is on the 15m marine terrace. So far this has proven to be the richest flint factory in Lebanon (Saidah 1970; 11-12). This site however was partially destroyed by British military installations during World War II.

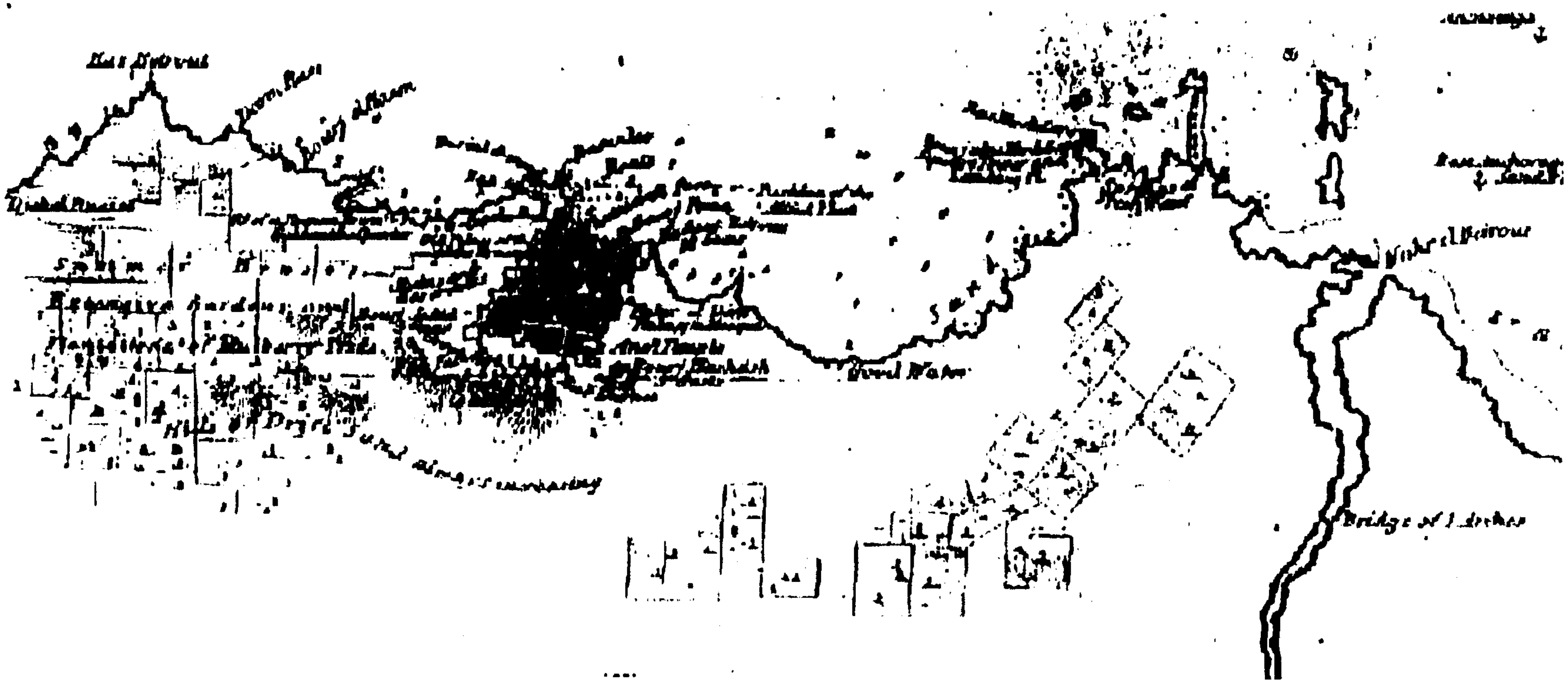
Figure 3-6: Relief Map of the Ras Beirut Hill from the Northwest. Arrow marks Minet ed-Dalieh



Bronze Age and Iron Age occupation in Ras Beirut is not supported by the literary or cartographic sources. This does not mean however that these periods are not present there. The chance discovery of the head of a basalt statue dating to the 1st millennium B.C near the A.U.B could hint at either domestic occupation or ritual activity in this part of the city. Certainly the topography of the area, its height and prominent position would seem to suggest that some form of Bronze Age and/or Iron Age archaeological deposits should be present. The fact that none have been discovered so far could be due to a series of factors ranging from archaeological visibility and clarity in the ground, to development pressure, and discoveries not being recognised for what they were. It is highly possible that there are sporadic burials along the north facing coastline from the BCD to Ain Mreiseh and beyond. A single burial dating to Rammeses IV was found in a well shaft near to the modern port (Thorpe et al 1998 in press, Thorpe and Seeden 1998 in press). Other rock cut burials have also been found in the vicinity of the Holiday Inn, though the western extent of these coastal burials is not known. it is possible that the Ras Beirut coast was used as a burial ground (among other things) during the Bronze and Iron ages.

The classical period seems to be better represented in the literature concerning west Beirut. Though the focus of ancient Beirut lay in the modern centre it is entirely possible that the suburbs of classical Beirut extended to the Ras Beirut hill and its south-eastern slopes. The medieval traveller Delarsiere noted in the diary of his travels that from Ras Beirut east to the Beirut River there were the remains of ruined buildings (El -. Nahar: 26/1/1994: 9-10). The Wyld map (Figure 3-7) identifies a small Roman town near to Minet El-Hosn.

Figure 3-7: The Wyld Map



From La marine anglaise- Beyrouth et ses environs en 1840 (publ. par James Wyld)

A Roman theatre is reputed to have been located in Mazraa (Jidejian 1993: 122) and Romano-Byzantine sarcophogai have been found facing Pigeon Rocks (Ibid: 94) and at the junction of Hamra and the inner ring road (Curvers 1997: 15-20). Late Roman villas have been excavated in Ouzaii and Jnah and it would seem very unlikely that the intervening area between these villas and the Ras Beirut hill was unoccupied in the Romano-Byzantine period. It is possible to speculate that Ras Beirut and its southern coast may have been the location of an external coastal suburb of Beirut west of the Sidon road. Davie's (1989: 163) speculation as to the age of Mar Elias may in part confirm the presence of a residential subburb between the coastal strip and the Road to Sidon. Mar Elias is reputed as a sacred place for the Christian faith, and may have been established on an earlier site of religious significance that was later converted to a church. The find spots of classical material from the Ras Beirut area would also seem to suggest that it was not without archaeological activity in this period.

The Löytved plan of 1876 clearly shows the extension of the field system seen on the Achrafieh hill (see *3.1.1.2.3.* above). Some ruined wall lines can also be seen in the Hamra, Corniche and Raouche areas as well as many road lines and field boundaries which seem to have been truncated or cut short by the sand dune area to the southwest (which now underlies Verdun and Mar Elias). It would seem reasonable to suggest that the further encroachment of the sand onto this part of Ras Beirut post-dates the establishment of these fields. It is also likely therefore that the encroachment of this sand may have inundated and covered the physical remains of classical buildings and structures, but may have also ensured good preservation of these archaeological levels. It is possible that the position of the western gates of the later medieval city and their road alignments may also reflect minor Roman roads into Berytus from the region of Ras Beirut along the coastal strip and along an axis approximating that of present day Hamra street.

During the later Islamic and Crusader periods the area of Ras Beirut seems to have been utilised for farming, gardens and Mulberry plantations. Though there is some evidence that the Ottomans built their castles on Ras Beirut hill (Weli 1993: 55) the cartographic evidence shows scattered buildings (farms) and outbuildings within a regular field system of wheat and Mulberry plantations. From 1621 the area of Mar Elias and Verdun was used by the Mamluks as a high status residential area, "Where palaces were erected" (Weli 1993: 156)

3.3.1 Summary of Periods Represented

Geographically it would seem that the western and south-western approaches to Beirut were extraneous to the development of Beirut as an urban centre. The fact that the Ras Beirut hill forms a promontory into the Mediterranean and is topographically isolated from the focus of classical and subsequent development may be taken as providing ample reason why relatively little archaeological material has been found in this area. However, further interpretation of the written and cartographic sources suggests that the hill of Ras Beirut was utilised sporadically and in different ways from the lower Palaeolithic to the Byzantine period.

3.3.1.1 Prehistoric Period

Palaeolithic occupation in the area is well attested. The presence of flint knapping sites on the coastal area dating from the lower to middle Palaeolithic suggests that this was an area where flint nodules could be both procured (from the exposed cliffs and on the beaches) and where they were subsequently worked. Walkers on the beaches of west Beirut still collect numerous flint tools possibly demonstrating this area as a flint source, and flint working occurring on several of the marine terraces.

The presence of a Chalcolithic flint processing site strongly suggests that this area continued to be exploited for its natural flint resources into later periods. The utilisation of this area would probably have been on a seasonal basis, though the area would possibly have been used by more than one tribe, clan, extended family grouping. This being the case, it is likely that Palaeolithic/Prehistoric activity could be fairly intense in the area and that ground interventions could disturb archaeological deposits.

3.3.1.2 Classical Period

The occupation of the western and south-western approaches to Beirut during the classical period can be characterised into three categories from the literary and cartographic sources.

3.3.1.2.1 Extra Mural Cemetery

Pervious archaeological finds have demonstrated that there were Romano-Byzantine sarcophagi on the north-western slopes of the Ras Beirut hill. However, Jidejian (1993) neither quotes her source, nor mentions how many had been found or whether they constituted a distinct and single archaeological group or a series of burials. In terms of Roman urban morphology it would not be unusual to find cemeteries so far outside the classical city in a commanding point. Indeed the presence of burials of Roman and Byzantine date may actually demonstrate that Classical Beirut and its suburbs is in fact larger than has been previously supposed. As with the Achrafieh hill, it is also possible that some form of temple or shrine may have stood on top of the hill.

The existence of an Hellenistic necropolis of shaft graves often with satellite burials (Curvers and Stewart 1995) on the coastal strip very near to the former north eastern city gate, suggests that a coastal road may have existed at one time in antiquity. The fact that a similar area slightly further to the east was used as an Islamic cemetery could also suggest that there is a certain continuity of use for the area to the west of the ancient and medieval city. However, given the dynamics of urban space and its utilisation it is totally possible that the use of the area as a cemetery in the Hellenistic and medieval periods is fortuitous rather than the product of a ritual tradition.

3.3.1.2.2 *Extra Mural Settlement / Villas and Farmstead*

It is plausible, given the morphology of the medieval city reflected in Löytveds' map, that there was a Roman precursor to the carriageways leading southwest and south-southwest from the southern gate. The road leading from the eastern gate certainly has a Romano-Byzantine precursor, which includes phases of metalling as well as stone paving. It is more debatable as to whether the most northern of the western gates followed an earlier Roman road. Though it is very possible that some form of road or track may have followed the coast to the west as far as Ras Beirut. Löytveds' map of 1876 shows this north-western road terminating at Pigeon rocks, though whether it overlie a Roman pre-cursor which reached outlying fields, a cemetery, religio/ritual buildings or a suburb is a matter of some speculation.

The other roads extending to the west from Beirut seem to radiate and cover different areas of the Ras Beirut hill. What is interesting to note is that they continue the general axiallity of the field and street pattern witnessed further to the east. This is illuminating for two possible reasons. This wide ranging field system seems to have been imposed upon the land at a single time and takes only scant regard (in its divisions) of local geological anomalies such as scarps and contours. Though it is entirely possible that Löytveds' map is inaccurate and purely representational in this respect, even if the map is accepted as a general representation of the type of land division on the ground, it must have been the product of deliberate and organised land surveying, quantification and division. As such this is good evidence of a certain amount of planning, organisation administration and ownership of the landscape. If as I am suggesting the land divisions represented on Löytveds' map are representational of land division established in an earlier period then it is highly likely that they are Roman in origin. The fact that the tracks and roads leaving Beirut to the west seem to respect this axiallity suggests that they are possibly contemporary with this land patterning and may also date initially to the Roman period. If this is the case then it is possible that these roads may have connected and served satellite settlements, villas, large farms, or other suburbs.

3.3.1.2.3 *Public Buildings / Religious Monuments*

The location of a Roman theatre is mooted by Jidejian to be in Mazraa, though she does not cite the source of her information topographically and morphologically this statement is plausible. The presence of funerary, religious, or public monuments cannot be discounted on Ras Beirut hill. The location of a sacred site possibly of ancient origin has been mooted (Davie 1989) in the Mar Elias, Verdun, Independence, region. Given the juxtaposition of Ras Beirut hill between the sea and ancient Berytus, the fact that it forms a protective southern promontory and that it is highly visible to approaching ships from the south, Ras Beirut hill would seem to provide the ideal situation for a temple monument or possibly a *pharos* or signal station.

3.3.1.3, Post Roman

The much vaunted decline of Beirut after 650 A.D is largely assumed from epigraphic sources, the fact that the post Roman city contracted does not necessarily mean a failure of urbanism but a restructuring of the economy of the cities hinterland. and a redefinition of town and country. It is likely that the late Roman / Umayyad transition constituted a variation on a theme, rather than a revolutionary change. It is likely that previously established land divisions and the ownership of property by the landed classes may in fact have continued for a time, as did the use of Greek as the official language of administration. However the literary and cartographic sources show the Ras Beirut area to have been covered with mulberry plantation and wheat. The Löytveld map shows the area around Ain Mreiseh to have had a large building in an enclosure with other ancillary buildings nearby (possibly a Hotel) and sparse coastal settlement up to the area of the AUB beach.

It is known that further south in the areas of Verdun, Mar Elias, and Independence, (Figure. 1-1) the Mamluks built wealthy residences or 'palaces' (Weli 1993: 156). While the Hamra area was settled in the fifteenth century when the Banou Hamra family settled there from El Biquaa. However, it was not until the foundation of the American University of Beirut in 1865 that the area began to witness more intense settlement and was prior to this, and indeed during most of the 19th Cent. an area of garden farming and dispersed farm houses. The beginnings of modern urbanisation and integration of this area as part of Greater Beirut did not come until after World War II (Khalaf 1971: 27, 28, 43).

4. SITE REPORTS

4.1 Introduction

The following individual reports address those sites that are proposed for some form of ground works, either in the form of ground grading and road improvement, the construction of a flyover or an underpass. The following reports constitute a synthesis of the original archive reports prepared by members of the Desktop Assessment project team which are reproduced in Appendix 1, while the bibliography for all of the reports is presented at the end of this full report

4.2 Antélias, Jal El-Dib and the Old Tripoli Road

The Old Tripoli Road lies between the Dog River to the northeast and the Beirut River to the southwest on the slight coastal strip between the mountains and the sea. It passes through Jal El-Dib, Antélias and Dbayeh before joining the modern Beirut – Tripoli road at the Dog River tunnels.

A survey of the literary and cartographic sources shows that the Old Tripoli road probably overlies the medieval and earlier road from Beirut to Tripoli. Given the local geography it is in fact highly likely that this coastal strip has been used to travel north and south since the formation of the Levant in its present geological form. Archaeological remains have been found in caves in the vicinity of Antélias dating to the upper Palaeolithic (10,000 B.C, 12,000 B.P) and other Palaeolithic remains have also been found in this area (Moufarrej 1969: 19-21). Unfortunately these discoveries have not been fully published and so further interpretation from the primary sources is problematic.

The Roman road from Antioch to Acre is reputed to have been built by Nero in 56 A.D. and was repaired on several occasions up to the rule of Constantine I (306-337) (Goodchild 1949: 115). Major improvement works were undertaken during the reign of Caracalla (198-217) in the area of the Nahr El-Kelb and it is from here that the only Roman milestone (N° 228) so far recovered from this region originates.

The Maronites are reputed to have settled in Antélias during the 7th Cent A.D. and to have built a Fortress for protection against the Umayyads, this fortress is now said to be beneath a monastery (Moufarrej 1969: 19-21). It appears from the literary and cartographic sources that the Metn area was characterised by sporadic settlements of unenclosed villages until the later half of the twentieth century.

4.2.1 Archaeological Interpretation

It is likely given the topography of the coastal strip to the east between the Dog River and the Nahr Beirut that this corridor has been used as a means of travelling up and down the coast since the Palaeolithic. It is also likely that the line of the Roman road followed a Hellenistic precursor which may itself have followed an older route possibly established in the Bronze Age. The construction of a six or seven arched bridge in the Borj Hammoud area in the Roman period provided easy access across the Beirut River and seems to have been utilised during the medieval period. It is known that this road line is of great antiquity as the inscriptions at the Dog River attest and probably witnessed ribbon development (roadside suburbs) during the Hellenistic, Roman, Islamic and medieval periods if not before. It is this road line that the Old Tripoli Road follows. It must therefore be assumed that any ground works that encounter undisturbed soil will impact on archaeological deposits and structures that may add to our knowledge of the longevity of this carriageway and the character of ribbon or roadside development.

4.2.2 Archaeological Implications

It is possible that fragments of the ancient road may survive along the line of the Old Tripoli road, it is also possible that there may be traces of ribbon development or satellite settlement associated with this road. An opportunity to establish the chronology of this road would be of archaeological significance and may actually enable us to suggest a date for the foundation of Beirut. Identifying any ribbon or satellite development along this road would also repay archaeological investigation and would go some way toward helping establish the relationship that Beirut had over time with its hinterland, and the land based trade connections between the cities further north (Byblos and Tripoli) and Beirut.

4.3 Borj Hammoud and Dora

The area of Borj Hammoud lies on the eastern bank of the Nahr Beirut astride the Beirut-Tripoli road Figure 4-1. The earliest archaeological finds from this area date to the Lower Palaeolithic and have been found on the banks of the Beirut River. Though the only structure of archaeological significance known to have existed in this area was the Roman bridge mentioned by Maundrell (1697 reprinted 1963) (Goodchild 1949: 100, 108). During the Crusader period the Banu Hammoud who came from Morocco to fight the Crusaders (El-Nimir 1994: 102) erected a tower in the area.

The cartographic sources that cover this area suggest that during the early 19th century the it was under mulberry plantation Figure 4-2. (Davie 1987) and only became incorporated into the urban fabric of Beirut after World War II.

4.3.1 Archaeological Interpretation

Though poorly represented in the literary sources, the area of Borj Hammoud seems to be one of archaeological potential. The outflow of the Nahr Beirut into the Mediterranean at this point created a marshy and fertile delta. The presence of Lower Palaeolithic material from this area could imply several things. The river bed may have been used as a resource for collecting water worn flint boulders as a raw material for producing flint tools. It may also have served as an area for hunting and fishing and as a source of water. It is likely that the fertile delta soils were sporadically cultivated from the Neolithic period and may have provided grazing for stock animals.

It is possible that the river was bridged or forded on or near this point prior to the construction of a bridge in the Roman period. Though it is unknown if this bridge replaced an earlier Phoenician or Hellenistic predecessor. The presence of the Roman road crossing the Beirut River here and the likelihood that this road followed the line of earlier roads implies that Borj Hammoud was a nodal point in antiquity. It would be surprising if there were no extraneous buildings associated with the bridge and the control of traffic it afforded. It is likely that some form of 'ribbon development also occurred outside the classical city along its major roads and the location of Borj Hammoud on fertile ground next to a river crossing would have made a prime site for such development.

Figure 4-1: Nahr Beirut as it is today. The deliberate coursing of the river will have helped preserve palaeo channels, sensitive bank deposits, and Palaeolithic deposits from erosion.

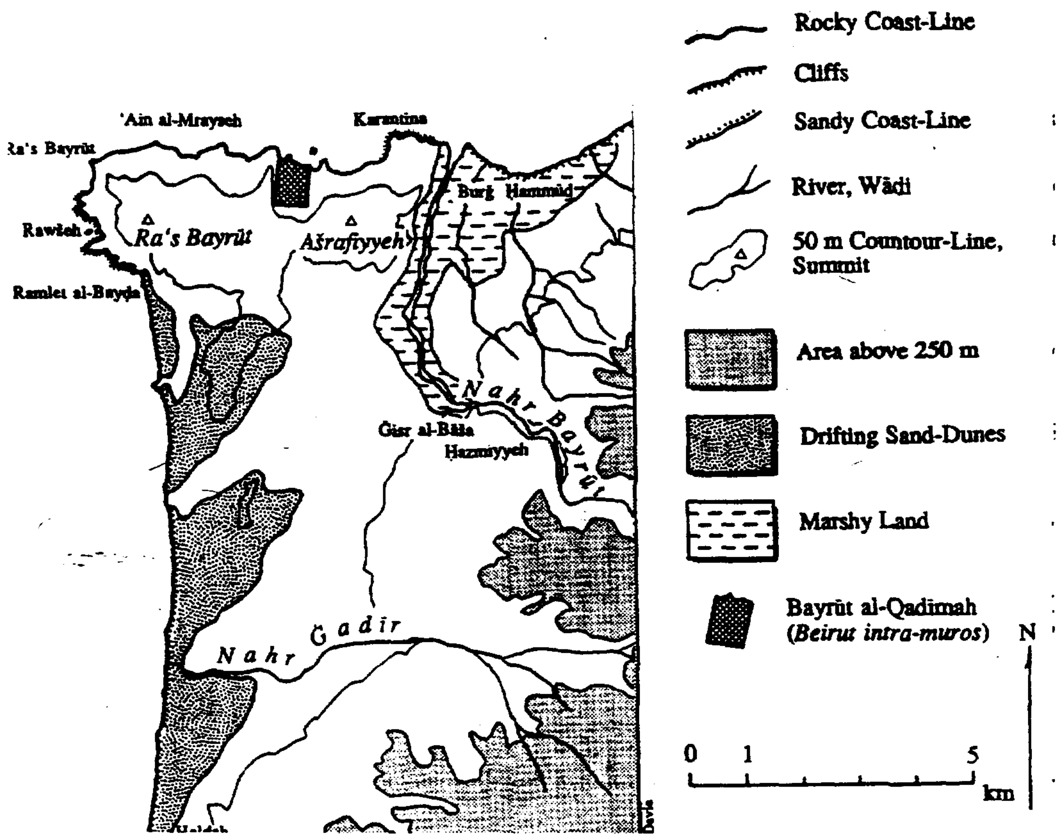
The Islamic and medieval road continued along the pre-established road line and it would not be surprising if some form of sporadic extra mural; settlement or village did not grow up in the area. As the main crossing point of the Beirut River on its eastern approach from Tripoli it is likely that the bridge would have had some form of small garrison or guard post to try and defend the bridge, warn the main garrisons in Beirut of an impending visitation.

4.3.2 Archaeological Implications

The area of Borj Hammoud is one that could prove archaeologically sensitive due to a combination of two factors. Firstly the potential for good preservation of artefacts and eco-facts on buried sites and secondly the area may have formed a nodal point at which one would expect a relatively significant level of archaeological activity.

The presence of lower Palaeolithic material in fluvial, riverine deposits is of regional and national significance and it is unlikely that the course of the Nahr Beirut remained static from the Palaeolithic to Roman period. This may then mean that low lying strata may preserve both palaeo-channels, (old river courses) and intact Palaeolithic assemblages. It is also possible that any remaining assemblages would reflect both flint production and the hunting/butchery of animals. As a means of understanding the prehistoric economy of the area, these deposits if surviving, could have vast potential. Pollen sampling of sealed marshland may yield pollen cores from the Upper Palaeolithic to the Late Roman period, which may help track both changes in land use and changes in climate. The presence of anaerobic deposits could also yield excellent absolute dating evidence in the form of preserved wood, which would prove valuable in refining the chronology of the development of Beirut.

Figure 4-2: The underlying morphology of the Beirut environs (after Davie 1987) showing the marshy course and delta of the Nahr Beirut.



Later periods may also be represented in the underlying strata of Borj Hammoud. Later Prehistoric, Phoenician and Hellenistic deposits are conspicuous by their absence from the literary record. This may be more to do with their archaeological visibility rather than their supposed absence. Only the waterlogged lowest piles and abutments would survive of any timber bridge that may have stood over the Nahr Beirut and any roads or trackways passing over marshy ground would have to have been built on brushwood mats or on driven timber piles or stakes. It is likely given later alleviation that these deposits may be well sealed, and that even where largely truncated by modern buildings would probably repay archaeological examination. It would also be archaeologically worthwhile to record the remains of the Roman Bridge if still surviving to attempt to establish its construction date and style to help refine the chronology of the Roman road.

Umayyad and later occupation of the site is not attested to in the archaeological record, this does not however mean that it is not present in the area. The name Borj Hammoud comes directly from the medieval period and it is a fallacy to think that such a strategic position, at a river crossing, on fertile ground, on the line of a major road, would have been ignored during this time. The turning of the area into mulberry plantation during the Ottoman Empire reflects the depopulation of Beirut and its hinterland and Beirut's changing economic base rather than seclusion and lack of habitation in the area.

Intrusive ground works at Dora square may also damage archaeological deposits though it is likely that these will be fragmentary and poorly preserved. Further archaeological work would be repaid however as the line of the medieval. Roman and earlier road passes through the square. There is also a possibility that structural deposits may be encountered associated with ribbon development.

4.4 Sin El-Fil (Saloume, Hayek and Mkalles roundabouts)

Sin El-Fil, which includes the Saloume, Hayek and Mkalles roundabouts (Figure 4-3) lies on the eastern bank of the Nahr Beirut to the south of Borj Hammoud.

Figure 4-3: Approach to Mkalles from the southeast

Figure 4-4: Saloume Roundabout from the southwest

The earliest recorded activity on the site dates to the Middle Bronze Age when it was a small satellite settlement under the patronage and control of the Beirut city state (Ward 1970: 22, Jidejian 1993: 33). Tombs dating to the Phoenician period have also been found in the area (Chehab 1939: 803-809). There is no evidence in the written sources of Hellenistic occupation, though the site was certainly a suburb of Roman Berytus and was on the road to the ritual site of Deir el Kalaa where rites dedicated to Baal Marquod (the god of earthquakes, identified with Poseidon) were performed (Jidejian 1993: 95).

A Church was built in Sin El-Fil during the 8th Cent. A.D. which was built over during the 20th century (Moufarrej 1969: 116), Sin-El Fil is also muted as the battleground between Arab tribes and the Crusaders on their way to Jerusalem in the 11th century (Moufarrej 1969, Merhej 1973: 220)

4.4.1 Archaeological Interpretation

Archaeological activity from the Bronze Age, Iron Age and the Roman period are all attested in the area of Sin-El Fil though the proximity of the discovery sites to the roundabouts of Saloume, Hayek and Mkalles is not known. It would be unusual if Hellenistic deposits were not present in the area, the God Baal Marquod was associated with the Greek god Poseidon the patron god of Beirut and as such Sin El-Fil would probably have constituted a stopping off place while journeying to Deir el Kalaa. It is unknown if deposits pre-dating the Bronze age are present in this area though it would not be surprising to find that the Bronze Age settlement had a Neolithic pre-cursor.

4.4.2 Archaeological Implications

It is likely that archaeological deposits will be present in the vicinity of the Saloume, Hayek and Mkalles roundabouts and any intrusive ground works may result in their being seriously compromised. If the deposits are suitably well preserved from a known site of importance, it is possible that deep ground intrusion may be totally unacceptable from an archaeological point of view.

A preliminary site visit to the area suggests that archaeological levels may still be preserved. The buildings standing in the area of the roundabout are low rise without deep basements, and mostly date to the first half of this century. This may then imply that not only will archaeological levels still be preserved but that the quality of preservation may be so good as to warrant preservation in situ and thus road improvement re-design with minimal ground intrusion.

4.5 Intersection of Bechara al-Khoury and Independence Avenue

The location of his site so close to the known southern limits of the walled city, and its juxtaposition between the roads to Damascus and Sidon imply that archaeological deposits may be encountered during any intrusive ground works. Mensil du Buison (1924) shows the line of one of the aqueducts supplying Roman Beirut as passing close to the area. Medieval and 17th century sources report the southern extension of the Roman city as being witnessed by ruins as late as 1697 (Maundrell) and the present day relief of the area (overlooking Downtown Beirut) would seem to suggest that the natural slope of the land has been accentuated and raised by made ground.

4.5.1 Archaeological Interpretation

There is no mention in any of the literary sources examined of chance finds in this area predating the Roman period. This may be due to the depth of general development in the area as most of the surrounding buildings are not deep basemented, or that chance finds have not been reported. The latter could well be the case as it is certain that archaeological deposits probably relating to 'ribbon' and suburb development should have survived in this area as it has only recently (over the last 100 years) been developed.

It is possible that early Islamic and Medieval archaeological deposits may survive in the area, though these may be associated with low level domestic dwelling or craft/industrial production outside the city walls. The area is shown as being mulberry plantation in 1841 (Davie 1987: Figure 2) though by 1876 a building with a central courtyard possibly a Khan stood on or near this location.

4.5.2 Archaeological Implications

It is highly likely that archaeological deposits dating to the Roman Period are preserved in this area. Though no mention of Hellenistic or earlier chance finds from the area is made in the literary sources it is possible that where later archaeological levels survive earlier periods may also be present.

It is also possible that ephemeral early Islamic and Medieval remains may also survive however there is little evidence in any of the written sources to substantiate this.

4.6 Intersection of Bechara el Khoury and Omar Beyhum Road

The intersection of Bechara el Khoury and Omar Beyhum road lies close to the intersection of the old Sidon road and the modern Airport road. No archaeological finds have been reported from the immediate vicinity though this should not be taken as indicative of the absence of archaeological material.

4.6.1 Archaeological Interpretation

The development of suburbs and 'ribbon' development to the south of Beirut is attested in medieval and later sources and the proximity of this junction to the Sidon road implies that if 'ribbon' and suburb development is present in this area between the Sidon and Damascus roads then it may be preserved. There is no evidence to suggest earlier occupation of the area other than the presence of the road to Sidon which in itself is of considerable antiquity, and the relative density of Palaeolithic occupation in the general area. If archaeological deposits are present in the area it is likely that they are well preserved. A site visit demonstrated the presence of red sand in the area which is known to be up to 9m thick in places and should contain the archaeological levels. The fact that naturally soil accumulation in the area occurred due to hill wash (colluvium) also suggests that archaeological deposits may remain preserved beneath successive layers of slope wash. The Omar Beyhum road cuts through the southern pine forest reputedly established by Fakhr-Eddine, this also provides favourable conditions for archaeological preservation ensuring that the area has not been built upon for approximately 400 years.

4.6.2 Archaeological Implications

The potential for the preservation of archaeological remains dating to the Roman and early Islamic periods is quite good. The local ground conditions seem to suggest that the area has not undergone a great degree of levelling down or horizontal truncation and if anything it seems likely that the soil cover has increased due to natural and urban formation processes. Though there is no evidence in the literary and cartographic sources of any occupation predating the Roman period, earlier archaeological deposits may be preserved beneath ones of a later date. It is possible given the relative density of Prehistoric activity on the southern approach corridor to Beirut that Palaeolithic or later prehistoric material may be well preserved in the area.

4.7 National Museum Damascus Road intersection and Palace of Justice

These sites are located on a marine erosion terrace that also encompasses Mazraa. Berbir and the Horch-Museum areas. A small perennial water course drains onto this terrace in the area of the National Museum that originates in the area of the southern pine forest. A small hill stands slightly to the east of this area. with the Mazraa hill slightly to the west. This marine terrace is known to be fertile and to have been cultivated during the 19th century (Davie 1987: 146).

4.7.1 Archaeological Interpretation

The fertility of this area coupled with its proximity to the Damascus road (known to be a route of some antiquity) implies that archaeological deposits relating to the Roman period should be present in the form of 'ribbon' development and/or cemeteries. A little to the west Jidejian states that many Roman artefacts have been unearthed during building works in the Mazraa area (1993: 112). Though no finds of antiquity have been reported from the area. this absence should be seen as a reflection of poor development control and procedures for instigating pro-active archaeological resource identification rather than absence of material. The presence of prehistoric and classical material to the east on the other bank of the Nahr Beirut at Saloume in conjunction with known find spots of sarcophagi and sepulchral caves on the southern slopes of the Achrafieh hill (Mensil du Buisson 1924). would seem to suggest that the blank area shown in the literary sources around the National Museum and the Palace of Justice is less to do with the presence of archaeological material and more to do with the reporting of discoveries. The area has been heavily urbanised during the latter half of the twentieth century though it sits on red-sand soils that are up to 9m deep in places that may hold or cover underlying archaeological deposits to a significant depth.

4.7.2 Archaeological Implications

There have been no reported chance finds of archaeological material in the immediate area of these sites. However. the sites should be seen in the context of their wider surrounding areas. The Roman remains at Mazraa. and the prehistoric and classical remains at Hayek should indicate that there ought to be archaeological deposits in this area. Further evidence for this summation is provided by the fact that the road to Damascus crosses this plain at this point which of itself should lead to speculation as to the presence of either/or/and roadside suburbs or cemeteries. It is also possible given the relative density of prehistoric or Palaeolithic sites in the wider vicinity that there may be prehistoric archaeological levels preserved within the deep red sand soils of the area. These sand soils and their colluvial build up may in fact have sealed and protected the archaeological levels from all but the deepest intrusions. A site visit leads to the speculation that the area has not been heavily denuded or levelled down.

4.8 Tayouneh and Damascus Road Chatila–Justice Palace Intersection

This site is situated at the southern end of Omar Beyhum road and the road running between Chatila and the Palace of Justice. Tayouneh is in what was once the southern pine forest planted by Fakhr-Eddine. part of which is still present to the west and northwest while the Chatila/Justice intersection is on the northwest fringe of the southern pine forest on the Damascus road.

4.8.1 Archaeological Interpretation

No archaeological finds have been reported at all from the locale of these sites. This may be due in part to the fact that the area has been forested since the 17th century at least (Figure 4-5) and that modern and one may venture insensitive development over the last four decades would not necessarily have resulted in the reporting of archaeological finds to the National museum.

It is possible given the relative density of archaeological activity in this landscape that there may be cultural material on the sites buried beneath colluvium. However. this cannot be substantiated in anyway without intrusive investigation.

4.8.2 Archaeological Implications

As with all the sites and areas mentioned within the southern approach corridor to Beirut there is a good possibility that archaeological material may be encountered. due to the relative density of reported archaeological and historical sites in the area.

Figure 4-5: The passage of the Damascus road through the Southern Pine Forest during the 1800's. Note that the carriageway has been levelled up and is much higher than the surrounding ground.

4.9 Airport Road, Chiyah Boulevard Intersection

This site is located to the south of Beirut on the Choueifat plain (Sanlaville 1977: 592) on the western edge of the Bir-Hassan sand dunes. The present crossroads are overflown by a modern bridge leading to the Airport Boulevard.

4.9.1 Archaeological Interpretation

This intersection is surrounded by known archaeological sites as well as being situated on the old Beirut-Sidon road. To the west Bir-Hassan has yielded Middle Palaeolithic and Neolithic material (Copeland and Westcomb 1966: 128) while Tell Arslan (Ouzaii) has also yielded artefacts dating to the Neolithic. Historically Bir-Hassan derives its name from the well (Bir) ordered by the prince Hassan al-Chehaby. The tomb of Cheikh ed-Dahar and a Khan extant in the 19th century are reported to be located in Bir-Hassan (Davie 1984: 56. 68).

Archaeological material has been discovered in Jnah to the southwest. comprising several late Roman Villas with impressive mosaic floors (Chehab 1957: 53-79). Indeed it is reputed that this area of the southern approach to Beirut along the Sidon road. also known as the 'sands station' is a veritable minefield of archaeological activity Jidejian reports that "important (Roman) suburbs developed between Jnah and Ouzaii (1997: 95). Though this is based on sketchy and incomplete archaeological evidence Jidejians interpretation of the archaeological landscape immediately to the west of the Chiyah Boulevard intersection is likely to have more than a little validity.

To the east of the intersection the site is bordered by Borj-El-Barajneh which has yielded Palaeolithic finds as well as Roman milestones and a marble statue (see section 3.2.above).

Later periods are also represented in the area. It is known that the village of Ouzaii (tell Arslan) was a village during the Umayyad period while a Borj or tower fort was built at Borj-al-Barajneh by Fakhr-Eddine to protect his forces against local rebels (Mufarrij 1970: 42-72).

4.9.2 Archaeological Implications

The relative density of sites in this area during the Palaeolithic and classical antiquity is hardly surprising given the local topography. Though reports of Hellenistic and Phoenician archaeological deposits are absent from the literary evidence for this area it would be foolhardy to assume that they do not exist in the area. Though this area witnessed systematic urban growth during the latter half of the twentieth century, it is likely that islands of archaeological stratigraphy may still be preserved under roads, buildings with shallow foundations and between buildings with deeper foundations. Site reports for the excavations in the area are dominated by late Roman finds, though it would seem reasonable to suggest that this part of the landscape on the southern approaches to Beirut has witnessed almost continual occupation since antiquity if not before.

4.10 Haret Hreik, Ghobeyri intersection

This site lies within the same geographic and topographic region as 4.9. above. To the southwest lies Haret Hreik and Bir-al-Abed. Ghobeyri lies to the north and south with Chiyah lying to the east.

4.10.1 Archaeological Interpretation

The only archaeological material reported in the literary sources from Haret Hreik is an assemblage of Upper and Lower Palaeolithic material that has since been built over (Copeland and Wescomb 1965: 133). However, chance finds of Roman material have been reported in Chiyah (Khuri 1975: 21-22) during building and gardening work including skeletal remains, ceramics, Iron and Bronze objects, four 'old' wells and two caves.

The settlement of Haret Hreik is believed to have its roots in the 15th century (though they may in fact be earlier) and remained a feudal village until 1861 when the Chehab family started selling the land to the villagers.

4.10.2 Archaeological Implications

Local oral reports from Haret Hreik and Chiyah confirm the likelihood of archaeological deposits in the area of this intersection. It is known that there is Palaeolithic activity in the area and chance finds of Roman material have also been reported from the locale. The absence of Hellenistic and Phoenician material from the area in the literary sources should not be taken as proof of its absence in the ground. The location of the site near to the Sidon road and the narrowness of the southern corridor approaching Beirut suggests that archaeological is likely to be present in this area and may be impacted upon by the proposed development.

4.11 Mar Mekhael Intersection

The Mar Mekhael intersection lies within the Chiyah area and in the later 19th century lay on the road that connected Beirut via Bab-Dherke with Sidon (Davie 1980: 62). It also forms the crossroad between Choueifat and Hazmiyyeh (Ibid: 68).

4.11.1 Archaeological Interpretation

The known archaeology of the Chiya area to the west is discussed above (section 4.8.), archaeological material is also known however from the nearby area of Hadath to the east dating to the Neolithic (Copeland and Wescombe 1965: 88). Abundant Roman finds have also been reported including ceramics. metal objects and monumental masonry during construction work in the village (Merhej 1971: 194).

Archaeological deposits dating to later periods may also be present in the area. The locale was settled in the 8th century by the Arslan family and was turned over into the production of citrus fruits and mulberry plantation. There may therefore be early Islamic and medieval domestic occupation/farmsteads or artisanal workshops in the vicinity. A site visit by the project team member, a specialist on ancient ceramic lamps, compiling the archive report resulted in her identifying fragments of pottery in the spoil tips of bulldozers that had been working near the intersection.

4.11.2 Archaeological Implications

The Mar Mekhael intersection is an area of definite archaeological potential and archaeological deposits are definitely attested from the immediate area. Its location on the Beirut – Sidon road portents Roman suburban development as does the archaeological material from the area. Though the roads have been levelled down revealing sections of the Hamrah sand dunes expansion of the roads will affect archaeologically sensitive layers. Any excavation into deposits that have not been disturbed since before 1918 carries a great chance of exposing and damaging archaeological material.

4.12 Galerie Semaan Intersection

The Galerie Semman intersection is bordered to the west by the sites mentioned above (see 4.9. to 4.11. above) and by Hadath and Fayadiyeh to the east. The site lies at the eastern end of the Chouefat Valley, a road passing through Galerie Semaan and Hazimiyyeh leads to the mountains. The intersection is roughly equidistant from the Damascus road to the east and the Mar Mekhael intersection to the west.

4.12.1 Archaeological Interpretation

The location of the site juxtaposed between the Sidon and Damascus roads would suggest that the site may overlie roadside ribbon development or a satellite settlement outside Beirut. The presence of so many archaeological sites in the vicinity and the narrowness of the corridor approaching Beirut from the south implies that archaeological levels may be present in this area. The presence of Bronze Age and Palaeolithic material at Fayadiyeh may also be indicative of earlier archaeological levels in the vicinity of this intersection. Later occupation is also known in the area indicated by a Khan of unknown date is reported by Davie in Hazimiyyeh (1980: 70).

4.12.2 Archaeological Implications

Although reports of archaeology are rare in this area, the material available is sufficient to indicate that the area is archaeologically significant. Evidence of Stone Age material was recorded at the beginning of the century at a location nearby. Bronze Age tombs were partially excavated close to Fayadiyeh (Copeland & Wescombe 1965: 86).

Galerie Semaan is not heavily urbanised and it retains its suburban character. Though modern buildings with deep foundations are the norm, the density of construction is unlike that further north which may facilitate the preservation of pockets of archaeological stratigraphy. A Khan is reported in Hazmiyyeh and is shown on maps of the 19th century adjacent to the Damascus road (Davie 1980: 70).

The frequency of finds in the area is significant, the area like the Mar Mekhael intersection is near to a major thoroughfare of demonstrable antiquity. This site and its environs may provide us with evidence of Bronze Age occupation in the southern approaches to Beirut. This may be of great significance in informing the archaeological community and the public about the settlement patterns and trade connections between Bronze Age Beirut its southern hinterland and its relations with Damascus.

4.13 Khaldeh

Khaldeh lies approximately 20 km to the south of Beirut on the old road to Sidon. It has been known as an area exceedingly rich in archaeological remains for some considerable period of time. The southern part of the 'sands station' lies adjacent to the west with high ground and mountains to the east.

4.13.1 Archaeological Interpretation

It is hard to overstate the richness and potential richness of the archaeological deposits in the Khaldeh area. The 'sands station' an area of sand dunes bordering on Khaldeh itself is extremely rich in Palaeolithic and prehistoric lithics assemblages that must represent seasonal camps and Neolithic settlement. Though many of those known sites have been developed without an adequate archaeological record the profusion of ancient activity in the area does not preclude the discovery of other lithics assemblages and seasonal occupation sites.

The importance of the Khaldeh area lies in the multi-period nature of its occupation, which ranges from the Middle Palaeolithic to the 7th Cent. A.D. Late Chalcolithic (copper age) domestic structures with evidence of their roof structures have been excavated at Khaldeh. Superimposed over these buildings was an Iron Age (Phoenician, 11th-8th century B.C.) cemetery of 422 burials which straddled the Beirut Sidon road. The full extents of this cemetery were never revealed and it is likely that the settlement with which it was associated lies under the modern day airport. The Iron Age cemetery was sealed by occupation and buildings dating from the Persian and Hellenistic periods (5th/4th Cent. B.C. – 1st B.C.), These buildings were in turn sealed by a large Roman 'small town'. Private houses were excavated with extensive mosaic floors, agricultural and industrial installations were also uncovered as well as a public bath-house. (Saidah 1969)

A few kilometres to the south, excavations on the Ottoman caravanserail known as Khan Kalde revealed the site of *Mutatio Heldua* (Duval and Caillet 1982: 315). This contained numerous olive presses, hundreds of private houses, many of which had mosaic floors, the complete street grid system with waste and fresh water supply and drainage and a rectangular temple with a central courtyard (peristyle) containing a winged sphinx (Saidah 1969: 134). Palaeolithic, Bronze Age and Iron Age deposits are also present on the site though they remain unexcavated beneath later occupation. The site prospered until the Muslim conquest in 650 A.D. and had two churches both dating from the 6th century A.D. (Callot 1982: 420)

4.13.2 Archaeological Implications

It is obvious without doubt that the Khaldeh area is rich in archaeological remains of national importance and regional significance. It is likely that any intrusive ground works in the area will encounter archaeological deposits that may date from the Palaeolithic to the early 7th century A.D.

5. CONCLUSIONS

This assessment has attempted to characterise the potential archaeological deposits within the area of Greater Beirut from the literary and cartographic sources alone. Interpretation of this data set is made difficult by the number of sources available and (with a few notable exceptions) their reliability, accuracy and rigour. Many of the general sources offer statements of *apriori* fact without recourse to references, or illumination of the process by which they reached their conclusions. However, a series of broad statements can be made about the archaeology of Beirut outside the BCD. Palaeolithic and Roman archaeological discoveries seem to predominate in the literary references to Beirut. This is interesting as it may reflect a number of factors or trends that confirm the observers as products of their time. Darwinism and the 'new science' of the mid to late 19th century spurred archaeological research into humanities earliest past when many of the identifications of Palaeolithic sites were made. The traditional bias of Classical archaeology towards Roman remains is also evident from the observations made in the literary sources. In the case of the former, the work undertaken in identifying sites dating to the Stone Age has ensured that this period (archaeologically one of the most difficult to recognise) has not been ignored. However the latter bias may have resulted in casual observations of archaeological deposits relating to Hellenistic, Phoenician, Islamic and medieval occupation being disregarded poorly understood or being unrecognised and so not finding their way into the written record

5.1 Archaeological Trends Represented in the Data and Analysis

Generally the overall picture regarding the archaeology of Greater Beirut is fairly uniform ie, there is the potential to encounter significant archaeological deposits in all of the areas examined. The fact that Beirut has been a nodal point for nearly 13,000 years is hardly surprising when one takes the topography, geology and geography of the area into consideration. The narrow coastal strip to the north east with its fertile colluvial soils, adequate rainfall, availability of flint for tool making either from water rolled river or beach boulders or from eroded cliff faces all contributed to the favourable location of the Beirut peninsula during the Palaeolithic, Mesolithic and Neolithic. This favourable setting is also reflected in the known Palaeolithic sites in Ras Beirut and on the southern approaches.

Evidence of later Neolithic occupation in the area is however, alarmingly sparse. The fertile soils between the Achrafieh hill and Ras Beirut as well as on the eastern approaches and ready access to a source of flint should have made the Beirut peninsula and its hinterland an attractive prospect. The fact that Neolithic material has been collected on the southern and soutwestern approaches to Beirut is interesting and may reflect a change in settlement patterns. The shortlived camps or stations of the Palaeolithic and to an extent Mesolithic being replaced by village (or proto urban) settlement on the fertile plain to the south of Beirut. The evidence however, is far too sparse to formulate population and site density models possibly due to poor site recognition and lack of archaeological monitoring during construction. One thing is certain however, that more work needs to be done in the environs and hinterland of Beirut to establish the nature of settlement in the area during these periods, Beiruts economic base, sphere of influence, and trade and exchange networks. It cannot be assumed that the relative absence of Neolithic sites from the literary record is indicative of anything other than a lack of recognition of these sites.

Beirut is known, from recent and earlier excavations to have been an urban settlement in the Bronze Age. Satellite settlements of this period seem to be distributed in the landscape towards the base of the foothills/mountains marking the eastern edge of the coastal plain. The exception to this seems to be Beirut itself which utilises the fertile coastal plain, the good water sources and an easily defend natural location with a good natural harbour. It is likely that the other Bronze Age sites in the area were client settlements of the Beirut city state. The relationship of Beirut to its hinterland during the Bronze Age (and indeed all subsequent periods) is yet to be addressed as is settlement patterning within Beirut's hinterland (and one may assume immediate sphere of political influence). As with the Neolithic period it is important that the relative paucity of the literature concerning the presence of Bronze Age sites in the vicinity of Beirut is not taken as an indication of absence. Relatively little systematic investigation of either a research or rescue nature has been undertaken outside the BCD. It is not surprising therefore that Bronze Age settlement may be under represented in the literature concerning the landscape.

Where archaeological excavation has taken place in the hinterland of Beirut it has usually revealed a superimposed sequence of archaeological deposits and a multi-period nature to the site. The archaeology of the Phoenicians (Iron Age) is present in only two areas, Mkalles and Khaldeh. Beirut is known to be a Phoenician city with an imposing defensive wall, however it is surprising that no satellite settlements to it have been excavated as yet. The Phoenician cemetery at Khaldeh on the southern approaches to Beirut must have been associated with a settlement. However this settlement could not be investigated as it probably lay under the airport. Phoenician graves were also found at Mkalles, however no corresponding settlement has come to light. The seeming absence of Phoenician settlement (in the sources) from the landscape around Beirut is somewhat enigmatic and should be addressed. It would otherwise seem that the urban centre of Beirut existed without a hinterland which would be so anomalous as to be utterly unbelievable.

The Hellenistic period is also peculiarly absent from the literary record. A necropolis is known to the west of the BCD and sporadic burial may continue as far as Ain Mreise though the extent of Hellenistic Beirut is uncertain. Excavation at Khaldeh has revealed Hellenistic and Persian deposits, other than this it would appear that Hellenistic occupation was sparse in the environs and hinterland of Beirut. This paucity of evidence is probably due to the socio-political and economic circumstances of Lebanon, as well as a lack of field work over the past 25 years and the understandable failure during the war to enforce Lebanese law relating to the reporting of archaeological finds and an inability to exercise development control.

By contrast Romano-Byzantine Beirut is extremely visible. In every area examined during this study there have been reports of one form or another of chance finds of Roman material culture, buildings, columns, mosaics and sarcophagi. One gains the impression of a utilised and populated landscape around Beirut with ribbon and suburb development along the roads to Sidon Damascus and Tripoli as well as the beach suburbs of Ouzaii and Jnah. Though the most visible archaeologically and in the literary sources, it is surprising how little we yet know of the morphology, extent, and patterns of land use in Roman Beirut and its southern and possibly western suburbs. It is possible that Roman archaeological levels will be present on all sites studied, and given the state of our knowledge of Roman Beirut each site could be of great importance to our developing understanding of the Classical city and its socio-economic base.

The contraction of Beirut in the years following the Muslim conquest and later Crusader, Mamluk and Ottoman occupation has been the subject of relatively little archaeological investigation outside the BCD. The presence of Khans (of unknown date) on the roads to Damascus and Sidon are attested in the maps of the 19th century. However early Islamic settlement and occupation of the southern approaches to Beirut is attested on several sites as is Mamluk occupation in the area of Verdun and Mar Elias. The presence of sepulchral caves on the eastern approach to Beirut and the location of a Crusader Chapel on the opposite bank of the Nahr Beirut to Borj Hammoud may illustrate that later occupation and settlement was mainly concentrated in the direct vicinity of the walled town. There is also some evidence for later Islamic occupation in Ras Beirut and on the Achrafieh hill. It seems that by the 17th century much of Beirut's formerly populated environs had become agricultural land and mulberry plantation at least until renewed urban development in the later years of the 19th century. However the archaeology of the Islamic, Crusader and later Islamic periods has almost undoubtedly suffered from 19th century and modern development without being recorded. The presence of these deposits in the areas studied should not be automatically discounted.

5.1.1 Recommendations for Further Work

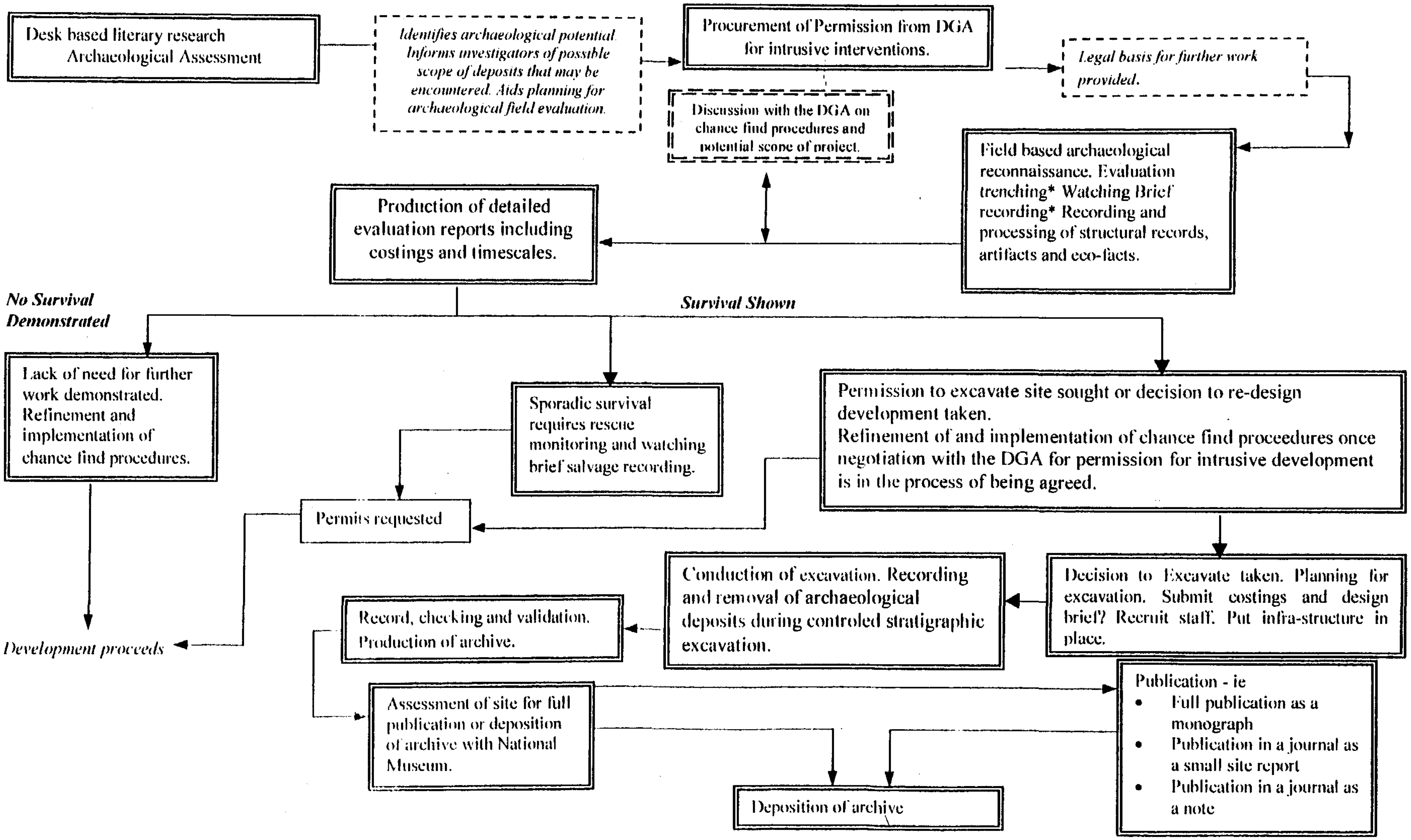
This assessment should only be seen as a precursor to and not a replacement for field survey and field based archaeological evaluation. In the absence of investigative trenching to the top of any archaeological deposits, or to the proposed depth of development this desktop based assessment should be taken as demonstrating the minimum archaeological potential for each site. It is impossible to fully identify and ringfence resources without conducting intrusive evaluative groundworks on the sites in question to identify the nature, date and chronological range of archaeological preservation. It would be foolish based on this (desktop) Assessment alone to plan the scope of archaeological excavation, identify training needs and mute decisions about preservation in situ or preservation by record. This report was commisioned with the sole purpose of providing an intelligent and informed lead in to the archaeological *potential* of the areas in question as a potential precursor of and without re-course to intrusive survey. The authors own experience from work in Beirut and on other urban excavations has shown that Remote Sensing Techniques are not particularly helpful in an urban context. Typically excavations in Beirut have shown the superposition of archaeological deposits to a depth of more than 5 metres and on occasion to a depth of 13m. When the particular intensity of human site formation processes are viewed in conjunction with the complex geomorphology of the area and the complexity of natural site formation, it is unlikely in extremis that remote sensing would have the penetration to deal with either the background noise caused by modern services, or the quality of definition to accurately evaluate any given sites complexity. It is this complexity which is the real key to determining how long a site may take and cost to excavate. Mitigation strategies for each particular site have been given in general of terms and are preesented at the end of this section. Without intrusive archaeological evaluation it is impossible to reliably predict the nature of archaeological preservation. The intention of this assessment is that it identify to the developers the potential of each area to be archaeologically sensitive and as such it must be seen as part of the pre-project planning process. Ideally, this report should be followed by an intrusive though non destructive field evaluation phase, then followed by a phase of consultation with the relevant bodies such as the National Museum and the Minister for Culture and Higher Education, prior to any decision to excavate or not. This can only be done with the full consultation of the Director General of Antiquities, once he has granted permission to conduct field based evaluation. The Director General of Antiquities by Law has the power to halt any development that is damaging archaeological deposit. Such a strong and empowering law is however rendered somewhat impotent without some form of predictive modelling for the archaeological deposits in Beirut and its hinterland. It is this dearth of structured and collated knowledge (in the form of a sites and monuments record) that has largely resulted in the absence of a national, regional or city based archaeological research agenda or research framework such as those that exist for the UK (see *Managing our Past* (1991) and the *Draft Research Agenda* (1997). It is exceptionally difficult to provide a relativistic league table of the types of archaeological site that may warrant preservation in Beirut when so little structured and intrusive reconnaissance has been done in many of the areas covered. Given the traditional cultural and nationalistic biases of archaeological research in the Levant the archaeology of the Greek and Roman world has a disproportionately high profile in relation to that of earlier and later periods. This is reflected in the written sources and has produced the apparent biases in this survey. Ideally archaeological research has to be pointed to answering specific questions within a research framework and engaged in the modelling of past societies and the predictive modelling of the vestiges that may remain so as to best conserve them in an unexcavated state and help draft site management plans. Archaeological evaluation does not entail excavation in the sense of a full stratigraphic investigation, it is a field based reconnaissance technique designed to help characterise the nature, depth, quality of preservation and extent of any archaeological deposits. Areas where no disturbance of the ground is planned should not interfere with archaeological deposits, the same is also true for areas where development is taking place over previously disturbed ground. However in the absence of any reliable or credible data with which to suggest models of deposit mapping the depth of archaeological deposits below the surface will vary drastically over the entire area covered from less than a meter to several meters. Improvement of transport infrastructure that already exists should not impact on any preserved archaeological deposits however new service trenches, the insertion of culverts and the digging of foundations for service roads, lighting gantries, drainage. electricity cable trenches should all be monitored archaeologically. Integrating archaeological concerns at the earliest opportunity in the development stage is a measure that can enable development work to continue to timetable while fulfilling a legal obligation to buried cultural remains.

As stated above the entire area around Beirut has the potential for the survival of archaeological material from at least one if not many periods of history. It is certain that in some areas urban development has removed all but the lowest lying archaeological deposits. However, roads do not cause the same damage to archaeological deposits in an urban context as deep foundations. The areas where underground car parks are proposed should be thoroughly evaluated by means of test excavations by a team of professional and experienced stratigraphic archaeologists. Those sites marked for grade separation should also be evaluated by means of intrusive excavation to the upper level of the surviving archaeological stratigraphy. Once the presence or absence of archaeological deposits, their age, character and quality of preservation has been established the decision as to whether the site should be fully excavated (removed) or preserved in situ has by law to be taken by the Department of Antiquities. It is only when this higher level of investigation has been conducted that a further plan for developmental works can be taken forward. Funding for any excavation has to be guaranteed in order to obtain excavation permission, legally this guarantee does not have to cover the cost of post excavation analysis and publication, though it should cover the costs of cataloguing, recording, conserving and archiving the different finds and records from an excavation. In law any person removing archaeological material without permission. either knowingly or unknowingly is liable to prosecution as a criminal rather than civil offence. Any archaeological fieldwork requires a permit from the Director of Antiquities of Lebanon, this includes all intrusive works. evaluations and archaeological watching briefs. The Lebanese Antiquity laws are intrinsically weighted towards the needs of the archaeological resource and preserving it in situ. Structured and well planned fieldwork is essential, coupled with constructive dialogue between all concerned parties (National Museum, archaeological contractors, site contractors and project management). Professionally executed evaluations, conducted by experienced stratigraphic urban archaeologists prior to any decision to excavate, build or redesign; should ensure that some of the worst mistakes witnessed in the BCD are not repeated.

It is therefore in the best interests of both the archaeological deposits and the effective project management of the Greater Beirut Transport project that a serious attempt at quantifying and identifying the nature and extent of the archaeological resource to be impacted upon is provided for. This Assessment is merely the first step towards this goal and constitutes what is recognised as 'best practice' in the UK. This assessment tails into other areas of the environmental impact assessment by virtue of highlighting the potential archaeological sensitivities of each area outlined as such it is an initial statement of the minimum archaeological presence that may be expected in any given area. A model of the process of archaeological investigation into which this assessment fits is presented in table 5-1 below.

Recommendations and possible mitigation strategies are outlined below. However. though any ground work that causes disturbance to a depth of 1 meter or less is probably within danger of affecting cultural deposits it is impossible and imprudent to offer this as a hard and fast rule. In certain cases in Beirut Roman rooms and cellars were terraced into underlying bedrock which resulted in excellent preservation of their interiors. While the bedrock itself was visible at contemporary ground level. The case by case nature of archaeological survival and building work necessitates flexibility and pragmatism.

Table 5-1: The life of an archaeological project in a development context



5.1.2 Definition of Working Practices (stage 1)

- Evaluative excavation aims at characterising the level of preservation within any given area. It frequently entails multiple trenching to the upper levels of the archaeological deposits. The intention of the strategy is to identify archaeologically sensitive areas prior to groundworks. aid in the production of costings for possible development and excavation. The conduct of an evaluative excavation in no way implies either the end of an archaeological project or that final permission to build will be granted by the Department of Antiquities. Potentially there are a diverse range of archaeological deposits that could be encountered. should this be the case there are a range of methodologies that will need to be applied which will have further implications vis a vis cost and time. These implications in terms of cost. time and mitigation strategy can only be determined after a visual examination of the state of archaeological preservation has been afforded.

- Watching brief excavation constitutes the archaeological supervision of machines while removing strata that is or is strongly suspected to be of little archaeological sensitivity. However it is conducted under archaeological supervision with the caveat that the archaeologists may stop machine work for an agreed period of time to record archaeological features encountered. This may result in a 'mini' excavation within the boundaries of the machine trench. for the purposes of creating a record prior to destruction.

- Skeletal remains by their very nature are both high profile and intrinsically sensitive. In the case of Roman Sarcophagi heavy lifting gear may be required.

- Chance find procedures have to be discussed and agreed with the Lebanese Department of Antiquities. though draft guidelines are included in Annexe 1 and will be re-drafted if needed following further consultation with the DGA. It would be prudent to ensure that each of the proposed intrusions has DGA approbation. This does not imply or guarantee that should archaeological deposits be encountered of an unusual nature, or in a state of good preservation. that further permission to excavate them will be granted. Even at this stage a project may be halted or have to be re-costed.

The following summary outlining the investigation methods suggested for each site is based on the area overviews presented above. A detailed Outline Work Plan for Stage 1 Evaluation is provided as Annexe 2.

Table 5-2: Site Evaluation Methodology

Key: Pal-Palaeolithic. B/A-Bronze Age. I/A-Iron Age. Hel-Hellenistic. Rom-Roman. Med-Medieval. Islm-Islamic.

SITE	PROPOSED GROUNDWORKS	KNOWN ARCHAEOLOGICAL SENSITIVITY	EVALUATION METHODOLOGY
Antalias, Jal-El Dib, Old Tripoli Rd.	Grade Separation	Pal, Upper Pal, ?B/A, ?I/A, ?Hel, Rom, Byz, Med, Islm.	Watching brief, evaluation excavation. Leading to costing of ?full excavation pending DGA permission and evaluation results.
Borj Hammoud, Dora.	Grade Separation	Pal, ?Upper Pal, ?Hel, Rom, Byz, ?Med/Islm	Detailed evaluation excavation of areas of likely Pal and Upper Pal survival. Wood and pollen core sampling, possible C14 and tree ring dating. Conservation requirements for ecofacts, soil sampling and wet sieving for floral and faunal remains. Continual archaeological monitoring in form of watching brief. Evaluation excavation for Roman bridge remains, architectural survey and mortar sampling. Watching brief for road and ribbon development deposits and structures, continual archaeological monitoring of intrusive groundworks, salvage recording and excavation of encountered structures, though it is likely that these remains will be fragmentary.
Saloume, Hayek, Mkalles	Ibid	?Neo, B/A, I/A, ?Hel, Rom, Byz, Med/Islm	Potential for excellent preservation and intact archaeological sequence. Evaluation excavation, followed by full excavation depending on DGA approval. High potential of area warranting preservation in situ, re-burial and redesign of intrusive structural elements to minimise impact on buried remains. Possibility of skeletal populations being encountered, cemetary excavation is laborious, and time consuming, necessity for recovery techniques to be in accordance with aims of skeletal analysis.
Bechara al Khoury, IndependenceAvenue intersection	Ibid	?Hel, Rom, Byz, Med/Islm	Evaluation excavation in all areas of intrusive groundworks over 0.7m, watching brief of areas with shallower interventions. Good potential for preservation of later remains and Islands of intact archaeological stratigraphy. Likelihood of architectural masonry in residual contexts. Likelihood of preservation of later antique, medieval and Islamic structures. Earth fast archaeology requires careful evaluation and skilful machine monitoring.
Bechara al Khoury, Omar Beyhum intersection.	Ibid	? Prehist, ?Hel, Rom, Byz, Med/Islm	High potential for preservation of Rom, Byz, Med/Islm levels. Possibility of earlier deposits. Evaluation excavation as above, watching brief works during construction.

Table 5-2: Site Evaluation Methodology (Cont'd)

SITE	PROPOSED GROUNDWORKS	KNOWN ARCHAEOLOGICAL SENSITIVITY	EVALUATION METHODOLOGY
National Museum, Damascus Rd intersection. Palace of Justice.	Ibid	?Prehist, Rom, Byz, ?Med/Islm	Watching brief during groundworks depending on proposed depth of development. Potential need for full excavation unproven but possible.
Tayoune/Damascus Rd, Chatila-Palace of Justice intersection.	Ibid	Ibid	Ibid
Airport Rd, Chiya Boulevard intersection	Ibid	Pal, Upper Pal, Neo, B/A, I/A, Hel, Rom, Byz, Med/Islm	Evaluation excavation in all areas of proposed intrusive groundworks. Full/partial excavation and/or preservation if warranted. Watching brief recording of pipe trenches etc.
Haret Hreik, Ghobeyri intersection	Ibid	?Pal, ?Upper Pal, Rom, Islm	Evaluation excavation, archaeological monitoring of pipe trenches etc. Further costings in advance of re-development.
Mar Mekhael Intersection	Ibid	?Neo, ?Hel, Rom, Byz, ?Med, Islm	Evaluation excavation within footprint of any intrusive groundworks. Watching brief recording of pipe trenches etc.
Galerie Semaan Intersection	Ibid	?Pal, ?B/A, ?Hel, Rom, Byz, Med, Islm	Evaluation excavation within footprint of any groundworks. Archaeological monitoring of pipe trenches.
Khaldeh	Ibid	Pal, B/A, I/A, Hel, Rom, Byz, Med, Islm	Evaluation excavation within footprint of groundworks.
Orthodox Hospital	Underground Parking	?B/A, ?I/A, ?Rom, ?Byz, ?Med/Islm	Evaluation excavation to determine degree to which site is undisturbed. Possible full excavation. Archaeological monitoring of further machine excavation for services.
Mar Nicholas	Underground Parking	?B/A, ?I/A, Rom, Byz, ?Med/Islm	Ibid
Verdun	Underground Parking	Pal, Upper Pal, Rom/Byz, Med/Islm	Ibid
Basta	Underground Parking	Pal, Upper Pal, ?B/A, ?I/A, Rom, Byz, Med/Islm.	Ibid
Hamra	Underground Parking	?Rom/Byz, Med/Islm	Small scale evaluation, and watching brief.

ANNEXE 1 CHANCE FIND PROCEDURES

Greater Beirut Urban Transport Archaeological Assessment.

Draft

Greater Beirut Urban Transport Archaeological Assesment

Suggested Chance Find Procedures

Introduction

The following are draft recommendations only and may be amended after further consultation with the DGA. As such these guidelines should be seen as a working document.

Some Definitions

The term find is defined for the purpose of this document as.

"Any object, structure, remain(s) or deposit(s) that is of demonstrable or suspected antiquity whether in situ or not"

Essentially this definition covers three classes or types of "find"

- Structural remains and cultural deposits
- Artefacts
- Ecofacts

1. Structural remains/Cultural deposits.

This includes (among others)

Walls, foundations, floors, decorated architectural stonework, architectural elements (columns, pilasters, column bases), architectural masonry (other than blank geometric stone), architectural fittings (stone, wood, ceramic, metal) ceramic building materials, marble/polished stone floor/wall covering, mosaics, (ceramic, stone and glass, tesserae, in any quantity) stucco, moulded plaster, painted plaster, earthfast/rockcut graves or tombs, wells/cisterns, structural wood/timber. Archaeological deposits/levels relating to construction, occupation/use, disuse/demolition/abandonment

2. Artefacts

Including (among others)

Ceramic objects (vessels, statuary, personal ornamentation, coin dies), Stone objects (worked flint, statuary, vessels, personal ornamentation, inscribed stonework, coin dies), objects made of glass (personal ornamentation, vessels, industrial residue, utensils), metal objects (personal ornamentation, vessels, industrial residue, utensils, coins, weapons).

3. Ecofacts

Including (among others)

Human bone (articulated or otherwise) Worked animal bone/ivory, wooden vessels, worked wood, deposits suspected of anaerobic preservation.

The terms '*of demonstrable or suspected antiquity*' in this instance is defined as anything appearing or thought to be belonging to any period up to the French Mandate of Lebanon (1919). This thus excludes objects made of polythene, plastic, pressed aluminium. In the case of doubt suspicion should be weighted toward antiquity.

Procedures

General principles

- In areas of archaeological preservation, development will be monitored by an archaeologist in liaison with the Senior Co-ordinator. The Senior Co-ordinator will liase with representatives of the DGA who have legal control over any archaeological works and ownership of any archaeological material.

- Chance finds of archaeological material must be reported to the Senior Co-ordinator, who will in consultation with the site contractors, project management team and the DGA devise the mitigation strategy.

- Archaeologists monitoring ground works must ensure that the context and security of (an) object(s), or structure has been established prior to removal. She/he must also ensure that no ground works that will affect the coherence or intelligibility of the object, deposit or structure take place once that object, deposit/structure has been discovered.

- Archaeological material deriving from chance finds should if necessary be photographed (monochrome and colour) with appropriate metric scale at the location of its discovery. If necessary its location should be surveyed in, and written notes in the daily site diary (accompanied by measured drawings if appropriate) made about its discovery. If on site conservation is required this will be arranged by the Senior Co-ordinator, if urgent conservation work is needed portable objects will be deposited with the National Museum Transportation and lifting of larger objects will be arranged at Developer expense with the advice of the DGA.

- Site contractors discovering archaeological materials must immediately report them to either the site archaeologist or the Senior Co-ordinator.

- The removal of archaeological deposits without the approbation of the DGA the theft of archaeological objects from sites is a criminal offence punishable by imprisonment and fines under Lebanese law.

Specifics

1. Sitess awaiting archaeological evaluation

Groundwork on sites undergoing preliminary works prior to archaeological field evaluation will be monitored on a daily basis by an archaeologist. In the event of archaeological deposits being encountered the archaeologist will either halt the relevant groundworks pending further assessment, or mitigation measures will be put in place after consultation with the site contractors and the Senior Archaeological Co-ordinator, prior to intrusive archaeological site evaluation. Chance finds of artefacts/ecofacts will be evaluated for context prior to removal (under archaeological supervision). Object removal will be archaeologically supervised and the DGA will be notified in the event of significant finds, the DGA and Police will be immediately notified by the Senior Co-ordinator in the event of the discovery of human remains.

2. Sites that have been archaeologically evaluated

Groundworks on sites that have been field evaluated will be monitored by an archaeologist until either their completion or the archaeologist has determined that they are in overburden/archaeologically sterile levels. Chance finds of artefacts/ecofacts will be evaluated for context prior to removal (under archaeological supervision). Object removal will be archaeologically supervised and the DGA will be notified in the event of significant finds, the DGA and Police will be immediately notified by the Senior Co-ordinator in the event of the discovery of human remains.

3. Infrastructure and service trenches

Interventions of this type will be monitored by an archaeologist, any archaeological levels encountered will be assessed and depending on quality, coherence and extent, mitigated against either by watching brief recording, excavation, or service trench diversion.

ANNEXE 2 OUTLINE WORK PLAN FOR STAGE 1 EVALUATION

Greater Beirut Urban Transport Archaeological Assessment

1 Groundworks By Site / Programme Implementation

2 Outline Staffing levels / Evaluation Duration per Site

Work Group	Intersection	Type of Grade Separation	Type of Foundation[1]	Approximate Total Area of the Site (m^2)	Excavated Area (m^2)	% Area Excavated below 1 0m	Maximum Depth of Excavation[2]	Area Previously Disturbed		Location and Depth of Utility Lines	Archeological Impact	Stage 1 Archeological Mitigation
								Y or N	Description			
1	Galerie Semaan	OP	deep	20,770	2,890	13.91	3.00	Yes	Infrastructure under Chiyah Blvd was completely rehabilitated in 1994	A large drainage culvert running N-S crosses the intersection at a depth of 3m below existing ground Other utilities (T,E,S and W) lines run underneath Chiyah Blvd at a depth up to 2m	Potential for an impact on 401 9 m3 of archaeological deposits depending on the depth of the natural Potential Low level impact	Watching brief, and salvage recording
	Hayek and Saloumeh	OP	deep and shallow	56,670	4,330	7 64	4.00	No		Utilities (T,E,S,W) lines run underneath the Hayek roundabout towards Jisr El-Wati and Qalaa at a depth up to 2m	Potential for an impact on 1323.2m3 of archaeological deposits depending on the depth of the natural Potential medium level impact.	Intrusive evaluation of approx 242m2 site sample.
	Tayouneh	UP	shallow	28,100	11,070	39 40	7 00	No			Potential for an impact on 21,808m3* of archaeological deposits depending on the depth of the natural. Potential high level impact	Intrusive evaluation of 25 % sample (1090.4m2).
	Dora	OP	deep	42,560	3,650	8.58	3.00	Yes	During the construction of the substructure units of the existing steel overpass		Potential for an impact on 939 51m3 of archaeological deposits depending on the depth of the natural Potential low medium impact	Intrusive evaluation of 12% (412m2) site sample
	Mkalles	OP	deep	17,900	2,290	12 79	3.00	No		A high tension electric line running E-W underneath the Mkalles roundabout at a depth of 1 50m Other Tele, water and sewer lines run within the project area at a depth up to 2 0m	Potential for an impact on 878.7m3 of archaeological deposits depending on the depth of the natural Potential medium high level impact	Intrusive evaluation of 15% (344m2) site sample
2	Beit Al-Atfal	UP	shallow	33,600	9,000	26 79	7 00	Yes	During the construction of the existing underpass along Bchara El-Khoury under Corniche EL-Mazraa		Potential for an impact on 12,055.5m3* of archaeological deposits depending on the depth of the natural Due to nature of previous intrusions potential low level impact	Intrusive evaluation of 10% site sample
	Airport	OP & UP	shallow	33,600	11,450	34 08	7.00	Yes	Infrastructure under both Airport Rd & Chiyah Blvd was completely rehabilitated in 1994and 1996	Utilities (T,E,S,W) lines run underneath Chiyah Blvd. and Airport Rd. at a depth up to 2m.	Potential for an impact on 19,511m3* of archaeological deposits. Due to the nature of the archaeology of the area despite later intrusions, potential for high to medium level impact	Intrusive evaluation of 15% (1,717m2) site sample
	Mar Mkhael	UP	shallow	14,710	7,310	49.69	7.00	Yes	Infrastructure under Chiyah Blvd was completely rehabilitated in 1994	Utilities (T,E,S,W) lines run underneath Chiyah Blvd at a depth up to 2m	Potential for an impact on 25,426.4m3* of archaeological deposits. Medium to low level impact.	Intrusive evaluation of 10% (750m2) site sample.
	Mucharrafieh	OP	deep	19,250	2,800	14.55	3.00	Yes	Infrastructure under Chiyah Blvd was completely rehabilitated in 1994	Utilities (T,E,S,W) lines run underneath Chiyah Blvd at a depth up to 2m	Potential for an impact on 1,222 2m3 of archaeological deposits Medium to low level impact.	Intrusive evaluation of 10% (280m2) site sample.
3	Sami El-Sol	UP	shallow	16,380	6,970	42.55	7.00	No			Potential for an impact on 14,829m3* of archaeological deposits. Potential high level impact.	Intrusive evaluation of 20% (1392m2) site sample
	Museum	UP	shallow	15,670	7,615	48.60	7.00	No			Potential for an impact on 18,504 5m3* of archaeological deposits. Potential high level impact.	Intrusive evaluation of 20% (1523m2) site sample.
	Antelias	OP	deep	31,980	3,790	11.85	3.00	Yes	During the construction of the substructure units of the existing steel overpass	An existing box culvert for the Antelias River crosses the Beirut-Tripoly Hwy within the project limits	Potential for an impact on 1251m3 of archaeological deposits Potential low level impact.	Watching brief, and salvage recording
	Jal El-Dib	OP	deep	37,328	2,625	7.03	3.00	Yes	During the construction of the substructure units of the existing steel overpass		Potential for an impact on 554m3 of archaeological deposits. Potential low level impact	Watching brief, and salvage recording
	Bchamoun-Aramoun	OP	shallow	20,270	2,790	13.76	3.00	No		A H T electric line running E-W underneath the Old Saida Rd. at a depth of 1.50m. Other T, W and S lines run within the project area at a depth up to 2 0m A box culvert for the Nahr El-Yabes crosses within the project limits	Potential impact on 1,152m3 of archaeological deposits Potential medium level impact.	Intrusive evaluation of 15% (418m2) site sample
	Bchara El-Khoury	UP	shallow	20,650	9,020	43.68	7.00	No			Potential impact on 19,699 7m3 of archaeological deposits. Potential high level impact	Intrusive evaluation of 20% (1804m2) site sample
	Adlieh	UP	shallow	34,660	13,820	39.64	7.00	Yes	During the construction of the substructure units of the existing overpass along Tahwita Road		Potential impact on 27,391m3 of archaeological deposits Potential medium to high level impact	Intrusive evaluation of 12% (1656m2) site sample

(1) Deep foundation type indicates the use of drilled cast-in-place concrete piles with depth up to approximately 18m below existing ground
(2) Where deep foundation is indicated under the type of foundation, the maximum depth of excavation shown is the depth of shallow excavation needed for the pile cap and the cover on top of it

Greater Beirut Urban Transport Project. Archaeological Assesment.

Outline Staffing Levels / Evaluation Duration per Site.

Work Group	1										2							
Site	1		2		3		4		5		6		7		8		9	
	Galerie Semaan	Producing Developer Report	Hayek and Saloumeh	Producing Developer Report	Tayounneh	Producing Developer Report	Dora	Producing Developer Report	Mkalles	Producing Developer Report	Beit Al-Atfal	Producing Developer Report	Airport	Producing Developer Report	Mar Mkhael	Producing Developer Report	Mucharrafieh	Producing Developer Report
Job — Estimated Duration (weeks)	3	2	4	2	8	4	3	2	3	2	4	2	4	2	4	2	4	2
Senior Co-ordinator [1] — Staff level (N°)																		
Co-ordinator	1	1	2	1	2	1	1	1	1	1	2	1	2	1	1	1	1	1
Archaeologist	7	4	10	4	12	4	5	4	10	4	15	4	15	4	10	4	10	4
Assistant Archaeologist	3	2	10	2	10	2	4	2	5	2	10	2	10	2	10	2	8	2
Worker	5	2	17	2	20	2	10	2	10	2	20	2	20	2	20	2	15	2

Work Group	3													
Site	10		11		12		13		14		15		16	
	Sami El-Sol	Producing Developer Report	Museum	Producing Developer Report	Antelias	Producing Developer Report	Jal El-Dib	Producing Developer Report	Bchamoun-Aramoun	Producing Developer Report	Bchara El-Khoury	Producing Developer Report	Adlieh	Producing Developer Report
Job — Estimated Duration (weeks)	6	3	6	3	3	2	3	2	4	2	6	3	6	3
Senior Co-ordinator [1] — Staff level (N°)														
Co-ordinator	2	1	2	1	1	1	1	1	2	1	2	1	2	1
Archaeologist	15	4	15	4	7	4	7	4	15	4	15	4	15	4
Assistant Archaeologist	10	2	10	2	3	2	3	2	10	2	10	2	10	2
Worker	20	2	20	2	5	2	5	2	20	2	20	2	20	2

Senior Co-ordinator [1] This post is essentially one of management, liason and evaluation strategy design and implementation.

APPENDIX 1

1. Assessment of Antelias (Old Tripoli Road, Jal El-Dib.)
2. Assessment of Burj Hammoud/Dora
3. Assessment of Nahr Street
4. Assessment of Mar Nicolas
5. Assessment of Orthodox Hospital
6. Assessment of Sassine
7. Assessment of the Sin El-Fil (Saloume, Hayek & Mkalles Roundabouts)
8. Assessment Report for BCD-Soddeco-Museum-Damascus Road
9. Assessment Report for Omar Beyhum BCD-Bechara el Khoury-Tayoune & BCD-Bechara el Khoury - Chatila
10. Assessment of the Airport Road-Chiyah Boulevard Intersection
11. Assessment of Haret Hreik (Haret Hreik, Ghobeyri intersection)
12. Assessment of Mar Mekhael intersection
13. Assessment of Galerie Semaan intersection
14. Assessment of Khaldeh

1. Archaeological Assessment Report for the old Tripoli Road Beirut Urban Transport Project

Joanna Abdallah - 5/7/98

BACKGROUND

The old Tripoli road lies to the north of Beirut, starting at Nahr el Mot, it passes through Jal El-Dib, Antélias and ends in Dbayeh. It is here where it joins the modern Beirut-Tripoli motorway at the Nahr El-Kalb tunnels. (see Figure 1-1)

ARCHAEOLOGICAL HISTORY

From an examination of the written and cartographic sources it seems that the old Tripoli road may be overlying the Roman road from Antioch to Acre built in 56 AD by a legate of the Emperor Nero a Caius Ummidius Durmius. This road was repaired several times by subsequent emperors until Constantine the Great in the years 333-337 AD (Goodchild 1949:112-113, 127). The road at Nahr EL-Kelb was cut in the year 211-217 AD during the reign of Emperor Caracalla and is considered as the last major work of improvement to the Roman road (Goodchild 1949:115). Milestones have been discovered along its course from Antioch to Acre, however, in the area discussed here the only milestone found so far is the one at Nehr EL-Kelb engraved by Caracalla's legions. Traces of the road have been found at the eastern entrance of Beirut, and a milestone found near the tram depot (milestone no. 228), shows that the Roman thoroughfare entered the city from this direction after crossing the Nahr Beirut by a seven-arched bridge (Goodchild 1949: 100). To the south of Dbaye, in the area of Antélias, Paleolithic remains have been found in the grotto of Kasr Akil dating to some 13000 years ago Other Palaeolithic caves have been found in the area such as Magharet Wara' and Magharet Al-Ballaneh (Moufarrej 1969: 19-20). The Maronites are reputed to have settled in Antélias as early as the 7th C AD, and to have built a fortress to ensure their protrection against the Umayyad armies. This fortress is said to lie below the present monastery (*see Figure 3-2*) (Moufarrej 1969: 19-21). During the Ottoman occupation of Lebanon Antélias' played a key role in the violent insurrections of 1820 and 1840 against the despotism (sic) of Emir Bechir, appointed by the Ottoman authorities as Emir of Mount Lebanon (Moufarrej 1939: 19-21). To the south of Antélias lies Jal El-Dib. Though no reference to it has been found in archaeological records, Its history could however have started during the 7th century with the coming of the Maronites to the Metn and their settling of the area (Merhej 1973: 32-33). In general, this area remained as a compound of villages of the Metn area until recently where it has become highly populated and is considered as part of greater Beirut.

SUMMARY OF LIKELY IMPACT

As the area has been classified as a parking action district, there is the possibility that any excavating may disturb archaeological material. It is very likely that the road could be overlying the old Roman road that linked Antioch with Acre: or following the same trajectory. In fact, the Roman road could also be following an earlier road (Hellenistic or earlier), since the 7th century stelae of Nahr El-Kalb are evidence of a continuous use of this track until the present century where kings have inscribed either their conquests of the area, or their visits. The road was also heavily used by the medieval pilgrims on their way to Jerusalem (Jidejian 1993: 54). From the pictoral evidence it seems that population expansion into this area has occurred over the last 50 years. (see Antélias 1 below). However, possible settlements are likely to be found as a natural result of ribbon development all along the road to Beirut. Since it is presently highly populated (Dbaye, Antélias, and Jal EL-Dib), Palaeolithic sites as well as other archaeological remains are less likely to be found in the vicinity of the road. However, in less populated areas such as river beds and valleys where no land leveling or deep foundations have cut into the bed rock yet their occurrence may be less sporadic and better preserved. It must be stated that the settlement history of the area is somewhat problematic to elucidate due to a lack of systematic field work in the area and the likelihood that chance discovery of artifacts from the area during the last 25 years may have found their way onto the antiquities market thus robbing them of their context.

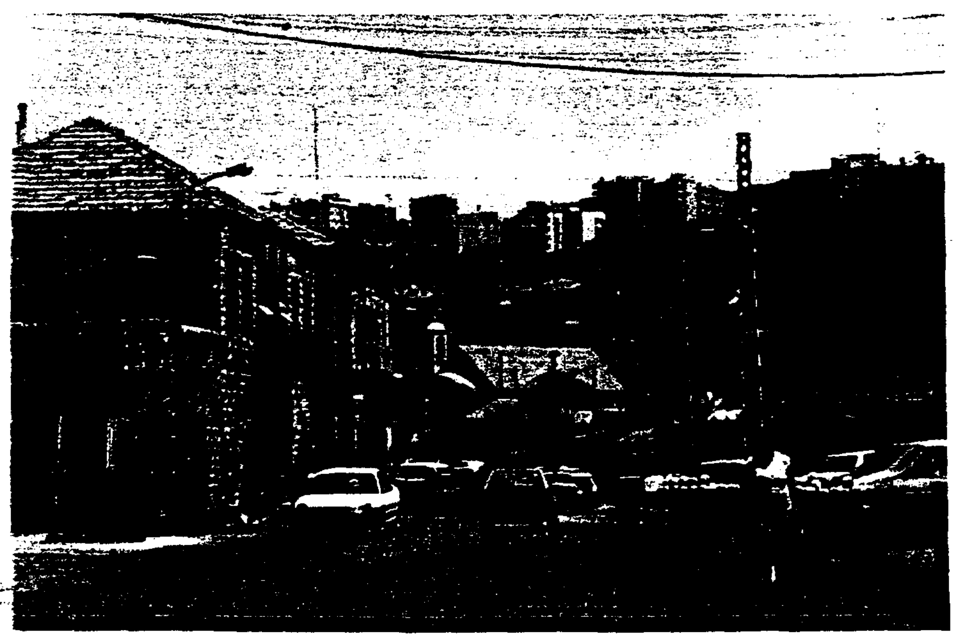
RECOMMENDED MITIGATION

Evaluation excavation is recommended in the location of deep interventions (over 0.7m) if development is to proceed no deeper than this an archaeological watching brief is recommended. In the case where ground seems to have been made or overburden extends to the level of development a watching brief is also recommended to retrieve residual artefacts in this area, though this does not preclude rescue excavation, should the level of preservation warrant such.

Gazetter of Illustrations:

Figure 1-1 Report Main Section
Figure 3-2 Report Main Section

Antélias 1-1: Antélias street along the old Tripoli road showing mandate period (1918-1943) houses with red tiled roofs



2. Archaeological Assessment Report for the Site of Burj Hammoud/Dora Greater Beirut Urban Transport Project

Joanna Abdallah - 10/7/98

BACKGROUND

This area lies north of Beirut, on the far bank of the Nahr Beirut which separates it from Ashrafieh (see 1 below).

ARCHAEOLOGICAL HISTORY

The only recorded archaeological remains from this area have been of Early Stone Age date which were found on the banks of the Nahr Beirut (Moufarrej 1969: 39). From the cartographic sources (Davie 1987 Figure 1, Figure 4-2 of this report) this area is known to be a marshy area, that was very fertile and lush with vegetation. Similar cartographic sources (Davie 1984: 53-57) show that the area was under cultivation with mulberry trees during the mid 19th century. Though there are few grounds to suspect a classical settlement in this location sporadic and isolated occupation cannot be ruled out on the margins of this marshland. If so later cultivation of the land for silk production will in all possibility have ensured a relatively good level of preservation. The area was known for its Burj that was erected by the Banu Hammoud who came originally from Morocco in order to fight against the Crusaders (El-Nimr 1994: 102). The ground remained a marshy area until the present century and more precisely the last 30 years when it became one of the major Armenian quarters in Lebanon (Moufarrej 1969:39).

SUMMARY OF LIKELY IMPACT

Burj Hammoud is presently highly populated (see plate 1 below), hence it is probable that the preservation of archaeological deposits is at best sporadic. However if archaeological levels are present it is likely that they will be very well preserved due to the anaeorobic conditions caused by water logging. However, one possible place in which Palaeolithic remains may be discovered could be the low undisturbed levels of the river bed, which has now been cannalised possibly adding to the potential for preservation in conjunction with earlier alluviation. It is also possible that remains of the eastern approach road to Beirut may be preserved as well as traces of a seven arched bridge which was recognised by Maundrell in 1697 as being of Roman origin (Maundrell 1963: 50). However, it is now built over and is covered with cement arches (Goodchild 1949: 100, 108).

DORA

Dora square and intersection (see 2 below) have not been designated as a parking action district, and it is therefore to be assumed that no deep cutting or any intrusive foundation is required. The possibility of disturbing archaeological deposits is very unlikely, other than sections of the medieval, Roman and possibly earlier road and/or possible ribbon development. The only reference in the written sources of archaeological buildings in the Dora area is the presence of a Khan on the road to Tripoli of which nothing above ground remains (Davie 1984: 56).

RECOMMENDED MITIGATION

Itr would be prudent to conduct evaluative excavations either in the form of an archaeological watching brief or in the form of evaluation trenches to the maximum depth of the intended development.

Plate 2-1: View of Borj Hammoud, heavily populated

Plate 2-2: Dora square

3. Archaeological Assessment Report for the Site of the Nahr Street Greater Beirut Urban Transport Project

Joanna Abdallah - 20/6/98

BACKGROUND

The Nahr Street is located on the northern slope of the Ashrafieh hill including the Gemayze, Rmeil, Mar-Mekhael, and Khodr areas, north of Mar-Nicholas however it is lower in altitude.

ARCHAEOLOGICAL HISTORY

Remains of the Roman road have been uncovered near the Railway station along the eastern edge of this area early this century (Goodchild 1949: 108). A milestone was also found in the vicinity near the tram depot demonstrating the approach from which the Roman road entered Beirut at its eastern entrance after crossing the Nahr Beirut by a six arched bridge (Maundrell 1963: 50), (see Figure 3-3). Lower down along the north-eastern edge of this street is located the Burj El-Khodor, which was first St. George's Crusader church and subsequently converted to a mosque, (Al-Khodor mosque). On this site, it is believed that St. George fought with the dragon and killed it by a well in front of the church (Jidejian 1993: 176-177). There is no later evidence from the litterary sources of any settlement in this area except for vegetation and the growing of sycamore trees along Gemayze area which was named after the "Gemayze" tree or Sycamore tree (Al-Wali 1993:157-158). The absence of this evidence is more likely due to poor research and a lack of informed and co-ordinated archaeological research as it is know that Roman and to some extent earlier classical settlement patterns would often line roads as they approached the city. The same is also true of craft production and artisans often working outside the city but close enough to supply the markets.

SUMMARY OF LIKELY IMPACT

The present street is densely populated and most of the buildings date from the last 30 years. Gemayze street however is known for its mandate period buildings (see plates 1 and 2); hence, there is a good potential of preservation of archaeological starta. Being a parking action district area, the possibility of hitting Roman levels is very high, thus it is possible that Roman road and/or the possible extension of a Roman necropolis and/or Roman or earlier ribbon development.

RECOMMENDED MITIGATION

At the very least an archaeological watching brief is urged. Where there is the probability that development will impact on archaeological levels that have not suffered truncation and/or redeposition it is recommended that an evaluation excavation take place. An archaeological watching brief should be conducted during groundwork in order to remove and record residual archaeological material that may have been redeposited due to earlier re-working of the strata.

List of Illustrations:

Plate 3-1: Gemayze area with a mandate period building

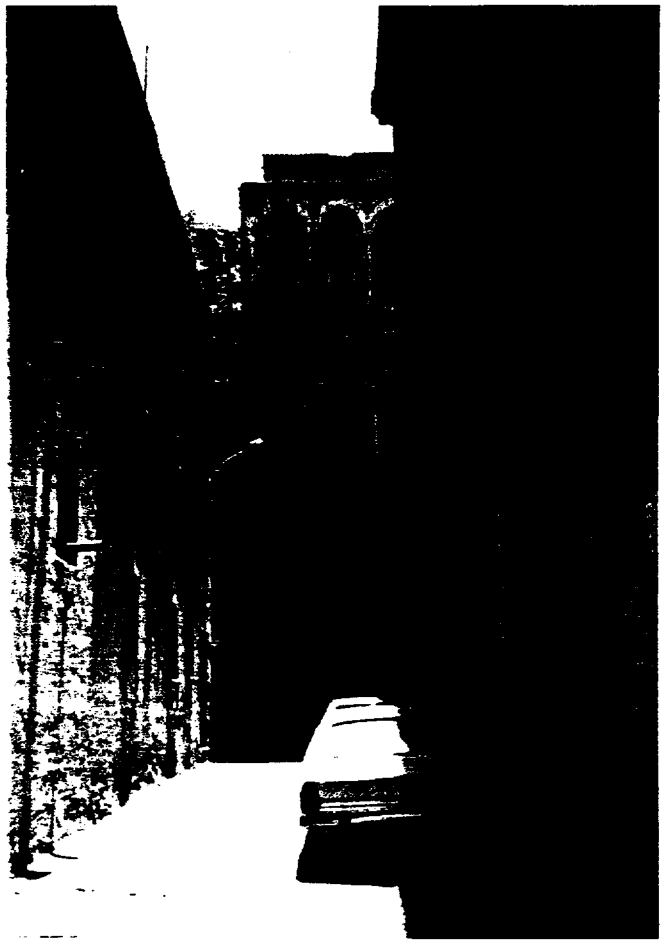
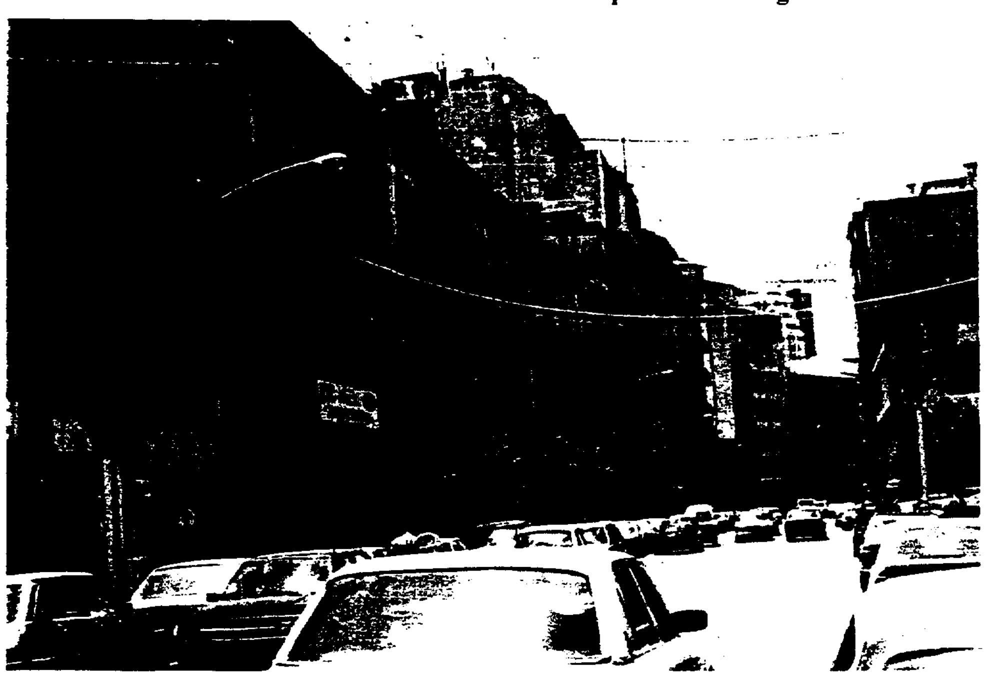


Plate 3-2: Nahr Street with mandate period buildings



4. Archaeological Assessment Report for the Site of Mar-Nicholas Greater Beirut Urban Transport Project

Joanna Abdallah- 15/6/98

BACKGROUND

This area covers the western part of the Ashrafieh hill, along the Mar-Nicholas area that lies on the slope east of the central district rising to Sassine square, the highest elevation in Ashrafieh.

ARCHAEOLOGICAL HISTORY

Together with the Ras Beirut hill, the Ashrafieh hill dominates the approach to Beirut (*see Figures 3-3 & 3-4 main report*). These hills have been considered as ideal for defence and communication, as they command the southern and northern coastline and the pass between the hills and the river fords (Davie 1987:146-147). It is however, not suitable for any settlement due to its infertile soils, its small summit, and its steeply sloped sides which make it inappropriate for agriculture (Davie 1987: 147). Ashrafieh was known to be a Roman necropolis, where several sarcophagi have been found scattered all around the hill (*see Figure 3-1 main report*). One Romano-Byzantine necropolis was found in Alfred Sursock's propriety on Sursock street (Jidejian 1993: 90). A Burj (tower) was later erected next to the house of Moussa Surscok some 150 meters away from St. Nicholas church and was known as Burj Karkouti. It does not stand there anymore, as it was destroyed in 1953 prior to the construction of the Italian embassy (Al-Nimr 1994: 104). Until the end of the 18^{th} century, this area, being a suburb of the walled city of Beirut, was a rural, highly vegetated area (Davie 1996: 31). It was not until the end of the 19^{th} century that it became more densely populated by the bourgeois families of Beirut, where they built their villas and gardens at the foot of the hill dominating the city (Davie 1996: 63) (*see Figure 3-4 main report*).

SUMMARY OF LIKELY IMPACT

Most of the buildings in this area date to the mandate period, therefore the potential for the preservation of archaeological levels maybe good. As this area is classified as a parking action district, it is likely that archaeological levels will be encountered. It is likely given the discoveries in the region of the Sursock House that the necropolis of Roman-Byzantine Beirut could have extended in to the locale of Sursock street including the municipal garden (see plate 4.1.) Some ground leveling has been done along Fouad Chehab avenue, which may have destroyed some later archaeological activity. However at the areas south eastern extremities, deep truncations and relatively little intact archaeological stratigraphy is expected due to much new building activity with no archaeological component attached to the project. (ex. Centre Sofil).

RECOMMENDED MITIGATION

An evaluation is recommended in this area, deep truncations of former cellars etc. may be used to gain some insight into the topography of the urban deposits in the area by removing their walls and cleaning and drawing the resulting section. Any deep intrusion that is not cutting through already disturbed ground, or that cuts through made ground should have an evaluative excavation conducted in advance. Development groundworks and the laying of services should be subject to watching brief archaeological recording.

Plate 4-1: The Municipal Gardens in Mar Nicholas. Some limited preservation may be expected

5. Archaeological Assessment Report for Site of the Orthodox HospitalGreater Beirut Urban Transport Project

Joanna Abdallah - 26/6/98

BACKGROUND

The area includes the Orthodox Hospital which is on top of a cliff dominating Nahr Street

ARCHAEOLOGICAL HISTORY

The area is situated on a high promontory that is still steeply sloped from its northern and eastern boundaries where it overlooks the river and the "quarantina" area respectively (*see Figure 1-2*) There is no reference to archaeological discoveries from this area in the literary sources examined. According to maps from the 19th century, the area was sparsely populated with a scatter of houses (*see Figure 3-4*). Moreover, from the map by Du Buisson (1924) the area is completely empty by comparison with other places on the Ashrafieh hill. Sarcphogi have been recorded to the north, the south-east and west of the hill (*see Figure 3-1*). The immediate area, like all of Ashrafieh hill, is considered as a good defensive position. However, the supposed infertility of the summit coupled with its lack of water sources would seem to make it unsuitable for settlement in antiquity. It is possible however that as a prominent point there may have been shrines or some form of ritual structure in the vicinity of the Orthodox Hospital.

SUMMARY OF LIKELY IMPACT

Presently, the area is densely populated. The buildings range in date of construction from the 1960s to the present, and there is a very high possibility of truncation into archaeological levels due to deep building foundations. However, archaeological deposits may be preserved on pillars of archaeological stratigraphy between building piles and deep basementing. In the case of preservation of any archaeology, (the area could be an extension of the necropolis on Ashrafieh hill, as sarcophagi have been noted by Du Buisson to the north and south of the area).

RECOMMENDED MITIGATION

Evaluative excavations are recommended in this area prior to developer intrusive groundworks. It is also recommended that watching brief recording and archaeological monitoring should take place during infrastructure works such as pipe laying etc.

6. Archaeological Assessment Report for Site of Sassine Square Greater Beirut Urban Transport Project

Joanna Abdallah - 31/6/98

BACKGROUND

This area deals with Sassine square, formerly known as Ashrafieh square, which lies on the top of Ashrafieh hill at its highest elevation. (*see Figures 3-5 & 3-6*).

ARCHAEOLOGICAL HISTORY

Due to its altitude (100 O.D.) and its small summit, this hill is not considered to be appropriate for cultivation, nor settlement. It could however have been chosen as a necropolis for the inhabitants of the city of Beirut through out the ages. Roman sarcophagi have been found on to its western side near the Nazareth convent (Mouterde 1929: 241) as well as numerous others scattered around this location (*see Figure 3-1*). It may have also served as a Roman temple site due to its high location later reused as source of building materialsa in later periods. There is the possibility that at some stage the summit may have served as a defensive area possibly in the early Islamic and later Crusader periods due to its good defensive qualities from the eastern side where the slope is very steep running towards Sin EL-Fil. It also commands the view to the northern coast, the eastern mountains, and the river gorge of Beirut that flows bellow it. In the 19th century and beginning of the 20th century, the area was sparsely populated (*see Figure 3-4*). It was not until the latter half of the 20th century that settlement density increased in this area. A tunnel has been excavated beneath the summit, connecting Mar Mitr street on the northern side, with Alfred Naccache street on the other side of the hill thus destroying any archaeology present. (*see Plate 6.1 below*).

SUMMARY OF LIKELY IMPACT

The slopes around the summit of the hill are still steep which implies that not much ground levelling has taken place. Although a tunnel has been dug deep below Sassine square, archaeology should be present along its eastern and western extremities, and should not be very deep bellow ground level.

RECOMMENDED MITIGATION

Evaluation excavation around the eastern and western extremities of the hill should be conducted if development were to impact on these areas. An archaeological watching brief should be conducted during other groundworks to retrieve and record any fragmentary archaeological deposits.

Plate 6-1: Sassine Square looking to the North

7. Archaeological Assessment Report for the Site of Sin El- Fil Greater Beirut Urban Transport Project

Joanna Abdallah - 14/6/98

BACKGROUND

Sin El-Fil is on the eastern side of Beirut, south of Burj Hammoud area. Including Saloume (*see Figure 4-3*), Hayek (*see Figure 4-4*), and Mkalles roundabouts, this area mainly lies in Sin El-Fil.

ARCHAEOLOGICAL HISTORY

Considered as a part of Greater Beirut, Sin El-Fil has been chosen as a settlement since the Middle Bronze Age period. Although the site hasn't been highly populated until the present century. During the Bronze Age it was considered as a town under the control of the city-state of Beirut (Jidejian 1993: 33, Ward 1970: 22). Maurice Chehab uncovered Phoenician tombs there in 1939 (Chehab 1939: 803-809). The area was later known as a Roman suburb to the city of Berytus, on the main road to Deir el Kalaa, where an important religious cult was performed dedicated to Baal Marqod, god of the earthquakes (Jidejian 1993: 95). Sin El-Fil was later populated by the Maronites, an 8th century church was built there and was built over in the present century (Moufarrej 1969: 116, Merhej 1973: 220). It is also mentioned that Sin El-Fil was the site of several battles between Arab tribes and the Crusaders on their way to Jerusalem in the 11th-12th centuries AD (Moufarrej 1969:116, Merhej 1973: 220).

SUMMARY OF LIKELY IMPACT

The Sin El Fil area is on high ground, higher than the Burj Hammoud area. It is now considered to be part of greater Beirut, a process that began in the present century when more intense urban settlement than in more recent history began. Since this area has been known to have a continuous settlement, it is highly likely that any intrusive groundworks on previously undisturbed ground will impact on archaeological deposits. The buildings around these roundabouts are not high rised, and if one considers that the earliest buildings date to the 1950s or a little earlier, the potential for a good levels of archaeological preservation in the area is very high.

RECOMMENDED MITIGATION

Archaeological evaluation excavations with a view to full excavation/post excavation and publication or preservation in situ. Watching brief recording of service trenches and shallower intrusions.

8. Archaeological Assessment Report for BCD-Soddeco-Museum-Damascus Road Greater Beirut Urban Transport Project

Amelie Beyhum - June 25th 1998

BACKGROUND

This assessment is of the portion of Corridor 5 (BCD-Museum-Chevrolet Damascus Road) which covers the Damascus Road, commencing on the Emir Bechir Road in the north, until the intersection with Charles Helou Road, passing through Furn El Chebbak. This area includes the Grade Separation Location of Museum Place which will be discussed as part of this report simply because of its continuity with the Grade Separation Location of Palace of Justice square. The traces of a hill are slightly apparent along the Damascus Road as the route is much lower than the cemeteries (which are accessed by stairs up) and lower than the few remaining empty lots. There is the question as to whether this implies that any of the earlier road structures may have been horizontally truncated away, if one excludes the natural tendency of urban strata to accumulate if not deliberately re-worked and removed. The level of the present Damascus road may then be higher than surrounding properties due to the superposition of earlier road surfaces but lower than the nearby cemeteries due to the actions of grave digging and soil accumulation. In addition, the slope of the Damascus road into the present Central District of Beirut (BCD) is very apparent. It is noticeable that in the area of Furn El-Chebbak, where the portion of the Damascus road passes through the road is completely flat. The area still retains the buildings constructed around the 50's. These generally range from six to eight floors in height and are not deep basemented. It is also apparent that the area of Furn El Chebbak still contains water and that the water table is quite near to the surface in this location (*See Figure 3-6*). The southern portion of the Damascus Road in the area near Hazmiyeh, one observes that the buildings are more modern in origin (post 1975) and were probably constructed on what appears to originally have been open lots of land. The site visit was conducted by Amelie Beyhum on July 22nd 1998.

ARCHAEOLOGICAL HISTORY

Furn El Chebbak

Morphology

The 65 meter marine terrace corresponds to a period when the principal hills of Beirut, Ashrafieh and Ras Beirut constituted two small islands at that time the mouth of Nahr Beirut was situated near Furn El Chebbak (Dubertret 1945-1946:50; Saidah 1970:3). These two hills, occupy the northern part of the peninsula, and overlook low-lying areas to the north and south. To the south a flat plain extends towards Burj al Barajneh and Chweifat. The soils are rich and fertile with deposits washed from the overlooking hill. However, the south-west, sand dunes which result from sediments brought to the shore by sea currents and blown inwards by the prevailing south-westerly winds have encroached on this plain. As vegetation has been unable to take over this area, the dunes have slowly advanced rendering agriculture precarious on the fringes of the fertile plain (Davie 1987:144). West of the two hills there is a marine erosion surface that constitutes part of the plain mentioned above, this includes the Mazraa, Berbir and Horch-Musuem areas (Ibid). On the Beirut peninsula movement was limited to a very narrow corridor, between the mountain on one side and the sand dunes on the other. These dunes blocked all movement along the coast, right up to the western hill, at what is today Ramlet al Bayda. One could not follow the beach in that general area because it is blocked by the Raouche cliffs. Access then must have been northwards as the Beirut river, blocked movement along the axis of Chweifat-Hazmiyeh-Gdaydeh, though some fords were passable but only during the summer, at low water. Bridges may have been built in antiquity but were limited by the technology used. Long-spanned bridges were not possible over the Beirut river, near its estuary, where it separated into several channels before reaching the sea.

It seems sensible to assume that movement along the coast would have been northwards between the two hills, were the topography was relatively flat, well drained and without obstacles or potential dangers. The hills are some distance away and relatively low. This axis is today reflected in the Damascus Road and Basta Roads. General topographical considerations must be combined with a detail examination of the Beirut peninsula's history in order to understand the rationale for the selection of the site for the city and the development of its suburbs (Davie 1987:146). The soils of Ras Beirut are not especially fertile and as the summits of the Achrafiyeh and Ras Beirut hills are small and slope steeply on all sides these locations were poorly suited to agriculture. Farmers would have therefore descended further down to the flatter and richer areas, such as the Hamra-Kantari-Basta-Sodeco-Geytawi marine terrace, to the north or to the Berbir-Museum terrace to the south (Davie 1987:146). Beirut was also located at the outlet of a passage between two hills -the only route along the coast. Beirut was an obligatory staging-post, conveniently situated halfway between Sidon and Byblos, and less than a day from Shweifat to the south and Sabra-Kaslik to the north (Davie1987:148). Beirut continued to serve as a main staging-post on the coastal Levantine axis, where ancient trade routes from the interior converged on its harbor and made it a valuable base over the millennia period (Davie 1987:157).

Prehistoric Cultural Remains

At the turn of this century at Furn El Chebbak, fifty Lower and Middle Acheulean stone bifaces of various form, patina and material as well as tools were gathered by Raoul Desribes as surface finds (Khalieh 1997:293; Jidejian 1993:21). This site identified as an open air station was located at Furn El Chebbak on the near bank of the Nahr Beirut. Today this settlement lies under modern apartment buildings (Jidejian 1993:12). The region of Furn El Chebbak close to Nahr Beirut used to constitute marshy land. A ford was located between Furn El Chebbak and Sin El Fil (Davie 1984:56). Davie also notes that all the maps drawn before 1840 are incorrect and inaccurate. Later additions to these maps show the addition of indications of sarcophagi and grotto burials. Unfortunately it is not specified to what period they date

Silk Production

It is interesting that the map of Beirut and its Suburbs of 1840 (*see Figure 3-4*), reveals extensive gardens and plantations of mulberry trees, represented in plots. It is possible that the patterns of land division represented on these maps are an echo of earlier land division. These allocations appear to be in the area of the Damascus Road and Furn El Chebbak, or the Hippodrome and Pine Forest region. In addition, the 1841 map of Beirut (*Figure 3-7*), the area of Bachoura, between the Basta Road and Damascus Road, is indicated as being built up with degraded mulberry plantations waste or fallow land. The placement of agricultural land division on the maps of 1840 to 1876 are not the most precise localization of the sectors of mulberry plantations, unfortunately we cannot therefore indicate the precise limits of the culture (Davie1984:45). The historical sources mention the presence of vast mulberry plantations intra and extra murous. The rapid expansion towards the end of the 19th century with the demolition of its defences marked the beginning Beirut's modern urban sprawl which overran the gardens and mulberry plantations surrounding the city.

Two inscriptions found in Beirut relate to the silk industry of the city. During the fourth and fifth centuries AD the silk industry was controlled by the Emperor. Large plantations of mulberry trees appeared, the leaves of which were used to raise silkworms (Jidejian 1973:74-75). After a decline, Fakhreddine revived the silk industry in the seventeenth century, Beirut was described by contemporary travelers as a place where an important public silk market took place every August (Debbas1986:8). In 1832 Lamartine described "they work, at the foot of the mulberry trees, at these beautiful silk cloths.....whose threads they attach from tree to tree and they weave in the tree's shade" (206-7). After 1860 Lebanon's role in silk production changed from that of an integrated industry, to one of silk worm breeding and coon-reeling to provide the raw material for French silk manufacturers. By the turn of century Lebanon had become virtually a single-crop economy. When the French demand for Lebanese silk vanished Lebanon suffered a major decline, except for a short revival in its fate during the 1930's (Joumblat et al 1989).

Roads

The survival through time of an ancient street pattern is of importance. Some of the roads, however are conditioned more by local topography than by history: fords, natural obstacles, marshy land etc. all determine the direction of movement (Davie 1987:148). The major axes of circulation were Beirut-Tripoli, Beirut-Sidon and Beirut-Damascus from the literary sources these appear continuous over time. The road running eastward from Beirut towards Baalbeck is not indicated, as its course in the vicinity of Beirut is uncertain (Goodchild 1948-1949:116). One of the three principal roads, the Damascus Road begins under the Borj el Keshef, and passes toward the south-east in the proximity of the several Khans. From 1876 map (*see Figure 3-4*) it is apparent that the old coastal road from Old Beirut is the continuation of the Basta Road. This road continues in the direction of Dear el Kumar. There is a Khan located along the Basta Road on the way to Sidon. Another track also takes one to Sidon, which crosses the sands on the western edge of the Beirut peninsula, with a khan as a relay or carrefour that takes one towards Nebbi Wezahi (Davie 1984:56). As stated above it is natural that the movement would have been between the two relatively low hills, as the topography between them is both relatively flat, well drained and without obstacles or potential dangers. These routes of access to Beorut hinterland and further a field form the contemporary axis of the Damascus and Basta roads (Davie 1987:146).The Du Bussion map 1924 (*Figure 3-1*) of Beirut indicates that the Damascus Road contained a Bir (well) el Harifeh and a sarcophagus nearby.

The 1841-1842 maps (Davie 1984:53) show the environs of Beirut, though they show only portions of the Beirut-Damascus road between the Ashrafieh and Ras Beirut hills. The Damascus Road was opened for horse-drawn circulation in 1863 (Jalabert1970:86). A French company had secured permission from the Turkish government to construct a road from Beirut to Damascus, and horse-drawn vehicles used it. The Damascus Road started south of the Borj square and ascended the hillside in a series of slight bends. Generally the surroundings of this road in the 1860's were semi-rural, with Maronite, Jewish and Protestant cemeteries (located along the road) marking the town limits (Debbas 1986:161). Today these cemeteries no longer mark the limit, but in general the area on both sides of the Damascus Road is not densely occupied. Photographs in the Debbas Collection reveal that in the Basta region especially along the Damascus Road it was surrounded by typical Lebanese Houses with the occasional gardens; which have since been destroyed and replaced by buildings that date to the 1950's and 1960's. Many khans were located along the Damascus and Basta route.

Khans

The Khans of Beirut have been scarcely studied. They are however, of particular importance as they formed necessary stops when traveling between the city and its hinterland. Eighteen Khans are mentioned as existing during the second half of the 19th century, unfortunately theses are recorded on an inaccurate map (Chevalier 1972:6). On the Damascus route towards the south, there is evidence from the cartographic sources of a military camp and two Khans. On the Damascus Road towards the southern portion where road forks there is also a khan depicted, at the section where both portions of the road run into an area of pine trees, this undoubtedly equates with today's region of the Hippodrome and Pine Forest. It is possible that the southern fork equates to what today forms the southern portion of Bechara el Khoury

Avenue. Contemporary sources show that the road continues into Furn El Chebbak which is shown as Mulbery plantation. These mulberries reach all the way to the Nahr Beirut. Contemporary nineteenth century maps also show that a Khan (of Barjaou) was situated 100 meters before the road forked through the pine forest. This khan was situated at the northern entry of Furn El Chebbak and served as a meeting place for inward and outward bound caravans. A little farther to the north there is evidence of a second Khan (Djedi) which was located on the plain of the Palace of Justice, on the meridional limit of the urban authority, towards the Pine Forest and Mar Mekhael, where there exists today the Mohammad el Hout Road, that takes one towards Choueifat. The Khan Djedi was found in the sector of Mazra' at Maydan, close to the Horch Mosque. The land situated between these two khan comprises the actual hippodrome, which undoubtedly refers to what once was called the maydan (fields) (Davie 1996:32). The hippodrome, Beirut's race-course was opened in 1921. The red soils in the region of the hippodrome are some 9 meters in thickness (Dubertret 1945:21). Strongly suggesting that traces of archaeological activity may still be protected within and under this soil. The Damascus road passes another Khan, situated on the hill of Hazmiyeh in the direction of Damascus. A further Khan located south of a Borj (tower), on the summit of a hill (possibly what is today Borj Abi-Haidar) in the Nouairi sector (Davie 1984:47). Note the regularity of these khans, installed at regular distances along the important roads. Undoubtedly they were located at these locales over hundreds of years as they satisfy a function that depends on the same means of travel (Davie 1984:55-56) indeed there is little reason to assume that the role of the *Mansio* of the Roman and Byzantine periods had not been adopted by the Khans of the Islamic period and it is even possible that their sitting may have corresponded given the antiquity of the Damascus road. As of 1922 all the ancient Khans were demolished. A large structure was also located on the 19th century maps, this had the form of an enclosure with a central court, with the name tagwhetah (Davie 1984:56). This corresponds to the actual Tahouita, which today signifies an enclosure, which is an actual sector in Furn El Chebbak.

SUMMARY OF LIKELY IMPACT

It is possible that the lower level of the Damascus Road indicates that in the past there was a certain amount of denudation or leveling down, which may have removed any earlier roads. However it is also equally possible that leveling up around the road for construction of buildings and the creation of soil during the agricultural process may be responsible for the disparity of these levels. The placement of any construction, whether ground grading, underpasses/overpasses, or underground car parking on the Damascus Road in the sector of Furn El Chebbak may encounter archaeology; in addition to the Grade Separation Location of Furn El Chebbak. The modern apartment buildings in this location appear to be the original structures built in this region, during the 1960's and 1970's, and as such they may not have disturbed the archaeological deposits too much leaving islands and tracts of archaeological stratigraphy preserved. It is already known that there were prehistoric open air stations in the vicinity of the Nahr Beirut. Further possible that certain pockets of archaeology will be preserved under some of the buildings, as there appears to have been little leveling down as the area was already flat to start with.

RECOMMENDED MITIGATION

If possible it is advisable to place evaluation trenches or watching brief machine trenches as close as possible to the present road to determine if any archaeology is present, especially the presence of road deposits and/or ribbon development/frontages. It is possible that in the locales of the known Khans traces of their foundations and associated features will be preserved. As the antiquity of these Khans is open to interpretation archaeological work in these areas should elucidate their changing morphology and date of establishment as well as determine the presence or absence of a precursor. If work is necessary in these areas, initial preservation could be determined by a watching brief followed if necessary by more complete excavation. The area of the hippodrome is especially sensitive and an eye out must be kept for any traces of red soil, as these may be as thick as nine meters in places and contain archaeological deposits within them. It is also important to assess the presence and preservation of any other possible structures (most likely Classical) on the outskirts of the old city of Beirut, in the form of ribbon development or funerary structures, these may explain the remnants of columns, building blocks, observed by medieval and later travelers.

9. Assessment Report for Omar Beyhum BCD-Bechara el Khoury-Tayoune & BCD-Bechara el Khoury-Chatila Greater Beirut Urban Transport Project

Amelie Beyhum - June 22nd 1998

BACKGROUND

This assessment of the BCD - Bechara el Khoury – Tayoune, BCD - Bechara el Khoury – Chatila, and covers the Avenue of Bechara el Khoury which commences from the Emir Bechir Rd in the north to Omar Beyhum square where road the forks into Omar Beyhum Rd. It also covers the Airport/November Avenue, until it intersects with the Omar Beyhum Rd and the Airport/November Avenue into J. Abdel Nasser Avenue. This includes the Grade Separation Location at the intersection of Bechara el Khoury Avenue and Independence Avenue and the Grade Separation Location of Omar Beyhum Square. The area along Bechara el Khoury along the fork into Omar Beyhum Rd and into the Airport/November Avenue has a mixture of buildings constructed over the 1950's, 1960's, 1970's, and since the end of the Lebanese civil war. the underpasses and overpasses. However, this area contains many standing buildings ravaged by the war. No construction sites were found along the roads enabling an examination of the stratigraphy of the sector. However, on the actual road of Bechara el Khoury, after the Omar Beyhum Place I found a small cut segment that revealed the lowest strata composed of the red soils that once covered this region these are reminiscent of the red soils in the hippodrome area and are discussed above. It is distinctly apparent that Omar Beyhum Rd appears to have cut through the Pine Forest, as is apparent from the surrounding Pine Forest on both sides of the road, and additionally by fact that the medium of the road actually contains pine trees .In addition, the drop of the Bechara el Khoury road into the present BCD is very apparent. This reflects the drainage pattern which explains how water flowed into old Beirut from the various points on the Basta/Abi Haidar hill.

Survey and site visit conducted by Amelie Beyhum on July 1st 1998.

ARCHAEOLOGICAL HISTORY

Urban development outside the city walls

The narratives of early travelers describe Beirut at the end of the 18th century as no more than a small harbor with a safe anchorage (Debbas 1986:8). In general travelers passing by the city of Beirut seemed unimpressed. Around the end of the 18th century Ahmad Pasha el Djezzar had reconstructed the city walls over the ancient enclosure, in order to ensure that potential attackers would not find taking Beirut easy. He razed orchards outside the city walls in order to defend himself from surprise attacks. At the start of the 19th century Beirut was a "village" with six thousand inhabitants enclosed within the city walls which included several open areas. Until 1835 the city of Beirut was completely fortified, about ¼ of a square mile surrounded by gardens. In 1837, Leon de Laborde observed that half of the population of Beirut lived in the gardens surrounding the town (Leon de Laborde 1837). His illustrations include a view of the city walls of Beirut, from which is apparent the cactus and rocky relieves of the terrain outside the city walls (Jidejian 1973:10).In general the area outside the city walls could distinguish into two different areas: the fallow places (e.g. watchtower, Khans, cemeteries, etc) and desert areas with cactus some gardens, and the agricultural fields (Du Buisson 1921:235-236; Davie 1996:30).

In 1840 the British demolished large sections of the enclosure walls during their bombardment of the town. The British naval squadron and their allies bombarded the city of Beirut, in order to liberate Beirut from Egyptian rule and prop up the 'sick man of Europe'. In the first half of the 19th century, during the Egyptian occupation, under the initiative of Ibrahim Pasha (1789-1848) a programme of demolition of parts of the city walls and ramparts was initiated with a view of extending and developing the city outside its walls. This marked the beginning of the extension of the city to the east in recent history. However, Beirut had expanded even before the time of Ibrahim Pasha's alterations.

During the second half of the 19th century the aqueduct of Herod the Great was damaged and the Sea Castle and Crusader fortress disappeared. Towards the end of the 19th century, with more efficient security the city began to expand rapidly and became more commercial and less residential as the inhabitants started to move into its outskirts. It is recorded that by 1880 Beirut had around 100,000 inhabitants and one could no longer observe any remnants of the city wall. In 1894 it was decided to create urban space along western European lines. Jemal (Cemal) Pasha wished to modernize the city and in 1915/16 new parallel and wide roads were cut (e.g. Allenby, Foch, Fakhreddine/Riad Solh Rds) through the old quarters of Beirut. During the second half of the 19th century a new historic period characterised by urban growth took place between 1860 to 1918, (Davie 1996:39). In addition, to what was not demolished intentionally, the earthquakes to which Beirut has been prone must account for the destruction and hence the lack of visibility of earlier archaeological remains. The intensity of the earthquake of 551 A.D. is reported to have caused the buildings of Beirut to collapse and brought down the Roman aqueduct which supplied the city with water (Jidejian 1973:71).

Though Davie mutes that the later fortifications and defences of Beirut were mostly likely identical to those of the Roman period (Davie 1987:157) there is little archaeological evidence to support this assertion. The line of the defences does however date back to at least the 10th century. They were gradually eliminated in the course of the 19th century beginning in 1840. Remnants of the city wall could still be found in the 20th century, even though had been destroyed and restored on several occasions.

Beirut by the end of the 19th century had lost any pretence of grandeur. A description of the city following the departure of the Egyptians, given in 1870 by William M. Thomson, foresaw the rapid rise and commercial development of Beirut: "Within the last thirty years our city has rapidly increased in population, commerce and wealth......thirty years ago there was scarcely a decent house outside of the walls; now two-thirds of the population reside in the gardens, and hundreds of convenient dwellings, and not a few large and noble mansions, adorn the charming suburbs. No city in Syria, perhaps none in the Turkish Empire, has had so rapid an expansion....and it must continue to grow and prosper......if Beirut can attract the mighty line of trade and travel to her door, she will quickly take rank among the great cities of the world...." (Thomson 1870:37). In studying the way the city physically developed two principal trends emerge, the first being the expansion within the walls built primarily for defence, the second occurring when the notion of a "walled city" disappeared and expansion stretched beyond. The moment the notion of defence disappeared and the "wall" lots its significance, expansion became tentacular and "suburbs" began accumulating in a most anarchic manner (Salam 1970:168). In addition, at the turn of the century the tramway had reduced the time spent traveling into Beirut from the suburbs. During the 1920's the city of Beirut was concentrated in the area around the old harbor and the main square of the Borj (Martyr's square) (an area of 700 meters by 700 meters), while the areas of Zeitoune, el Bachoura, Mousseitbeh, Saifi, Rumaili and Ashrafieh served as suburban residential quarters (Ghosn 1970:186).

The period between 1920-1950, corresponding roughly with the French Mandate, saw an expansion of the city to the east-west and north-south. The dense part of the city stretched out to include St. Dimitri, Ashrafieh, Rumaili, Saifi, el Bachoura, Mouseitbeh, Ras Beirut (along the coast and Bliss Road, with the region of Hamra Street still being amid orchards), an area of 1.5 kilometers (Ghosn 1970:189). The demographic pressure and the sudden growth of Beirut during the fifties had its repercussions on the outskirts. The Beiruti families moved and installed themselves outside the walls in the closest regions. They settled at Mazra'at ay Saifi in the east and in the sectors near Bab al Dirkah and Bab Yacoub at Ghalghoul/Ain al Bachoura, Mazra'at al Qantari and Zaytouni, to the south and west (Davie 1996:35). The small villages surrounding the capital (Chiyah, Borj Brajneh, Sin el Fil, Antélias) were all being converted into capitals and slowly closing in on Beirut (Salam 1970:175). The capital in the 1950's underwent an unpredictable and colossal expansion with almost no planning provision for it (Salam 1970:176). The city of Beirut was expanding in all directions and had absorbed all or most of the satellite settlements around it.

The ancient maps are historical sources of prime importance, as they illustrate the morphology of the city before its rapid expansion towards the end of the 19th century. In general the reliability of the post-1840 maps is excellent, whereas the pre-1840 are quite inaccurate (Davie 1987:144). The pre-1840 maps are useful however as they note the presence of ancient ruins, on the outskirts of the city, south of the walls (Davie 1987:143-144). The Beirut and Suburbs map of 1840 (*Figure 3-7*), shows the presence of granite columns in the region outside city walls, in what today roughly corresponds to the region of Bechara el-Khoury and slightly south. As the maps were drafted by military engineers their interests were essentially to produce documents that could have been used in event of military action. All the topographical details are marked: cliffs, hills, hillocks, stream incisions, vegetation (both natural and planted) (Davie 1987:144). The pre-1840 maps or paintings also indicate fallen columns outside the medieval walls, suggesting that the Roman city of Berytus and its suburbs extended southwards. It is probable that the Roman (perhaps even Hellenistic) city extended much farther than the medieval walled city. However this does not imply that the walls of the Roman colony extended so far that the extensions were suburbs other than ribbon development The profusion of granite and marble columns and stone blocks scattered within and outside of the city impressed medieval travelers to Beirut. Indeed these architectural elements were so numerous that Nasir-i-Khusrau, a Persian who journeyed to Beirut in A.D. 1047, recorded in his diary that the surrounding plain was covered with columns and capitals of marble and granite (Nasir-i-Khusrau. 1047, PPTS IV 1983:9-11; Jidejian 1973:3). However, conversely Nasir-i-Khusrau saw no remarkable buildings still standing on the surrounding plain.

Many of these columns have since disappeared, and have certainly been re-used in other constructions. As late as the 17th century the abundance of granite shafts still attracted comment. In 1697 Henry Maundrell passed by the city of Beirut and recounts that "On the south side the town-wall is still entire, but built out of the ruins of the Old City, as appears by pieces of pillars and marble, which help built it.....A little without this wall, we see many granite pillars, and remnants of mosaic floors, and in an heap of rubbish, several pieces of polished marbles, fragments of statues, and other poor relics of this city's ancient magnificence." (Henry Maundrell.1697, 1769:38, Jidejian 1973:3).

In 1799 F. B. Spilsbury sailed into Beirut harbor with the British fleet and wrote, "The town is walled round with towers at intervening distances. On the outside of the walls are some extensive ruins which reach down to the edge of the sea." (F. B. Spilsbury, 1823:25) (Jidejian 1973:4). All accounts are corroborated further by many prints of ancient Beirut by travelers in the 19th century. In addition, at the end of the 18th century el-Djezzar sent entire boatloads of marble columns and stone blocks from Beirut, Sidon and Tyre to construct the magnificent mosque of Acre (Jidejian 1993:XV).

Water Supply

The problem of water supply to the city of Beirut was apparently solved very early in the history of the city. Water was available in the area between the two hills, the source of Ras el Nab'a, whose water ran down the slope to the coves. Numerous springs supplied Beirut with water, however during the Roman period a developing colony with the demands of its public buildings required an increased water supply. A large aqueduct was built that spanned the Nahr Beirut and carried water to the city. The aqueduct itself crossed the river from north to south for a distance of 240 meters and consisted of three superimposed levels of arches across the river. The aqueduct is locally called "the bridge of Zebeida". This feet of elaborate engineering of twelve masonry arches or vaults, are still visible along a ledge of the cliff and to the right of the tunnel entrance there are many well shafts sunk in the course of piercing the tunnel along its westward course toward Beirut. These shafts, protected from the rain by their masonry arch roofs, also serve as light wells for the passage or service tunnel (2½ meters height by 1¼ meters wide) which run immediately above the water tunnel proper. The latter, with its pointed roof, is identical to those portions of a water tunnel discovered by contractors in 1952 near the Place d'Assour (Riad el Solh Place) when excavating the foundations for the new Middle East Airlines building and other new buildings in downtown Beirut (Conde 1955:29).

A water canal commencing from a rectangular reservoir, located at Khan Derhydey, at the actual crossing of Damascus Road with the Bechara Khoury Avenue (Ring), near the Eshmun building. This terminates in the cultivated region under Borj square (Davie 1984:44). The water from the aqueduct was taken to different quarters by a series of drains. Along the eastern slope of the rise on which the Serail is built there are remnants of a drain partially cut out of rock leading to rock-cut basins. Maundrell noted that fresh springs flowed down from nearby hills and water was distributed throughout the city in handsome fountains (Henry Maundrell 1697, reprinted in 1769:38. Jidejian 1973:96). These springs that flowed down from nearby hills where located at what is today Ras el Nabaa (the source of the spring) located on a 25 meter terrace. The stream that drains onto the plain of the Museum and the Palace of Justice until Justice Road, a confluence was created in the proximity of the Pine Forest, under the Palais de Justice, the other at the Khan Djedi (Davie 1984:54). The Du Bussion map (Figure 3-1) indicates the drains into Beirut, which correlate with what today is the Bechara el-Khoury Avenue. Along with the drains supplying Beirut with water the presence of sarcophagi. Are also noted It is possible that Bechara el-Khoury Avenue is placed directly over these drains or very close to them. The map of Beirut drawn in 1841 reveals a reservoir and water system that again appears to support that assertion that Bechara el Khoury Avenue falls on the same alignment at the intersection of what is today the Basta Road and Independence Avenue. This is supported further by Goodchild's coastal road map of Phoenicia that indicates that the aqueduct goes straight into Old Beirut. In all likelihood this can be equated to the canalizations of other maps, along the alignment of Avenue of Bechara el Khoury.

Pine Forest

Under Fakhreddine II (1598-1635) many improvements were made to the city. Fakhreddine planted a forest of fir trees south of the city to improve the water supply. As it was believed that the presence of pine trees would make the springs more abundant (Jidejian 1973:9). Historians often credit Fakhredddine with the original plantation of the Pine Forest (e.g. D'Arvieux). However, texts as early as the 12th century, by William of Tyre, refer to it as the "Sapinoye de Baruth". During the Crusader period, in 1110, the history of William of Tyre, recounts the siege of Beirut. He mentions how Baldwin and Bertand used the pine trees in the neighborhood of the city to provide the wood necessary for the Crusaders to build their siege engines (e.g. siege towers, ladders, bridges, and catapults) (Jidejian 1973:83). It is therefore probable that (as mentioned by other travelers) the sculptor and architect Cioli, whom Emir Fakhreddine brought from Italy, organized the wood into regular lines of trees and avenues (Jalabert 1970:69; Debbas 1986:156). In the map of Beirut of 1876 *(Figure 3-4)* the Pine Forest is shown to extend from the Damascus Road all the way to Basta. The forest was always used as a park by the nearby inhabitants of Mazraa, Basta and Moussaitbeh. The el Horch (forest) mosque was built here in 1899 for the bedouins living in the neighborhood (Debbas 1986:156). However there is no specific mention of whether these bedouins lived in tents or actual permanent structures. In the Beirut and its Suburbs map of 1840 other pine trees allocated in the region indicate what must now correspond with the Bachoura today. In addition to the Pine Forest, wooded areas between Nouairi and Mazraa are indicated on this map. Wells and reservoirs located at Ras en Nabaa and the Pine Forest at Wata Moussaitbeh are also indicated (Davie 1984:56).

ARCHAEOLOGICAL IMPACT

The Grade Separation Location at the intersection of Avenue of Bechara el Khoury and Independence Avenue and the Grade Separation Location of Omar Beyhum Place may reveal archaeological pockets. The Grade Separation Location of Omar Beyhum Place may reveal traces preserved of red soil, as already apparent from the cut in the road. It's possible that this red soil strata may be as thick as nine meters in places, hence the possibly of the preservation of pockets of archaeological material.

The buildings along Bechara el Khoury Avenue, may not have all disturbed the remenants of the water system. Especially as already have persevered traces of this water system. Further possible that certain pockets of archaeology will be preserved under some of the buildings as there appears to have been no complete ground leveling as clearly drops into the BCD.

RECOMMENDED MITIGATION

In the area of the hippodrome traces of the red soils which possibly seal and contain archaeological deposits. Additionally it would be prudent to be aware that it is likely that structures most likely Classical in date may be present on the outskirts of the old city. This may explain the remnants of columns, building blocks, as observed by medieval and later travelers. If possible an evaluative excavation should be placed in the locale of Bechara el Khoury Avenue (northern portion) for any remnants of the water system. Especially as there is already preserved traces of this water system. It is likely that certain pockets of archaeology may be preserved under some of the buildings, as there appears to have been little leveling down as the ground clearly drops into the BCD.

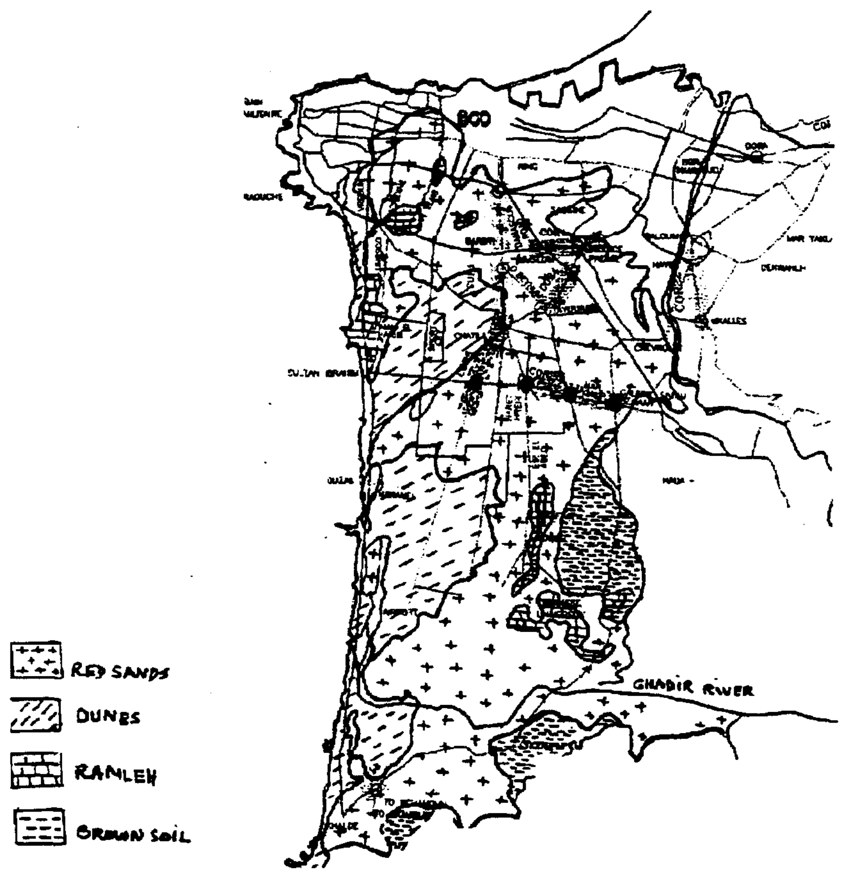
10. Archaeological Assessment of the Airport Road-Chiyah Boulevard Intersection

Rima Mikati and Rana Mikati (*see Figure 1-1*)

BACKGROUND

The site is located to the south of Beirut, at a crossroad covered by a modern bridge leading to the Airport Boulevard. It lies at the end of a slope to the west of the sand dunes of Bir-Hessian (el-Kareh 1984&: Davie 1984). This area has been landscaped in the last thirty years. Like most of Beirut and its environs, it did not witness any major topographic change prior to the beginning of the 20[th] century. It lies within the narrow corridor utilized since antiquity as route from the south towards Beirut (Davie 1989: 146). Greater Beirut is limited the to north by the hill of Ashrafieh, to the east by the Beirut River, and to the south-west or the shore by the Raouche cliffs (Davie 1989: 146). Sanlaville (1977:592) locates this site in the plane of Choueifat (*see Plate 10.1 below*). This plain forms a 20m to 30m deep depression surrounded by higher ground. To the west of it are sand dune accumulations reaching 50 m in height on their northern edges. To the south of this study area and precisely in the Borj al-Barajneh area is the al-Ghadir river. The Choueifat plane is covered with three types of sand (*see 10.1 below*). First the Ramleh (beach-rock) found on the consolidated dunes of Ouzai'i and Jnah and which can be found under the ochre and red sands of Bir-Hassan. Red sand is found in the areas of Haret Hreik, Chiyah, Borj el- Barajneh and Khaldeh. Red sand or Hamra, reaches its maximum depth at Bir-Hassan with 14.50 m. These layers of sands have covered vast areas of Ramleh (el-Kareh 1984: 605-607). Active modern sand dunes overlay the Hamra or red sand and are usually blown from the sea shore (Copeland & Wescombe 1965;126).

Plate 10-1: Geomorphology of the Bir-Hassan area



ARCHAEOLOGICAL HISTORY:

Related Sites

Bir-Hassan

Historical Evidence

The Airport- Chiyah intersection is limited to the west by the area of Bir-Hassan. Bir-Hassan is 55m above sea level. It extends to the south-west to Jnah and Ouzai'i (Copeland & Wescomb 1966:128). In the beginning of the 20th century this site was known as a village with few settlements all of which depended on agriculture for their livelihood. The origin of the name Bir-Hassan is derives from the Prince Hasan al-Chehaby who stayed in the area with his army before entering the city of Beirut. It is believed that he ordered the digging of a well that took his name and continued to be used till the 1950's (Alloush 1993: 173). Bir-Hassan contains the tomb of a saint known as Cheikh ed-Daher and a Khan shows on the 19th century map of the area (Davie 1984: 56 & 68).

Archaeological Evidence

Upper Paleolithic material has been collected from the surface in the area. Some of the finds were at a depth of 3.5m. The area of Bir-Hassan also contained Middle Paleolithic remains. A trace of Neolithic (8000 BC-6000 BC) material was also found, however the presence of a Neolithic site is not confirmed (Copeland & Wescomb 1966:128, Figure 5). The site of Bir-Hassan has been heavily reworked or truncated and its surface archaeological material has been lost. Studies conducted in the area have all been salvage works and the material collected is exhibited in the Museums of the American University of Beirut (AUB) and the University of Saint Joseph (USJ). Evidence of archaeology (if occurring) other than that mentioned above has not been reported. The period spanning the Neolithic to the present day is still obscure in this area and poorly represented in the sources. The Sports city construction and urban street planning has resulted in a certain degree of leveling down and has thus removed any existing material from the surface, However, archaeological deposits are likely to be preserved both between buildings and deep intrusions and in the lower lying deposits.

Jnah

The area of Jnah lies to the south of Beirut. This area is the furthest from the area under investigation, the Airport-Chiyah highway intersection lying to the north-west. The only evidence of archaeological activity in Jnah comes from the mosaic floors of several Late Roman villas discovered by the Emir Maurice Chehab. Chehab dates these mosaics to between the 3rd and the 6th century AD (1957: 53-79). However, little is known about this area, the extent of any settlement or the periods of occupation covered. Jidejian claims "important suburbs developed between Jnah and Ouzai'i" (Jidejian 1997: 95), though probably a sound interpretation of the available settlement evidence in the absence of systematic fieldwork the statement is as yet uncorroborated.

East Saint Simon (Tell-aux-Scies)

East St Simon lies east of the St. Simon beach between 15-20m O.D. on the red consolidated dunes of Ramleh. Evidence of a Stone Age flint industry has been found in this area, covered with layers of sand. The lithic assemblages found here date to the Early Paleolithic period.

Borj el-Barajneh (E 129/ N 212- 50m ASL)

Historical Evidence

Borj-el-Barajneh is limited to its north by Haret Hreik and to the west by the Airport boulevard. To the south lay the airport and the area of Tehwitet-el-Ghadir. Borj-el-Barajneh is 7 km south of Beirut. This area is a pastiche of modern buildings and old stone houses. It was known, like all the southern suburb villages as an agricultural area. The only time the Borj was mentioned in historical texts was by Saleh Bin Yahya the Arab historian who lived in the 1450 AD. He talks of a rebellion of a group of people in the Borj known as the Barajina against Fakhr-Eddine. The locals are said to have killed one of his slaves and thrown him in a well. The well took the name of Bir-el-Abed or the 'slave's well' and lies to the east of Borj-al-Barajneh (Mufarrij1970: 42). The Barajina are the Arab tribe that settled the area during with the Muslim conquest, and were expected to protect the area. The exact date of their arrival from Ma'rrah in Syria is 799 AD. Borj-el-Barajneh belonged to the feudal family of Arslan the heirs of the first Arab settlers. A parallel could be drawn between the Barajina of the Borj or tower and the Roman Burgarii , 'quartered in the Burgi' or tower (Chevallier 1976: 189), and whose function was to maintain and protect the area and the road. Archaeological investigation proved that sites like Khan Khaldeh and Ouzai'i retained their function as road station and summer residency respectively through the Hellenistic, Roman and Early Islamic Umayyad period (Saidah1975:51, Chehab 19 :135-39). This is mainly due to continuity in the settlement and intrinsic character of the area. Furthermore, the passage of the Roman coastal road successively through Khan Khaldeh—excavated by Roger Saidah (1975) - and Borj al Barajneh would suggest the presence of some kind of settlement as early as the Hellenistic or Roman period. No archaeological evidence dating to early Islamic periods (Umayyad-Abbasid) has been reported from the area.

Archaeological Evidence

The Borj knew activities in the Stone Age (Tell Aux Crochets) . This open site had an "extraordinary concentration of microliths"(Epipaleolithic) on its surface (Copeland 1991: 33). The Borj has also yielded three archaeologically valuable Roman finds: Two milestones (nos. 233 & 234- AUB Museum) and a marble statue. The first milestone's find spot was unrecorded, however the inscription, more precisely the mileage figure, enabled scholars to trace it to the Borj area,1600 meters north of Nahr al Ghadir (Goodchild 1948:91,119). Milestone no.233 bears four inscriptions (see below). The primary inscription is possibly of Vespasian, the latest belongs to Constantine and the three Caesars. Milestone no.234 was uncovered by cultivators in 1906, 150 meters north of Wadi Ghadir (Mouterde 1907:336). Its inscriptions are dated to Nero (AD 56) and Vespasian (AD 72) (Goodchild 1948:120). This milestone is the oldest found on the Antioch-Ptolemais road. The most remarkable and peculiar find is one dug out in the same region around 1897; a larger than life white marble torso. Mouterde (1907: 337) identifies it as a Roman Emperor's statue pointing out the belt 'noue sur l'abdomen' frequently present in Imperial iconography. Both arms and head are missing. These finds are now displayed in the AUB museum.

Who set up this statue? Was it a Roman legion displaying its allegiance to the emperor? Lauffray and many other archaeologists relied on evidence such as statues to locate forums, temples and other public monuments. Could the same be done here? Could this statue be a remnant of a Roman settlement. The development of nearby *Mutatio Heldua* could initiate and attract settlement. Chevallier states that the official *mutationes* and *stationes* drew a lot of activity around them especially under the form of private establishments such as inns (Chevallier 1976:190).

Borj al-Barajneh was completely covered by the growing suburbs of Beirut. The only archaeological evidence reported in the literature is a 'Borj' or fort which still stands in part to this date. Oral tradition from the locals attribute this building to Fakreddine who built it to protect his army against local rebels (Mufarrij 1970: 42-47). It is possible that Fakherddine's Borj existed before or was built on an earlier structure, whose date and function remain uncertain.

Ouzai' (Tell Arslan: 128 E/ 210 N)

Ouzai' lies to the south-west of the Airport-Chiyah intersection. It is located 5 Km south of Beirut and 800 m away from the sea.

Historical Evidence

This area was known as the village of Hantouss in the Umayyad period (Ziadeh 1992:53). The area lost its older name to the new name Ouzai'i after the Imam Abdul-Rahman al-Ouzai'i (707- 773 AD) was buried there.

Archaeological Evidence

The earliest archaeological evidence in Ouzai'i is recorded as Stone Age material on Tell Arslan. In this area, unlike most of the Sands material was found directly on virgin soil. This site is Neolithic and had evidence of flint and pottery. The construction of the aerodrome has completely removed this site and actually overlies its location. Directly over the Neolithic period were layers of the Roman period (Cauvin 1968 :255).

Excavations undertaken by the Emir Maurice Chehab yielded a late Roman (4th- 6th c. AD) for the Roman phase of the settlement. Morphologically it comprises a series of villas with well preserved mosaic floors (Mouterde 1958: 38). These mosaics were dated by Chehab according to stylistic criteria and coin evidence. Chehab concluded that the site's prosperity lie mainly in the fourth century AD (Chehab 1957: 139). He based his conclusion about the sites period of affluence on the frequency of coins of Constance II (337- 361 AD).

SUMMARY OF LIKELY IMPACT

The Airport-Chiyah intersection lies within an area that knew starting the 20th century continuous development activity. Still the area can easily have pockets of well-preserved archaeology especially under roads and in areas where the basements of modern buildings have missed.

The survey conducted resulted in the formation of a clear picture of the area. Archaeology has been recorded in the vicinity of this area as early as the Stone Age. The area witnessed a lot of activity during the late Roman period, since the report is dominated by Late Roman finds. The site knows continuous settlement and exploitation till modern times.

The quantity of finds or sites reported and their diffusion produced, in this case, an archaeologically significant zone.

The size of the work of development to be undertaken necessitates an adequate response to the probable presence of archaeology.

RECOMMENDED MITTIGATION

It is advisable that a sounding is made prior to development. This would provide an idea of the absence or presence of archaeology, its extent, nature and importance as to preservation in situ, excavation, or the need for applying a watching brief.

11. Archaeological Assessment Report for Haret Hreik - Ghobeyri Intersection

Rana Mikati and Rima Mikati (*Figure 1-1*)

TOPOGRAPHIC BACKGROUND

This area lies within the same geographic setting as the previous *site* (*appendix 1 section 12*). It is surrounded by several sites discussed below. To the south of it is Haret Hreik and Bir al Abed. To the north and stretching southwards is Ghobeyri. Chiyah is to the east and is limited by Ain al Rommaneh to the north

ARCHAEOLOGICAL HISTORY

Related Sites

Haret Hreik (130 E/ 213 N- 30 m ASL)

Lies 6 km south of the capital, with an area of 181 hectares. The area is densely occupied with modern buildings leaving little open space. It is believed that Haret Hreik's earliest settlement was in the 15^{th} century during the rule of Fakhreddine (Mufarrij 1970: 115). The village remained until the 19^{th} century (1861) the property of the feudal family of Chehab (Merhej 1971: 115). Following this date, local villagers started buying land, a step that would initiate a rapid development of the area from a village to an urbanized suburb. The study of toponyms here proved useless, since the available source (Merhej 1971: 115) does not provide a feasible analysis of the name.

Archaeological Evidence

The earliest and only archaeological evidence reported and recorded in Haret Hreik is Upper and Lower Paleolithic material that disappeared under modern construction (Copeland & Wescomb 1965: 133).

Chiyah (130 E/214 N-50m O.D)

The area of Chiyah is limited to the north by Ain el Roummaneh and to the east by Ghobeyri.

Historical Evidence

The locals of the area of Chiyah talk of chance finds found in the gardens of some of the inhabitants. It is said that a certain Elias Sayf found, while digging house foundations, a group of pottery objects. It is believed that the pottery resembled the material from the Khaldeh excavations. This story relies completely on oral transmission since nothing official or scientific backs it up. Yusuf Maroun found in his garden a grave with a group of finds that included pottery, skeletal remains, bronze and iron objects as well as seashell plates. Four old wells and two caves are believed to signify the area as an archaeological site (Khuri 1975: 21-22). The study of the origin of the name Chiyah is again unsatisfactory. There is a belief that the name is derived form the Arabic verb Chiyah which is to plant a shrub called chih used in silk production (1975: 22).

Archaeological Evidence

No published or excavated material has been located from research. The only mention of archaeological remains comes through oral transmission.

Ghobeyri (130 E/214 N- 50m O.D.)

This area is 8 km south of Beirut and is 50 m above sea level. The area like most of the southern suburbs belonged to the Chehab family. People settled this area in the 18th century coming from villages in the Bekaa and southern Lebanon. Ghobeyri was known, like Chiyah, for its silk production from the Ma'nid emirate (1591- 1697) to the end of the 19th century (Mufarrij 1971: 286). This area is an expansion of Chiyah that grew in the 1930's.

Archaeological Evidence

No archaeological evidence was reported in this area.

SUMMARY OF LIKELY IMPACT

In this area, both Haret Hreik and Chiyah are the most likely to have retained some of their archaeological evidence. Haret Hreik was certainly settled in the Stone Age and the later medieval period, though nothing is known about the Hellenistic and Roman period. This could be cleared by a few sondages. Chiyah, today is mixture of old and new buildings, the former will probably preserve traces of Chiyah's past. Both sites, throughout their history, were distant villages living from agriculture and silk production. Ghobeyri is a later development of Chiyah that grew in the early 1900's. This area has produced no evidence from excavations. But the reports of the locals confirm the areas potential for archaeological discovery. It is likely that Roman or later material will be found in the area especially if the excavation of tunnels reveal undisturbed layers of soil.

RECOMMENDATION

It is advisable that a sounding is made prior to development. This would provide an idea of the absence or presence of archaeology, its extent, nature and importance as to preservation in situ, excavation, or the need for applying a watching brief.

12. Archaeological Assessment of the Mar Mekhael Intersection

Rima Mikati and Rana Mikati (*Figure 1-1*)

TOPOGRAPHIC BACKGROUND

The Mar Mekhael intersection is in the same environment discussed in Report 2. This intersection lies within the area of Chiyah that continues south to the area of Hadath. The geology of the area is the same as in the sites discussed above. Mar Mekhael in the 19th century was the road that connected the city Beirut through Bab ed-Derkeh, Basta, Tahta and Faouqa to Saida (Davie 1980: 62). It is also a crossroad between Choueifat and Hazmiyeh (1980: 68).

ARCHAEOLOGICAL HISTORY

Related Sites

Chiyah

See above, for the history of the area.

Hadath (131 E/ 211 N- 70- 300 m ASL)

Hadath lies 8 km south of Beirut with an altitude ranging from 70m to 300m above sea level. It is limited to the north by the villages of Baabda and Hazmiyeh. In 1971, 75 % of the buildings in the area were constructed after 1950. The remainder of the dwellings were old traditional Lebanese houses (Mufarrij 1971: 142-3). The site visit during the conduction of this research showed a developed area with dense occupation, nevertheless, leaving a hint of the village setting.

Historical Evidence

The area, like all sites mentioned above, belonged throughout history to Lebanese feudal families. Laws protected the landlords and forbade the selling of the land. The village was covered with citrus trees, as well as mulberry plantations and was a vital part in the silk industry (Mufarrij 1971: 143). The site's earliest owners were therefore the Arslan family that arrived in the 8th century. The oldest settlement can be deduced with precaution from the analysis of its toponym. Hadath is believed to be derived from a Syriac word (Hatta) meaning new (1971:143). It is possible that the area was occupied in pre-Islamic times when languages like Syriac or Aramaic were in use.

Archaeological Evidence

No excavation report on archaeological work done in Hadath has been located. The only work done in the area is the recording and collection of Neolithic material from the surface. The authors of these reports note that Hadath was already built up at the time of writing their work (Copeland & Wescombe 1965: 88). Local people reported an abundance of Roman finds (pottery, metal objects, and monumental stoneings) in a lot of the construction digs that took place in the village (Merhej1971: 194).

SUMMARY OF LIKELY IMPACT

The Mar Mekhael intersection is an area of definite archaeological potential. The visual examination of the site in its present state has provided the author with a glimpse into its geography as well as degree of urban development. The roads have been leveled down and sections of the Hamra sand dunes can be seen on the street sides. The expansion of the roads will go into undisturbed layers in some cases where houses were built. A look into the sand piles accumulated by bulldozers shows fragments of pottery. The area lies on a road that has always connected north to south and is likely to have had agglomerations continuously.

RECOMMENDATION

It is advisable that a sounding is made prior to development. This would provide an idea of the absence or presence of archaeology, its extent, nature and importance as to preservation in situ, excavation, or the need for applying a watching brief.

13. Archaeological Assessment Report for the Galerie Seman Intersection

Rana Mikati and Rima Mikati *(Figure 1-1)*

This report deals with an intersection that lies in the middle of areas discussed before, like Borj al Barajneh, Bir al Abed, Chiyah. Areas to be discussed here are Hadath and Fayadiyeh, overlook the site from the east.

TOPOGRAPHIC BACKGROUND

This site is at the eastern end of the Choueifat valley mentioned above. A road through Galerie Semaan and passing through Hazmiyeh leads to the mountains.

ARCHAEOLOGICAL HISTORY

Related Sites

Borj el Barajneh:

See above for the history of the area.

Bir el Abed:

See above.

Chiyah:

See above.

Fayadiyeh (133 E/ 212 N- 250 ASL)

To the east of the Galerie Semaan intersection is Fayadieh which is 8 Km south of Beirut and 400m above sea level.

Archaeological Evidence

Upper Paleolithic material was recovered from the hills of Fayadieh. Excavations undertaken by R. Saidah in 1964 uncovered one of several Middle Bronze Age tombs. Leveling of the hill has caused the Middle Bronze tombs to be buried (Copeland & Wescombe 1965:86). In the area of Hazmiyeh, to the east of Chiyah, a Khan was located on a plan from the 19th century next to the Damascus road (Davie 1980:56).

SUMMARY OF LIKELY IMPACT

Although reports of archaeology are rare in this area, the material available is enough to indicate the area as archaeologically significant. Evidence of Stone Age material has been recorded and rescued in the beginning of the century from a nearby location. Bronze Age tombs were partially dug by R. Saidah in the close by Fayadiyeh (Copeland & Wescombe 1965: 86). Galerie Semaan is not heavily built and it retains its suburban nature. Modern buildings with deep foundations are the norm, but the density of construction is not like the capital. A Khan is reported in Hazmiyeh from the 19th century sources as lying next to the Damascus road (Davie 1980: 70). The frequency of finds in the area is significant and the area like the Mar Mekhael site is on the road to Damascus. It provides us for the first time in the southern suburbs evidence of Bronze Age finds that are of great value and can be highly informative about the sequence of archaeology in Beirut's southern suburbs.

RECOMMENDATION

It is advisable that a sounding is made prior to development. This would provide an idea of the absence or presence of archaeology, its extent, nature and importance as to preservation in situ, excavation, or the need for applying a watching brief.

Milestone no. 233 (Goodchild 1948-9: 119)

Find Spot: Unrecorded, presumed 1600 m N. of Wadi Ghadir. Location: American Univ. of Beirut Museum Inscription:

IM?____________AL AVR
___.RO
DDDD NNNN
FL VAL CONSTANTINO
MAXIMO VICTORI
AC TRIVMFATORI
SEMPER AVG ET
FL IVL CONSTANTIO ET
FL IVL CONSTANTE
///////////...
NOBILLL CA ESSS

Milestone no. 234 (Mouterde, 1907: 337-9)
Find Spot: 150 m N. of Wadi Ghadir
Location: American Univ. of Beirut Museum
Inscription:

IMP[ERA]
[TOR] CAIS(AR) VESP-
[SIA]NUS AVG(VSTVS) PONT(IFEX)
[MAX(IMVS), T[R(IBVNICIA)] P[OT]ES(ATE) III, P-
[AT(ER) PATIAE] CO(N)S(VL) IIII
[CVR(ANTE) L(VCIO) C]A[E]SENNIO
[PAETO] LEG[ATO] AVG(VSTI) PRO
[P]R(AETORE) CCXXXIIII

[NERO CL]AVDIV[S]
[CAISAR AV]G(VSTVS) GERMANICUS
[TRIB(VNICIA) POTES(TATE) BIS, CO(N)S(VL) [DESI]
[GNATVS] ITERVM
[VIAM?] AB ANTIOCHEA
[MVNIT ? AD N]OVAM COLON[IA]M
[PTOLEMAI]DA. MILIA PASSV[VM]
[CCXX]XIIII
[M(ILLIA) P(ASSVVM) X]XXXVII
[C(AIO) VMMIDI]O DVRMIO
[QVADRA]TO LEG(ATO) PRO PR(AETORE)

14. Archaeological Assessment Report for Portion of Corridor 18 (Tayouneh-Old Sidon Road) Greater Beirut Urban Transport Project

Amelie Beyhum - June 28th 1998

BACKGROUND

This assessment is of the Khaldeh and Chweifat segment of Corridor 18 (Tayouneh - Old Sidon Road). This includes the Grade Separation Location of Bchamoun/to Aramoun, and was conducted by Amelie Beyhum on July 2nd 1998.

The Portion of the highway in the Ouzai' region is intensely inhabited by squatters. So densely inhabited that can not see sea to the west, nor the red soil to the east. In one portion, along the eastern side can still see traces of a high elevated red soil 'hill,' which contains some vegetation. It appears that the surrounding region is levelled down. However the author notes that the road perpendicular from Ouzai'i'i that takes one to the airport road, actually cuts across a flat area of red soil, though I am uncertain as to whether this area has been completely leveled down. There are major construction works taking place on the segment of road in the vicinity of Khaldeh due to the extension and construction of new runways for Beirut International Airport, and as a result moving present road. The construction of this new road has involved the building of new underpasses. In this segment of road construction, I noticed on both sides of the present road that large stone boulders have been transported in for the construction of new runways. These stone boulders have been quarried from the nearby mountains further south. The large garbage dump that was once placed between the road and the runways (in the 1960' and 1970's) is no longer there, and appears to have been removed in the process of construction. Before the Choueifat roundabout, between the airport runways and present eastern portion of the road, I noted a red soil hill/elevation with vegetation on the eastern side of the road. Towards the southern portion of this road, in the vicinity of the roundabout that takes one to Choueifat, the construction of new overpass in addition to several new high rise buildings (post 1980's) is underway. The original red soil of the region has not been completely levelled down, and is still apparent. in the area of the Choueifat roundabout. From this point begins dense urban build up on the foothills and actual mountains with the new high rise buildings (post 1980's). Very few empty lots appear and very little vegetation left in this area. The sand dunes that once covered this area are no longer apparent, neither are the olive groves that once covered the Chweifat and Khlade areas. The sand dunes were most likely mined away and the olive groves destroyed during the war or intentionally moved to make way for all the new high rise buildings.

An Englishmen journeying in the region in 1852 wrote "The horses seemed to know they were near the end of their journey and we.....galloped over sand and surf which soon brought us near Beyruth....A bad torrent-channelled road across the northern horn of the little haven took us in a few minutes to its walls......" (Jidejian 1973:5). The 19th century maps indicate that the southern extremities of Beirut was a flat and covered with gardens, olive trees and sand dunes. The Beirut and Suburbs map of 1840, indicate that the hills of drifting sand are always increasing in the region south/west of Old Beirut. The modern topographic maps created after 1920 with aerial photography reveal the sand hills between Mar Elias and Ouzai'i conforming those noted by early travellers and pocket traces apparent today in Ouzai'i -Khaldeh stretch (Davie 1984:54). Map of Beirut in 1876 (map 7) interesting as the sand dunes in Khaldeh vicinity contain contour lines. The placement on the 1841-1842 map of moving sand dunes implies the absence of agriculture (Davie 1984:45). However, this region contains other cultures. In a pocket, north of Ouzaai have ble, which translated as corn (Davie 1984:54-55), but may also be wheat. Apparent that the most precise indications are the localization of the sectors of wheat/corn and olive grounds, though unfortunately cannot next indicate the precise limits of each culture (see Rima scanned map). The whole plain of Chouifet is covered with olives (Davie 1984:54-55). The Choufiet green area of olive trees had been protected by special regulations (Salam 1970:168), unfortunately today the majority have disappeared due to the ravages of the war and development.

ARCHAEOLOGICAL HISTORY

Khaldeh

Khaldeh situated in close proximity to the city of Beirut, around fifteen kilometers south of the city of Beirut. Seven annual campaigns conducted on the site by the Department of Antiquities from 1965 to 1967.

The site of Khaldeh owes it importance to remnants from various periods, ranging in date from the Middle Paleolithic until 7th century A.D. The stratigraphy of site summarized from the lowest excavated point upwards to the surface as follows:

Late Chalcolithic oval house which show traces of mud and reed roofs. The late Bronze Age structures (stone walls protecting a spring and stone foundations) that are quite distinct stratigraphy from the Iron Age cemetery. The Iron Age Phoenician cemetery (11th to the end of the 8th century B.C.). The large number of Iron Age burials found intact in situ (to date 422 burials) on both sides of the modern coastal highway. Together with the burial had hundreds of various objects consisting mainly of pottery vessels. This extensive cemetery indicates an equally large settlement that must be located in the vicinity. The complete Phoenician cemetery could not be exposed since it lies partially beneath the modern coastal highway. Unfortunately the settlement is still to be found, but hints from the excavation may locate it south of the excavated region, the greater part lying probably under the airport runways. Hellenistic-Persian foundations (5th - 4th century B.C.) found superimposed directly on the Iron Age graves. The three uppermost occupation levels represent the Roman city that covered practically the entire surface of the mound with mosaic floored private houses, agricultural and industrial installations an public bath. This level is separated from the lower ones by a thick level of pure sand (Saidah 1969:130).

The lack of epigraphical and literary evidence concerning name of the site of Khaldeh lead to the exploration of another mound situated a few miles to the south near the old Ottoman Khan Khaldeh.

North of Khaldeh

Khan Khaldeh

Khan Khaldeh situated twenty kilometers south of the city of Beirut, very close to the modern road. The site of Khan Khaldeh discovered with the construction of the Beirut- Sidon highway. This road actually cuts into the site of Khan Khaldeh. Khan Khaldeh is about twelve meters over the Mediterranean, a small mound, which some consider hardly worthy to be dignified by the name of a "tell."

Before any excavations undertaken the only apparent surface archaeological remains in the vicinity of Khaldeh was the Ottoman caravanserail (khan/inn), which for a long time was considered the only indicator of an ancient settlement at Khan Khaldeh. Other than his modest way station found the numerous tombs (certain travelers call them large sarcophagi) cut into the calcerous rock hills that clustering around the site. These burials were frequently mentioned by travelers and pilgrims of the 18th and 19th century, who also recount seeing the cemetery of the site of Naame (ancient Leontopolis) situated 2 km south of Khan Khaldeh. Many of 19th century travelers (e.g. De Saulcy and Robinson) were mystified by the abundance of sarcophagi and the almost complete absence of other remains (Goodchild 1948-1949:102).(See coastal map). Renan observes that Khan Khaldeh appears to be more akin to a religious sanctuary than a settlement, however he does not seek and alternative site to identity with ancient Heldua (1864:515-516). It was originally believed to be the ancient necropolis of Naa'me. Three seasons of excavations between 1967 to 1973 permitted the partial exploration of the Khan Khaldeh site, revealing a true agglomeration identified by its ancient name Mutatio Heldua (Duval and Caillet 1982:315). This site revealed interesting results, included among the excavated finds are several olive press installations, almost a hundred private houses, many with mosaic floors, a street grid complete with alleys with their canalizations of sewage pipes and channels, and an important rectangular building (17 x 14 m) (a temple?) with a peristyled courtyard carefully paved, where a winged sphinx was found (Saidah 1969:134). There dates range from the Hellenistic period to the start of the Roman period, 7th century A.D (Duval and Caillet 1982:315). Two sounding carried out on the southern slope of the tell revealed stone foundations of Middle Iron Age (8th - 7th century B.C.) dwellings, built over traces of occupation dating back to a Middle Paleolithic camp site (Saidah 1969:134). In addition, a large quantity of Early Bronze (III) pottery sherds scattered all over the mound, indicating a large settlement, partially disturbed by the Iron Age installations (Saidah 1969:134).

The last phase of occupation dated to the start of the Roman period until the Arab conquest, mainly from the 4th to 7th B.C., when the settlement knew it's largest extension (Callot 1982:419). The northern and the southern zones of the mound contain two basilicas and the inn for the travelers and pilgrims (Callot 1982:420). The two churches found at Khan Khaldeh, the "Eglise superieure" dated to the second half of the 6th century and the "Eglise inferieure". A small basilica was built in the 6th century B.C. and enlarged in the 7th century B.C.

The site's development appears to be linked to an important agriculture and commercial activity, partly based on the olive groves and the oil. What is rather interesting is the presence of several olive processing plants/presses in each section. Apparently each house contain one, sometimes two olive presses. Certain of these installations were still in situ, other destroyed by the construction of the highway (Callot 1982:420).

All these elements indicate that Khan Khaldeh had a specialized function in the production of olive oil, possibly on a large scale. On the eastern side of the road have indications of olive trees. The hills that dominant the Khan Khaldeh settlement from the east (the first foothills/escarpment of the Lebanese mountains), their low altitude and good orientation, makes them ideal terrain for the vast olive groves (Callot 1982:419).

Its placement at the foot of the fertile hills and on a great axial road predisposed this small way station and a place of pilgrimage to become an important agricultural and industrial center.

Further explorations required to complete the historical setting of this stretch of coastal Phoenician extending from Khaldeh to Khan Khaldeh, and the important nearby tell of Naa'ame (Saidah 1969:134).

Prehistoric

In 1930 Father Auguste Bergy identified the earliest known Neolithic village site, at Tell Arslan, near the Beirut Airport (Khalieh 1997:293; Jidejian 1993:14). This Neolithic site differed from other Stone Age sites nearby in the sands of Beirut in that the flint tools were not scattered in the sandy wasteland but found in a tell (mound) extending over one acre. Tell Arslan, near the mouth of Nahr Ghadir (Rhadir) was a real tell with an accumulation of nearly six meters of human occupation levels (Saidah 1970:11). Unfortunately this tell was razed in

1948 during the construction of the runways of Beirut International Airport, and whatever remains may have survived lie buried under the modern runway. A large number of Neolithic stone and flint tools and potsherds collected from this site (Jidejian 1993:14). In addition, Tell Arslan was covered with a Roman settlement. Nahr Ghadir never a real major river, more of a source.

Another site north of Khaldeh is the site of the large Tell of Khan el Ghufr, close to Baal en Naa'ame. Is a conspicuous mound, 200 meters in diameter, and has been severely damaged by stone diggers. Eventhough its surface is littered with Roman pottery and structural remains. Recently bulldozers mining for sand in the dunes of Jiyeh uncovered a church with mosaics. This church 12 km north of Khlade is contemporary to that found at Khan Khaldeh (5th and 7th century) and both similar in that exploited the surrounding olive groves (Jounblatt et al 1989).

South of Khaldeh

Prehistoric

The 6 meter stage, that corresponds to the European Wurum, is represented on the Lebanese coast by two types of deposits: sand dunes and river deposits. The sands dunes most often occur south of Ras Beirut and the river sediments are usually found along the short streams that cross the coastal plain north of Beirut. The sand dunes were slowly invading the Beirut platform towards the end of the Lower Paleololithic Age represented by the 45 and 35 meter marine terrace, but by now some 50,000 years have passed and the Beirut platform represents approximately 60 square kilometers, generally the size it is today. A site associated with the 45 meter marine terrace and containing stratified stratifeied Lover Paleolithic industries is on the breccia slope immediately west of Jneh Road, above Zenzir Road and above Diab Road. The second now covered by a refuse dump, is situated under Jeneh Road (Saidah 1970:4).

Towards the end of the Lower Paleolithic sand dunes were slowly and progressively advanced and invading the rocky platform of Beirut (Jidejian 1993:XV). During the Middle Paleolithic the Beirut platform began to take shape on the 35 meter stage. Sand dunes appeared for the first time with a substratum of sandstone, the soft ramleh thirties. The shoreline was similar to the one present today (Saidah 1970:5-6; Jidejian 1993:13). Unfortunately today the region has been completely invaded by modern apartment buildings. In addition the dumping of building debris on unbuilt surfaces around Beirut, extension of airport runways, road-widening as well as urban development of the southern suburb have all taken their toll (Jidejian 1993:15). These Upper Paleolithic inhabitants occupied two kinds of sites both represented in the Beirut area: open-air camp sites and caves and/or rock shelters. Innumerable open-air camp sites existed in the sands area south of Beirut, called "the Sands Station" by archaeologists. The ten kilometer stretch of seashore and sand dunes stretching from Ramlet el Beida to south of Khaldeh, called "the Sands Station" by archaeologists, is by far the most extensive and important Stone Age site disappear (Jidejian 1993:15). In the early 1960's around twenty Upper Paleolithic open air campsites recognized by Lorraine Copeland's survey in the sand around Beirut (Copeland and Wescombe 1965:125ff). Many of these sites have since been destroyed due to the building and extension of Beirut International Airport and the construction of modern buildings (Jidejian 1993:13).

At this rate these important Stone Age sites of Lebanon are doomed to eventually disappear, however possible that more are still to be discovered. The main difficulty with all these sand sites is that they were inhabited for very short periods of time, and the only way to identify such a site is by locating concentrations of flint tools and flakes (Saidah 1970:8; Jidejian 1993:15).

The west coast of the peninsula, the Khaldeh and Ramlet al Bayda sector - "the Sands Station", is unfavorable for urban settlement because it is exposed to the prevailing south-westerly winds and swell; the waves hit the shore with their full force, as they are paralleled to the coast. The currents are northerly and rapid. They are the cause of both extensive shore erosion and sedimentation. Any port or jetty would be filled-in very quickly, especially as the sea is quite shallow here. Another obstacle for this sector is the obstacle of sand dunes (Davie 1987:147).

Near the southeast end of one of the main runways of the airport identified an important site, where among the human burials six stone circles were visible. The circles vary in diameter from eight to fifteen meters and are composed of one course of large river boulders (Saidah 1970:8). With extension of these runways should be able to examine these enigmatic stone circles and determine whether or not they are related to similar structures found in the Nautufian Upper Paleolithic open-air sites of Palestine and Transjordan. The Khaldeh circles of rough stones are irregular oval or round and varying in diameter between three and six meters. There are not enough stone courses to suppose that they originally formed walls. Suppose that in all likelihood these stones were rather used to hold down the edges of huts or tents made of animal skins or other perishable material (Saidah 1970:8-9; Jidejian 1993:13).

Traces of Natufian tools in the form of microlithic arrow heads and other small geometric tools found in "the Sands Station" area, especially at Burj el Barajne, south of Beirut. No excavations undertaken in this area but many surface finds of flints have been found, and according to information the sites lies under a village on the fringe of the dunes (Saidah 1970:11).

Neolithic flint tools and Neolithic pottery generally collected in two areas: other than the above mentioned at Tell Arslan, the second concentration from the sands south of Beirut (Jidejian 1993:15).

Medieval Period

Imam Al Aouza'i

The 1841-1842 map indicates the Nebbi Wezahi, a Moham[ddine] Saint's tomb at Ouzaai' surrounded by sand dunes (see map Rima scanned) (Davie 1984:55). This tomb is still present today.

Among the residents of Beirut during the Medieval Period who became well known was Imam Al Aouza'i. Born in Baalbeck in 707 or 712, his personal name was Abd er Rahman bin Omar. A learned man of his day, well versed in Islamic technology and law he moved and became stationed in Beirut were he practiced and distinguished himself. He became a world-famous Moslem jurisconsult of the first and second centuries of the Hijra, and was regarded as the Imam of Syria (Jidejian 1993:12). He died in 774, and the Moslem shrine on the south coast of Beirut was erected for him.

It is said that the Imam Al Aouza'i was extremely fond of the Hantus village and that he often expressed the wish to be buried beside the tiny single-domed mosque, in which he taught (Conde 1955:20). After his burial in 774 Hantus was virtually destroyed by an earthquake and when it was reconstructed and reinhabited, it was name after this holy man and benefactor, Al Aouza'i (Conde 1955:20). Since than, Al Aouza'i has become Lebanon's second holiest shrine. Imam Al Aouza'i's original 7th century needle-like white minaret mosque building is the small room with a low dome which adjoins the minaret on the east (mountain) side. The mosque marks the resting-place of its famous namesake, and has since become the name for this region. Although it has undoubtedly been repaired and rehabilitated many a times since the earthquake that destroyed Hantus, it essentially remains the structure that Al Aouza'i knew (Conde 1955:20). Observed that in 1955, the mosque's minaret rose from a picturesque cluster of multi-colored house groups on the buffs (Conde 1955:19). Only with the opening of the Beirut International Airport, in nearby Khaldeh, did one witness the intensive development of the beach area, and the unmistakable southern expansion of Beirut toward the red sand dunes in the back of the beaches. The sand of the dunes at Khaldeh, are located a small distance from the sea, is red. The moving sand dunes are located over this red soil (Dubertret 1945:43). Hence today one observes the removal of the moving sand dunes (most likely by mining) and construction onto the red soil.

In 1955 the Al Aouza'i sector remained a sleepy summer resort for Beirutis who still preferred the traditional ways of the country over the foreign style further north beach resorts of the St. Michel and St. Simon (Conde 1955:19).

This region referred to as the al Aouza'i hill (Conde 1955:19), remnants and traces are only apparent in few areas of the Aouza'i. Not certain as to when all the leveling took place, but quite likely with the major boom of squatters during the 70's and 80's. Along the al Aouza'i hillside find ancient wells of fresh water along the beach itself that still continue to provide water for domestic purposes (Conde 1955:19).

Classical Period

Apparent that it did not take the Romans long to discover the potentialities of the beautiful sandy beaches which stretched to the south of Beirut, as revealed by the numerous Byzantine and Roman mosaics and Roman artefacts and coins have turned up in the process of excavations for buildings at al Aouza'i. Rescue operations salvaged only portions of these suburbs that developed on the sandy beaches south of Beirut during the Classical period. Uncovered several mosaic floors which belonged to villas which had been built by the sea indicate the development between Jnah and Ouzai'i of important Roman seaside suburbs, (Jidejian 1973:49; Khalieh 1997:294). Among the mosaic were the Good Shepherd from Jnah dated to the 5th century A.D, and a mosaic with four vases, vines and floral designs from Jnah dated to the Roman-Byzantine period. This suggests an ancient tradition favored this region for their beach villas (Conde 1955:19). Almost as if continued an earlier Roman tradition, with this region being settled by few old (but not ancient) beach villas of earlier days, the few remanding houses among the new cement structures (Conde 1955:19).

Roman Road

At Khaldeh have traces of about 150m2 of Roman road belonging to Rome's Antioch to Acre highway (see map 2). Along Lebanon's 135-mile coastal-line, from Nahr el Kebir in the north to Ras Nakoura in the south, are traces of this great Roman road from Antioch to Acre. Although most of its length now covered by modern highway and railroad, there are stretches where the Roman road's pavement, cutting, walling and curbstones are visible, together with more than twenty of its milestone pillars, a few road-building inscriptions and one intact bridge (Conde 1955:264).

Finished in the year 56 by Emperor Nero's legate Caius Ummidius Durmius and kept in constant repair for the next six centuries, this coastal road formed an important link in the imperial communications system of Roman and Byzantine periods, and with occasional straightening, is the basis of all subsequent and present coastal highways of Lebanon (Conde 1955:264).

One of the longest preserved portions of around 150 m2 of the ancient strategic Roman road, la Via Maris from Antioch to Ptolemais is the excvated Khaldeh segment (Saidah 1975:57).

The portion of the excavated road at Khaldeh revealed layers of gravel and pottery sherds lies with a compact claying soil, labelled "earth cement" (Saidah 1975:56). Placed a sounding to measure the different structures of the Roman road, and to investigate the possibility of the existence of earlier roads, which highly likely considering the Assyrian, Egyptian and Greek conquers who left their traces further north on the rocks of Nahr el Kelb (Saidah 1975:57).

More than 600 milestones once marked its 313 mile-stations coastal road from Antioch southward. These milestones are inscribed with the titles of the reigning emperor and occasionally with the names of his provincial governors (Goodchild 1948-1949:92; Conde 1955:264). These Roman milestones serve as epigraphic documents and frequently provide the names of provincial governors otherwise unknown to history. They also indicate the lines of Roman roads that have vanished from sight, and give distances to ancient sites whose exact location is otherwise unknown, providing a reliable and official 'intermarry' that can be used to check and correct the documented Itineraria that have survived from the Roman period (Goodchild 1948-1949:92).

In the vicinity of Beirut, before the Ghadir river (which today located under the airport runway) discovered three Roman milestone. Found Roman milestone marked with the 233rd mile south of Antioch, discovered at Wadi Gadir near Beirut on estate of Emir Tewfic Arslan (Conde 1955:265). Wadi Ghadir is located on the old Sidon road not far from Burj-el Brajneh. . Found another Roman milestone marked with the 234th mile south of Antioch, another Roman milestone with no mileage marking, but should be the 235th mile south of Antioch.

Further south of Beirut have the intermediate station of Heluda, long identified with Khan Khaldeh, were found a Roman milestone marking the 239th mile-station south of Antioch (today about 360 kilometers) and the 12th from Beirut (today around 18 km), located next to the foot of the small mound of Khan Khaldeh (Goodchild 1948-1949:101). This Roman milestone dates to 129 A.D. under Hadrian's reign (Duval and Caillet 1982:315).

A necropolis found in the vicinity of the Roman route from Antioch to Ptolemais and under the Sidon road, that passes along the sands (Mouterde 1964:33). Unfortunately no other specific details are given, however may be the tombs that early travelers mention found in the vicinity of Khan Khaldeh. Goodchild's drawing is only plan of its placement found (see my map 2), possible that their placement may be in same manner as the sarcophagi found along the Roman and Byzantine road in Tyre (Bass).

The next road station is that of Porphyron, a site that know exists in the sand dunes between the site of Khan Nebi-Yunes and Jiyheh. A partial rescue excavation by the Department of Antiquities revealed an elaborate and prosperous Roman and Byzantine settlement, with mosaics and numerous olive presses (Saidah 1970). The site Khan Nebi-Yunes served much in the same manner as Khan Khaldeh, especially with its numerous olive press installations.

Generally speaking the old and new roads appear to be coincidental. Unfortunately from the Nahr el Kelb to the Wadi Choueifat, south of Beirut, there are no visible remains of the Roman road (Goodchild 1948-1949:108). Certain portions of the Roman road have been obliterated by the recent road constructions and the railway works (Goodchild 1948-1949:107). Southward from Beirut, the old Sidon road represents the line of the Roman highway, as proven by the Wadi Ghadir milestone.

At the next wadi (valley), the Nahr el Yabes the Roman road begins to emerge from its covering of the sand dunes and plantations, and a good section of rammed gravel, 21 feet 6 in wide, and 2 ft thick is visible in the cut ditch for a railway culvert (Goodchild 1948-

1949:101). From this point to the Khan el Ghufr tell, the Roman road is visible continuously on the seaward side of the modern road in an overgrown and mutilated condition, walled, on the inland side, for part of its course (Goodchild 1948-1949:108).

A deep cutting of the old road leaving Beirut outside its south-western walls mentioned (Robinson 1841:438), which has since been built over (Goodchild 1948-1949:108).

Generalisations can be made on the characteristics of this Roman road, as the present knowledge confined to the surface indications of the road and to chance discoveries. Undertaken to uncover a short sector of the road in order to determine its engineering features, contributing details that should keep an eye out for.

With the scarce available observations can make the following tentative conclusions. The road follows as close to the sea-shore as is practicable, diverging from it only to avoid sand dunes or to cross rocky promontories. Its width is approximately 22 ft, and is normally paved with irregular blocks of stone and provided with carefully-laid curbs of larger stones. On rocky headlands, however these curbs are replaces by side walls of stones quarried from the course of the road. The section visible from the Choufiet sector shows that gravel was sometimes substituted for the paving, but this may be a later repair to the road, or the base for slabs since removed (Goodchild 1948-1949:111-112). The coastal route appears in Phoenician history not as a line of communications but rather as a line of attack. Possible that during the Persian period the coastal route may have developed from a geographical line of approach into an administrative line of communication, but it is only in the Roman period that have evidence of a continuous engineered from Antioch to Ptolemais (Goodchild 1948-1949:112).

Quarry

The demand for worked stone for the construction caused the dismantling of antiquities (!), for example the sections of the Roman aqueduct in the plains of Choufiet (Thomson 1910). The soft ramleh from the surrounding regions of the city extensively quarried by Beirutis from antiquity up to the thirties (Saidah 1970:5-6). Similar to the situation today with the of the construction of extension of Beirut International Airport runways stone have been quarried from the mountains further south and transported in by the truckloads.

SUMMARY 0F LIKELY IMPACT

Quite likely will come across further archaeological traces in the region of Khaldeh, as apparent was almost a continuosly occupied strech over many different periods. Apparent that most of the sand dunes already mined away in this region, therefore will require close supervision in areas of red soil, as may find traces of archaeological pockets.

As for the region further east, inland, in the vicinity of Choufiet, an area once entirely covered with olive groves, may come across portions of the above mentioned aqueduct, of which most likely only portions of it will be preserved, if any.

RECOMMENDED MITTIGATION

The Grade Separation Location of Chweifat may reveal traces of preserved archaeological elements, especially of the aqueduct. Hence will require constant monitoring by an archaeologist, in the early digging phase of this Grade Separation Location. Possibly place a sounding in one of the empty lots of the Damascus Road, as close as possible to the present road to see if any archaeology present, especially the presence of any road usage over time. Possible that in the above mentioned stretch of Khaldeh, if work necessary in that area, conduct a watching brief to see if any traces of the archaeology (whether burials, villas, milestone, road structures, etc) are still preserved. Much in the same way found traces of actual Roman Road in vicinity of Khaldeh site. Must keep an eye out, especially in the areas of red soil, as aware quite thick in places, hence possibly preserving pockets of archaeological elements (whether burials, structures, etc).

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APPENDIX 3

SAFETY, HEALTH, AND ENVIRONMENTAL REGULATIONS

STANDARD BIDDING DOCUMENTS

Safety, Health and Environmental Regulations

Council for Development and Reconstruction
Beirut, Lebanon

June 1996

Safety, Health and Environmental Regulations

Table of Contents

Drafting Notes[2]

2	These drafting notes are intended to assist those preparing the Safety. Health and Environmental Regulations. **These drafting notes should not be incorporated in the bidding documents.**

1 These CDR Safety ... Regs. Issue June 96 (c:\wp51\docs\Safety\CDRRegs) can be used with all CDR Standard Conditions of Contract.

2 The CDR Safety. Health and Environmental Regulations are in two parts:

- PART I - General Safety. Health and Environmental Regulations;
- PART II - Supplementary Safety. Health and Environmental Regulations.

3 PART I. General Safety. Health and Environmental Regulations. together with the front cover page and pages i to iii. shall be included as printed. **without amendment**.

The pages of PART I are set up for. and should be photocopied on. double sided paper.

4 PART II. Supplementary Safety. Health and Environmental Regulations. will comprise changes. modifications and additional requirements to PART I. applicable to the Sector and/or the contract for which the Regulations are being prepared. PART II should be prepared by the Consultant responsible for preparation of the bidding documents in conjunction with the SIU.

PART II has priority over PART I (see Preamble).

If no changes. modifications or additional requirements are included in PART II. the page for PART II should be included with the addition of the following below the Table of Clauses:

"NONE"

The name of the contract should be added to the footer of pages. PART II.

5 In PART I. the amounts to be witheld in the event of non-compliance (Sub-Clause 3.2.2) are expressed in USD. PART II includes provision for contracts in currencies other than USD (eg Lebanese Pounds).

6 The Regulations should be included as Appendix 1 to the Conditions of Contract[2].

Sample clause for inclusion in the Conditions of Contract[2]:

X Safety, Health and Environmental Regulations

X.X The Contractor shall comply with the requirements of CDR Safety. Health and Environment Regulations. The regulations and requirements. and specific measures and actions available to the Employer and the Engineer in the event of non-compliance by the Contractor. are attached as Appendix 1 to these Conditions of Contract.

3 The positioning and numbering of the above Clause varies according to the Conditions of Contract being used:

- for CDR Integrated Conditions of Contract for Works of Civil Engineering Construction: Part I - Standard Conditions, Sub-Clause 19.1;
- for CDR Conditions of Contract for Works of a Civil Engineering Construction: Part II - Conditions of Particular Application, Sub-Clause 78.1;
- for CDR Standard Bidding Documents, Procurement of Works, Smaller Contracts: Section 3, Conditions of Contract, Clause 19.2.

For other Conditions of Contract the Sub-Clause should be positioned and numbered as appropriate.

7 Throughout the Regulations the term "Engineer" is used.

However, in the CDR Standard Bidding Documents, Procurement of Works, Smaller Contracts the term "Engineer" is replaced by "Project Manager".

When "Engineer" is used in the bidding documents, the first alternative page iii "Preamble" should be included. When "Project Manager" is used in the bidding documents, the second alternative page iii, "Preamble", should be included.

Preamble

The Safety, Health and Environmental Regulations are in two parts:

PART I - General Safety, Health and Environmental Regulations:

PART II - Supplementary Safety, Health and Environmental Regulations.

PART II shall have priority over PART I.

Whenever the term "Engineer" is used in these Safety, Health and Environmental Regulations, it shall be construed as meaning "Project Manager" as defined in the Conditions of Contract.

Part I

General Safety, Health and Environmental Regulations

Table of Clauses

Part I

General Safety, Health and Environmental Regulations

1 Introduction

1.1 The prevention of injury and/or illness to site personnel and the public. damage to the Works and to public and private property. protection of the environment. and compliance with applicable laws. are primary objectives of CDR (the Employer). Because of the importance CDR places on meeting these objectives. selected minimum requirements are outlined in these Safety. Health and Environmental Regulations with which Contractors shall comply while working on CDR contracts. Given that these Regulations cannot cover every eventuality. the Contractor shall be expected to exercise good judgement in all such matters. even though not mentioned in these Regulations. and shall take any and all additional measures. as required or necessary. to meet his responsibility for safety. health and environmental matters during the period of the Contract.

CDR and its representatives shall not be held liable for any actions taken by the Contractor that are attributed to following the minimum requirements stated hereinafter.

1.2 The Contractor shall. throughout the execution and completion of the Works and the remedying of any defects therein:

(a) have full regard for the safety of all persons on the Site and keep the Site and the Works in an orderly state appropriate to the avoidance of danger to any person:

(b) know and understand all laws governing his activities along with any site requirements and work site hazards. Such information shall be communicated by the Contractor to his personnel and subcontractors:

(c) take all necessary measures to protect his personnel. the Employer's personnel. other persons. the general public and the environment:

(d) avoid damage or nuisance to persons or to property of the public or others resulting from pollution. noise or other causes arising as a consequence of carrying out the Works.

2 Compliance with Regulations

2.1 The Contractor shall comply with the requirements of these Safety. Health and Environmental Regulations and all other applicable regulations or requirements under Lebanese laws. laid down by relevant authorities or issued by the Employer or the Engineer concerning safety. health and the environment. in force or introduced or issued from time to time during the period of the Contract.

In so far as these Regulations are applicable, they shall apply to sites and personnel outside the Site associated with the performance of the Contract.

2.2 The Regulations equally apply to subcontractors and all other parties engaged by the Contractor and their personnel. The Contractor shall ensure all such parties are fully aware of and comply with the Regulations.

2.3 The Contractor shall comply with all notifications and written or verbal instruction regarding safety issued pursuant to these Regulations by the Employer, Engineer or relevant authorities within the time specified in the notification or instruction.

Whenever the Contractor is required to obtain the approval, agreement, permission, etc of the Engineer, such approval, agreement, permission, etc shall not relieve the Contractor of his responsibilities and obligations under these Regulations or the Contract.

2.4 The Contractor shall adopt a positive approach, awareness and responsibility towards safety, health and the environment, and take appropriate action, by:

(a) ensuring the Regulations are enforced and followed by the Contractor's personnel. Any failure by the Contractor's personnel to follow the Regulations, shall be regarded as a failure by the Contractor.

(b) paying attention to possible injury to unauthorised persons entering the site, particularly children.

2.5 Whenever in these Regulations the Contractor is required to provide test certificates for equipment and personnel or to comply the relevant authorities' requirements and no independent test facilities are available or no relevant authorities exist in Lebanon, the Contractor shall provide:

a) in lieu of independent test certificates:

- for equipment - details of the tests and the date of the tests that have been carried out by the Contractor and a written statement that the Contractor has satisfied himself that the item of equipment is fit and safe for use;
- for personnel - details of the training and experience and a written statement that the Contractor has satisfied himself that the person has the required level of competency;

b) in lieu of relevant authorities' requirements - details of the Contractor's own rules, regulations, requirements and procedures regarding safety, health and the environment.

If the Engineer is dissatisfied with the details provided by the Contractor, the Contractor shall provide further details or carry out further tests or provide further written statements as may be reasonably required by the Engineer.

When the Engineer has satisfied himself regarding the Contractor's own rules, regulations, requirements and procedures provided in accordance with (b) above, such rules, etc shall be deemed to form part of these Regulations and to which Clause 3 shall equally apply.

3 Failure to Comply with Regulations

3.1 General

3.1.1 Should the Contractor fail to comply with any of the Regulations or requirements:

(a) the Engineer may suspend the Works or part of the Works until the Contractor has taken necessary steps, to the satisfaction of the Engineer, to comply with the regulations or requirements.

(b) the Employer may, following written notice to the Contractor, carry out themselves or arrange for another contractor to carry out such measures as they consider appropriate on behalf of the Contractor. Any such actions by the Employer shall not affect or diminish the Contractor's obligations or responsibilities under the Contract.

(c) the Engineer may, following written notice to the Contractor, deduct from payments to the Contractor the amounts stipulated in Sub-Clause 3.2. Such notice shall specify:

(i) the nature of the failure or failures;

(ii) the period after the date of the notice within which the Contractor shall remedy each failure; and

(iii) the amount to be deducted.

Such suspension of payment will remain in force until such time as the Contractor has rectified the breach or breaches to the satisfaction of the Engineer. No interest shall be paid on the suspended payments.

3.1.2 Failure to comply with the Regulations or requirements shall be considered a breach of contract by the Contractor and may result in termination of the Contract by the Employer.

3.1.3 In the event of the Employer or Engineer taking action based on Sub-Clause 3.1.1(a) or (b) or 3.1.2, the Contractor shall not be entitled to any additional costs or extension to the Contract Completion Date.

3.1.4 All costs incurred by the Employer pursuant to Sub-Clause 3.1.1(b) and the deductions from payments imposed on the Contractor by the Engineer under Sub-Clause 3.1.1(c) shall be deducted from amounts otherwise due to the Contractor.

3.2 Deductions from Payments

3.2.1 Failures by the Contractor to comply with the Regulations or requirements are classified as follows:

D1 - breaches of Sub-Clause 5.6 (personal protective equipment);
D2 - breaches of Clause 7 (work in Public Areas);
D3 - breaches other than D1 and D2.

3.2.2 The basic deduction from payment for each classification in Sub-Clause 3.2.1. is as follows:

for D1 - $2000;
for D2 - $10000;
for D3 - $5000.

3.2.3 Deductions from payments will be applied as follows:

(a) for the first breach of each regulation or requirement - the basic deduction. If the same or similar breaches occur in different situations or locations at the same time, the Engineer may apply deductions for each situation or location: this will not apply to breaches related to personal protective equipment.

(b) for a second or subsequent breach of the same Regulation or requirement or failure to rectify a previous failure within the time specified by the Engineer - twice the basic deduction.

4 General Requirements

4.1 Preamble

4.1.1 All references to safety shall be deemed to include health and the environment.

4.2 Safety Officer

4.2.1 The Contractor shall appoint a competent Safety Officer who shall be responsible for safety, health and the environment. The Safety Officer shall be given sufficient time by the Contractor to carry out his duties; minimum requirements shall be as follows:

Workforce on Site of over 250	-	full time Safety Officer;
Workforce on Site of 100-250	-	50% of Safety Officer's time;
Workforce on Site below 100	-	as required for the Works but a minimum of 5 hours per week of Safety Officer's time where more than 20 workers.

4.2.2 The Contractor shall provide the Safety Officer with appropriate identification, including a white hard hat with red cross symbol and a identification badge. The appointment of the Safety Officer shall be in writing and copied to the Engineer. The appointment shall include specific instructions to enforce these Regulations and delegated authority to take any action, measure or to issue instructions regarding their enforcement. All persons on Site shall be made aware of the name and authority of the Safety Officer and instructed to comply with any instruction or direction on safety matters, verbal or in writing, issued by the Safety Officer.

4.2.3 The Safety Officer shall be provided with a mobile phone or other similar means of communication. The Safety Officer shall be accessible and available at all times including outside normal working hours.

4.3 Safety Training

4.3.1 The Contractor shall provide safety induction training for all site personnel upon starting on site.

4.3.2 The Contractor shall provide safety refresher/reinforcement training at regular intervals for his staff.

4.4 Safety Meetings

4.4.1 The Contractor shall hold regular safety meetings to provide safety instructions and receive feedback from site personnel on safety, health and environmental matters. A weekly Safety Meeting shall be chaired by the Safety Officer and minutes shall be taken of the meeting. The meeting/minutes shall cover all relevant issues including actions to be taken. A copy of the minutes shall be given to the Engineer. The Safety Officer should attend the Contractor's weekly site meetings and "Safety" should be an item on the agenda.

4.5 Safety Inspections

4.5.1 The Safety Officer shall make regular safety inspections of the work site. The Safety Officer shall prepare a report of each inspection. This report shall include details of all breaches of these Regulations and any other matters or situations relating to safety found during the inspection, instructions issued by the Safety Officer and actions taken by the Contractor. A copy of the Safety Officer's inspection reports shall be given to the Engineer.

4.6 Control of Substances Hazardous to Health

4.6.1 Hazardous materials shall be stored in approved safety containers and handled in a manner specified by the manufactures and/or prescribed by relevant Authorities (see Sub-Clause 2.5).

4.6.2 Only properly trained and equipped personnel shall handle hazardous materials.

4.7 Potential Hazards

4.7.1 The Contractor shall inform employees of potential hazards, take appropriate steps to reduce hazards and be prepared for emergency situations.

4.7.2 The Contractor shall make an assessment of every operation involving hazardous substances. The assessment shall be recorded on a Hazardous and Flammable Substances Assessment Method Statement which shall be submitted to the Engineer prior to the delivery and use of the substance on Site.

4.8 Accident Reporting

4.8.1 The Contractor shall report all accidents and dangerous occurrences to the Engineer. The Contractor shall prepare a report on each accident or dangerous occurrence and a copy of the report, together with witness statements and any other relevant information, shall be submitted to the Engineer. A reportable accident or dangerous occurrence shall include any accident to any person on Site requiring medical attention or resulting in the loss of working hours or any incident that resulted, or could have resulted, in injury, damage or a danger to the Works, persons, property or the environment.

4.8.2 In the event of an accident or dangerous occurrence, the Contractor shall be responsible for completing all statutory notifications and reports. Copies of all statutory notifications and reports shall be passed to the Engineer.

4.8.3 All accidents and dangerous occurrences shall be recorded in a Site Accident Book. The Site Accident Book shall be available at all times for inspection by the Engineer.

4.8.3 The Contractor shall immediately rectify any situation or condition that could result in injury, damage or a danger to the Works, person, property or the environment. If the situation or condition cannot be corrected immediately, the Contractor shall provide temporary barriers and appropriate warning signs and devices and/or take other appropriate action necessary for the protection of persons, property and the environment.

4.9 Notices, Signs, Etc

4.9.1 All safety, health, environmental and other notices and signs shall be clearly displayed and written in both Arabic and either English or French. All requirements, instructions, procedures, etc issued by the Contractor concerning these Regulations shall be printed in both Arabic and English and displayed and readily available to Contractor's personnel.

4.10 First Aid and Medical Attention

4.10.1 The Contractor shall have comprehensive First Aid Kit(s) on Site at all times. First Aid Kits shall be conveniently located and clearly identifiable.

4.10.2 The Contractor shall have one employee on site trained in first aid for every 25 employees. Such persons shall be provided with appropriate identification, including a red hard hat with a white "red cross" symbol and a identification badge.

4.10.3 The Contractor shall make contingency arrangements for calling a Doctor and transporting injured persons to hospital. The telephone numbers of the emergency services and the name, address and telephone number of the Doctor and nearest hospital shall be prominently displayed in the Contractor's site office.

4.11 Employee Qualifications and Conduct

4.11.1 The Contractor shall employ only persons who are fit, qualified and skilled in the work to be preformed. All persons shall be above the minimum working age.

4.11.2 Contractor's personnel shall use the toilet facilities provided by the Contractor.

4.11.3 The Contractor shall ensure:

(a) that no firearms, weapons, controlled or illegal substances or alcoholic beverages are brought onto the Site and that no personnel under the influence of alcohol or drugs are permitted on Site.

(b) that all personnel obey warning signs, product or process labels and posted instructions.

(c) that drivers or operators of vehicles, machinery, plant and equipment follow the rules for safe operations. Drivers shall wear seat belts and obey all signs and posted speed limits.

5 Safety Requirements

5.1 Personal Protective Equipment

5.1.1 The Contractor shall provide personal protective equipment, including hard hats, safety glasses, respirators, gloves, safety shoes, and such other equipment as required, and shall take all measures or actions for the protection and safety of Contractor's personnel.

5.1.2 Non-metallic hard hats shall be worn at all times by all personnel at the worksite with the exception of those areas where the Engineer has indicated it is not necessary to do so.

5.1.3 Safety glasses shall meet international standards and be available for use and worn in specified worksite areas. As a minimum, safety glasses shall be worn for the following types of work: hammering, chipping, welding, grinding, use of electrically powered or pneumatic equipment, insulation handling, spray painting, working with solvents, and other jobs where the potential of an eye injury exists. Face shields and/or monogoggles shall be worn where possible exposure to hazardous chemicals, cryogenic fluids, acids, caustics, or dust exists and where safety glasses may not provide adequate protection.

5.1.4 When handling acids, caustics, and chemicals with corrosive or toxic properties, suitable protection, such as acid suits or chemical resistant aprons and gloves, shall be worn to prevent accidental contact with the substance.

5.1.5 Personnel shall not be permitted to work whilst wearing personal clothing or footwear likely to be hazardous to themselves or others.

5.1.6 The wearing of safety shoes with steel reinforced toes is recommended for all Contractor's personnel on site. In all cases, Contractor's personnel shall wear substantial work shoes that are commensurate with the hazards of the work and the worksite area.

5.1.7 Hearing protection, including muffs, plugs or a combination thereof, shall be provided for all personnel operating in areas where the noise level exceeds 90 decibels. Such protection shall also be provided for operators working with equipment exceeding such a level. This may include equipment such as excavators, shovels, jackhammers, saws, drills, grinders, and the like are being used.

5.1.8 The Contractor shall encourage employees to wear substantial work gloves whenever practical and safe to do so.

5.2 Fire Protection and Prevention

5.2.1 The Contractor shall comply with fire protection instructions given by the Authorities having jurisdiction in regard to fire protection regulations.

5.2.2 The Contractor shall, upon moving on site, provide to the Engineer and the Authorities a fire prevention and evacuation plan. This shall include drawing(s) showing the fire assembly points. The fire prevention and evacuation plan and drawing(s) shall be updated from time to time as the Works progress. The Contractor shall ensure all personnel are fully informed on escape routes and assembly points and any changes thereto.

5.2.3 Fuel storage will not be permitted in construction work areas. Contractors may establish fuel storage tanks in special areas set aside for the purpose and approved by the Engineer. Storage tanks shall be adequately bunded to control spillage. Fire extinguishers shall be provided and installed in a suitable nearby location.

5.2.4 Highly combustible or volatile materials shall be stored separately from other materials and as prescribed by relevant authorities and under no circumstances within buildings or structures forming part of the permanent Works. All such materials shall be protected and not exposed to open flame or other situations which could result in a fire risk.

5.2.5 No combustible site accommodation shall be located inside or within 10 metres of a building or structure forming part of the permanent Works. Where units have to be used in these circumstances, they shall be constructed of non-combustible materials and have a half-hour fire rating inside to outside and outside to inside. Non-combustible furniture shall be used where practical.

5.2.6 All temporary accommodation and stores shall be provided with smoke detectors and fire alarms.

5.2.7 Smoking shall be banned in high risk areas.

5.2.8 Expanded polystyrene with or without flame retarding additive, polythene, cardboard and hardboard shall not be used as protection materials.

5.2.9 Plywood and chipboard shall only be used as protection on floors. Vertical protection shall be non-combustible. Debris netting and weather protection sheeting shall be fire retardant.

5.2.10 When using cutting or welding torches or other equipment with an open flame, the Contractor shall provide a fire extinguisher close by at all times. All flammable material shall be cleared from areas of hot works, or work locations prior to welding or oxy/gas burning operations. All hot works shall cease half an hour before the end of a work shift to allow for thorough checking for fires or smouldering materials. Where appropriate, areas of hot works are to be doused in water before the shift ends.

5.2.11 An adequate number of fire extinguishers of types suited to the fire risk and the materials exposed shall be provided. These shall be placed in accessible, well-marked locations throughout the job site. Contractor's personnel shall be trained in their use. Extinguishers shall be checked monthly for service condition and replaced or recharged, as appropriate after use.

5.2.12 Only approved containers shall be used for the storage, transport and dispensing of flammable substances. Portable containers used for transporting or transferring gasoline or other flammable liquids shall be approved safety cans.

5.2.13 Fuel burning engines shall be shut off while being refuelled.

5.2.14 Adequate ventilation to prevent an accumulation of flammable vapours shall be provided where solvents or volatile cleaning agents are used.

5.2.15 Flammables shall not be stored under overhead pipelines, cable trays, electrical wires, or stairways used for emergency egress.

5.2.16 Paints shall be stored and mixed in a room assigned for the purpose. This room shall be kept under lock and key.

5.2.17 Oily waste, rags and any other such combustible materials shall be stored in proper metal containers with self-closing lids and removed every night to a safe area or off site. Every precaution shall be taken to prevent spontaneous combustion.

5.3 Electrical Safety

5.3.1 All temporary electrical installations, tools and equipment shall comply with current regulations dealing with on-site electrical installations.

5.3.2 The Contractor shall establish a permit-to-work system for work on or in proximity to energized circuits of any voltage. Contractor's personnel shall not commence work on such circuits unless a permit to work has been issued and adequate safety measures have been taken and the work operation has been reviewed and approved by the Engineer.

5.3.3 Only authorised personnel shall be allowed to work or repair electrical installations and equipment.

5.3.4 Portable tools and equipment shall be 110 volt, unless otherwise agreed by the Engineer.

5.3.5 When portable or semi-mobile equipment operates at voltages in excess of 110 volts. the supply shall be protected by a Residual Current Device (RCD) regardless of any such device fitted to the equipment. The RCD must have a tripping characteristic of 30 milliamps at 30 milliseconds maximum.

5.3.6 All static electrically powered equipment. including motors. transformers. generators. welders. and other machinery. shall be properly earthed. insulated. and/or protected by a ground fault interruption device. In addition. the skin of metal buildings and trailers with electric service shall be earthed. Metal steps. when used. shall be securely fixed to the trailer.

5.3.7 Lampholders on festoon lighting shall be moulded to flexible cable and be of the screw in type. Clip on guards shall be fitted to each lamp unit.

5.3.8 All tungsten-halogen lamps shall be fitted with a glass guard to the element. These lamps must be permanently fixed at high level.

5.3.9 Electrical equipment shall be periodically inspected and repaired as necessary by competent persons.

5.3.10 Any work on electrical equipment and systems shall be made safe through locking, tagging, and/or isolation of the equipment before work commences. Prior to the start of the work, the equipment or systems shall be tested to insure that they have been properly de-energized and isolated.

5.3.11 Electrical repair work on energized systems shall be avoided whenever possible.

5.3.12 Electrical trouble shooting shall be conducted only after getting written approval of the Engineer.

5.3.13 Unauthorized personnel shall not enter enclosures or areas containing high voltage equipment such as switch gear. transformers. or substations.

5.4 Oxygen/Acetylene/Fuel Gases/Cartridge Tools

5.4.1 Compressed oxygen shall never be used in the place of compressed air.

5.4.2 Flash-back (Spark) arrestors shall be fitted to all gas equipment.

5.4.3 Liquid Petroleum Gas (LPG) cylinders shall not be stored or left in areas below ground level overnight. Cylinders must be stored upright.

5.4.4 The quantity of oxygen. acetylene and LPG cylinders at the point of work shall be restricted to a maximum of one day's supply. Cylinders shall be kept in upright vertical rack containers or be safely secured to a vertical support.

5.4.5 Cartridge tools shall be of the low velocity type. Operators must have received adequate training in the safe use and operation of the tool to be used.

5.5 Scaffolding/Temporary Works

5.5.1 No aluminum tube shall be used, except for proprietary mobile towers, unless otherwise agreed with the Engineer.

5.5.2 Drawings and calculations shall be submitted to the Engineer, prior to commencement of work on site, for all Temporary Works, including excavations, falsework, tower cranes, hoists, services and scaffolding. Design shall conform to international standards.

5.5.3 The Engineer will not approve Temporary Work designs but the Contractor shall take account of any comments on such designs made by the Engineer.

5.5.4 The Contractor shall inspect and approve all Temporary Works after erection and before access, loading or use is allowed. Completed and approved Temporary Works shall be tagged with a scaff-tag or similar safety system and the Safe Structure insert displayed. For scaffolding, one tag shall be displayed every 32 m2 of face area. A central record system shall be kept on all Temporary Work. Temporary Works shall be inspected weekly and similarly recorded.

5.5.5 All mobile scaffold towers shall be erected in accordance with the manufacture's instructions and a copy of these shall be submitted to the Engineer prior to any use on site. Additionally, all towers shall be erected complete with access ladder, safety rails and kick boards whatever the height.

5.5.6 The Contractor shall repair or replace, immediately, any scaffold including accessories, damaged or weakened from any cause.

5.5.7 The Contractor shall ensure that any slippery conditions on scaffolds are eliminated as soon as possible after they occur.

5.5.8 All scaffolds used for storing materials, for brick or block laying, for access to formwork or for any other purpose where materials may accidentally fall, shall be provided with wire mesh guards or guards of a substantial material, in addition to kick boards.

5.6 Use of Ladders

5.6.1 Manufactured ladders shall meet the applicable safety codes for wood or metal ladders. Metal ladders shall not be used where there is any likelihood of contract with electric cables and equipment. All metal ladders shall be clearly marked: "Caution - Do not use around electrical equipment".

5.6.2 Job made ladders shall not be permitted.

5.6.3 Extension or straight ladders shall be equipped with non-skid safety feet, and shall be no more than 12 m in height. The maximum height of a step ladder shall be 2 m. Ladders shall not be used as platforms or scaffold planks.

5.6.4 Ladders rungs and steps shall be kept clean and free of grease and oil.

5.6.5 Extension and straight ladders shall be tied off at the top and/or bottom when in use. Only one person shall be allowed on a ladder at a time.

5.6.6 Defective ladders shall be taken out of service and not used. Ladders shall not be painted and shall be inspected for defects prior to use.

5.7 Elevated Work

5.7.1 The Contractor shall provide all personnel, while working at an elevated position, with adequate protection from falls. Details of such protection shall be submitted to and approved by the Engineer.

5.7.2 The Contractor shall carry out daily inspections of all elevated work platforms. Defects shall be corrected prior to use.

5.7.3 Roofing & Sheet Material Laying

(a) A Method Statement detailing the procedures to be adopted shall be submitted to and agreed with the Engineer prior to commencement of work on site.

(b) Mobile elevating work platforms or the equivalent shall be used to install roofing and sheet materials wherever practicable and a suitable base is available.

5.7.4 Erection of Structures

(a) A Method Statement detailing the procedures to be adopted shall be submitted and agreed with the Engineer prior to commencement of work on site.

(b) Safety harnesses and lines shall be provided by the Contractor for use by the erection personnel and worn at all times.

(c) Mobile elevating work platforms or the equivalent shall be used to erect structures wherever practicable and a suitable base is available.

5.7.5 Mobile Elevating Work Platforms

Operators shall be trained in the safe use of such platforms and hold a current Certificate of Competence (see Sub-Clause 2.5).

5.7.6 Hoists

(a) A copy of the current Test Certificate (see Sub-Clause 2.5) shall be submitted to the Engineer before any hoist (personnel or material) is brought into operation on the site. Where the range of travel is increased or reduced a copy of the revised Test Certificate shall be submitted.

(b) Each landing gate shall be fitted with a mechanical or electrical interlock to prevent movement of the hoist when any such gate is in the open position.

(c) Safety harnesses must be worn and used by personnel erecting, altering and dismantling hoists.

5.7.7 Suspended Cradles

(a) Suspended cradles shall be installed, moved and dismantled by a specialist contractor.

(b) Suspended cradles shall comply with local regulations.

(c) All powered suspended cradles shall incorporate independent safety lines to overspeed braking devices and independent suspension lines for personal safety harness attachment.

5.8 Use of Temporary Equipment

5.8.1 The safe design capacity of any piece of equipment shall not be exceeded, nor shall the equipment be modified in any manner that alters the original factor of safety or capacity.

5.8.2 Mobile equipment shall be fitted with suitable alarm and motion sensing devices, including backup alarm, when required.

5.8.3 The Contractor shall ensure that the installation and use of equipment are in accordance with the safety rules and recommendations laid down by the manufacturer, taking into account the other installations already in place or to be installed in the future.

5.8.4 The Contractor shall inspect Equipment prior to its use on the Works and periodically thereafter to ensure that it is in safe working order. Special attention shall be given to such items as cables, hoses, guards, booms, blocks, hooks and safety devices. Equipment found to be defective shall not be used and immediately removed from service, and a warning tag attached.

5.8.5 Natural and synthetic fibre rope made of material such as manila, nylon, polyester, or polypropylene shall not be used as slings if approved by the Engineer.

5.8.6 Only trained, qualified and authorized personnel shall operate equipment. All drivers and operators shall hold a current Certificate of Training Achievement for the equipment being used (see Sub-Clause 2.5).

5.8.7 A safety observer shall be assigned to watch movements of heavy mobile equipment where hazards may exist to other personnel from the movement of such equipment, or where equipment could hit overhead lines or structures. The observer shall also ensure that people are kept clear of mobile equipment and suspended loads.

5.8.8 When mobile or heavy equipment is travelling onto a public thoroughfare or roadway, a flagman shall insure that traffic has been stopped prior to such equipment proceeding. While the mobile or heavy equipment is travelling on a public roadway, a trailing escort vehicle with a sign warning of a slow-moving vehicle that is dangerous to pass shall be provided.

5.8.9 Cranes:

(a) The Contractor shall give a minimum of 48 hours notice to the Engineer prior to bringing a mobile crane on site.

(b) No cranes shall be erected on the site without the prior approval of the Engineer. The Engineer may direct the Contractor as to locations where cranes may not be located. The Contractor shall take such directions into account when submitting his proposals for crane location points, base footings, pick up points and swing radius. Compliance with any such direction shall not entitle the Contractor to any extension of the Period of Completion or to any increase in the Contract Price.

(c) Safety harnesses shall be worn and used at all times by personnel engaged on the erection, alterations and dismantling of tower cranes.

(d) The Contractor shall provide a copy of the current Test Certificate (see Sub-Clause 2.5) to the Engineer before any crane (tower or mobile) is brought into operation on the Site.

(e) All lifting tackle must hold a current Test Certificate (see Sub-Clause 2.5). All lifting tackle must be thoroughly examined every 6 months and an inspection report raised.

(f) All fibrous/web slings shall be destroyed and replaced 6 months after first use.

(g) All crane drivers/operators shall hold a Certificate of Training Achievement for the class of crane operated (see Sub-Clause 2.5).

(h) All banksman/slingers shall hold a Training Certificate from a recognized training agency (see Sub-Clause 2.5).

(i) Only certified slingers/banksmans shall sling loads or guide crane/load movement.

(j) The maximum weekly working hours of a crane driver or banksman shall be restricted to 60 hours.

(k) Under no circumstances, shall a crane or load come within 4 m of any energized overhead power line or other critical structure.

5.9 Locking-out, Isolating, and Tagging of Equipment

5.9.1 Equipment that could present a hazard to personnel if accidentally activated during the performance of installation, repair, alteration, cleaning, or inspection work shall be made inoperable and free of stored energy and/or material prior to the start of work. Such equipment shall include circuit breakers, compressors, conveyors, elevators, machine tools, pipelines, pumps, valves, and similar equipment.

5.9.2 Where equipment is subject to unexpected external physical movement such as rotating, turning, dropping, falling, rolling, sliding, etc., mechanical and/or structural constraints shall be applied to prevent such movement.

5.9.3 Equipment which has been locked-out, immobilized, or taken out of service for repair or because of a potentially hazardous condition shall be appropriately tagged indicating the reason it has been isolated and/or taken out of service.

5.9.4 Where safety locks are used for locking out or isolating equipment, the lock shall be specially identified and easily recognized as a safety lock.

5.10 Installation of Temporary or Permanent Equipment

5.10.1 During installation and testing the Contractor's specialist engineer shall be in attendance.

5.10.2 All control mechanism panel and wiring diagrams shall be available and printed in both Arabic and either English or French.

5.11 Laser Survey Instruments

5.11.1 Details of the types and use of laser instruments shall be submitted and agreed with the Engineer.

5.12 Working in Confined Spaces

5.12.1 Confined spaces, including tanks, vessels, containers, pits, bins, vaults, tunnels, shafts, trenches, ventilation ducts, or other enclosures where known or potential hazards may exist, shall not be entered without prior inspection by and authorisation from the Site Safety Officer and the issuance of a Hazardous Work Permit.

5.12.2 Prior to entering the confined space, the area shall be completely isolated to prevent the entry of any hazardous substances or materials which could cause an oxygen deficient atmosphere. All equipment that could become energized or mobilized shall be physically restrained and tagged. All lines going into the confined space shall be isolated and/or blanked.

5.12.3 Personnel working in a confined space where emergency escape or rescue could be difficult, shall wear a safety harness attached to a lifeline.

5.12.4 A qualified attendant(s), trained and knowledgeable in job-related emergency procedures, shall be present at all times while persons are working within the confined space. The attendant shall be capable of effecting a rescue, have necessary rescue equipment immediately available, and be equipped with at least the same protective equipment as the person making entry.

5.12.5 All equipment to be used in a confined space shall be inspected to determine its acceptability for use. Where a hazard from electricity may exist, equipment utilized shall be of low voltage type.

5.12.6 The atmosphere within the confined space shall be tested to determine it is safe to enter. Acceptable limits are:

- oxygen: 19.5% lower, 22% higher;
- flammable gas: not to exceed 10% of lower explosion limit;
- toxic contaminants: not to exceed the permissible exposure limit.

Subsequent testing shall be done after each interruption and before re-entering the confined space, as well as at intervals not exceeding 4 hours. Continuous monitoring is preferable and may be necessary in certain situations.

5.12.7 Adequate ventilation shall be provided to ensure the atmosphere is maintained within acceptable limits.

5.13 Demolition

5.13.1 A detailed Method Statement detailing the demolition procedures/techniques to be used shall be submitted to and approved by the Engineer prior to commencement of work on site.

The Method Statement must include full details of measures to be taken to ensure that there are no persons remaining in the building/structure and to distance members of the public and Contractor's personnel from the building/structure prior to demolition.

5.14 Use of Explosives

5.14.1 The Contractor shall not use explosives without the written permission from the Engineer and relevant authorities (see Sub-Clause 2.5).

5.14.2 The Contractor shall observe all regulations regarding proper purchasing, transportation, storage, handling and use of explosives.

5.14.3 The Contractor shall ensure that explosives and detonators are stored in separate special buildings. These secured buildings shall be constructed, located and clearly marked in Arabic and English:

"DANGER - EXPLOSIVES"

all as approved by the Engineer and relevant authorities (see Sub-Clause 2.5).

5.14.4 The Contractor shall ensure that all possible precautions are taken against accidental fire or explosion, and ensure that explosives and detonators are kept in a proper and safe condition.

5.14.5 The Contractor shall ensure that explosives and detonators are always transported in separate vehicles and kept apart until the last possible moment and that metallic tools are not used to open boxes of explosives or detonators.

5.14.6 Blasting Procedure: the Contractor shall carry out blasting operations in a manner that will not endanger the safety of persons and property. The Contractor shall, along with other necessary precautions:

(a) clear all persons from buildings and the area affected by the blasting. All such persons shall be given adequate notice of the actual time and date of blasting.

(b) ensure that police and other local authorities are kept fully informed, in advance, of the blasting programme so that they may be present when blasting takes place if they so require.

(c) erect warning notices around the area affected that blasting operations are in progress.

(d) carry out a thorough search of buildings and the area affected prior to blasting.

(e) ensure that blasting is only carried out by experienced shot firers. Priming, charging, stemming and shot firing shall be carried out with greatest regard for safety and in strict accordance with the rules and regulations of the relevant authorities (see Sub-Clause 2.5).

(f) ensure that explosive charges are not excessive, charged boreholes are properly protected and proper precautions are taken for the safety of persons and property.

5.14.7 The Contractor shall maintain an up-to-date inventory of all explosives and explosive devices and shall submit a monthly report to the Engineer, detailing the use of all explosives by date and location.

5.15 Excavation and Trenching

5.15.1 An excavation permit signed by the Engineer must be issued before excavation proceeds in any work location. The Contractor shall investigate and identify the location of existing services by study of the drawings, a visual/physical study of the site, sweeping by appropriate detection equipment and where necessary hand excavation of trial holes.

Following this investigation, the Contractor shall submit a written request for an excavation permit to the Engineer.

The Engineer will return the permit signed and dated to indicate:

- services which are to be maintained.
- services which are to be isolated.
- any special precautions to be taken.

A sample Excavation Permit is given in Appendix 1.

5.15.2 The issue of an Excavation Permit by the Engineer shall not relieve the Contractor of his responsibilities under the Contract.

5.15.3 The side of all excavations and trenches exceeding 1.3 meters in depth which might expose personnel or facilities to danger resulting from shifting earth shall be protected by adequate temporary supports or sloped to the appropriate angle of repose.

5.15.4 All excavations, slopes and temporary supports shall be inspected daily and after each rain, before allowing personnel to enter the excavation.

5.15.5 Excavations 1.3 metres or more in depth and occupied by personnel shall be provided with ladders as a means for entrance and egress. Ladders shall extend not less than 1 metre above the top of the excavation.

5.15.6 The Contractor shall provide adequate barrier protection to all excavations. Barriers shall be readily visible by day or night.

5.15.7 Excavated or other materials shall not be stored at least 0.65 metres from the side of excavations.

5.16 Concrete Reinforcement Starter Bars

5.16.1 The Contractor shall ensure concrete reinforcement starter bars are not a danger to personnel. Where permitted by the Engineer, starter bars shall be bent down. Alternatively, the starter bars shall be protected using either hooked starters, plastic caps, plywood covers or other methods agreed with the Engineer.

6 Environmental and Health Requirements

6.1 Protection of the Environment

6.1.1 The Contractor shall be knowledgeable of and comply with all environmental laws, rules and regulations for materials, including hazardous substances or wastes under his control. The Contractor shall not dump, release or otherwise discharge or dispose of any such material without the authorisation of the Engineer.

6.1.2 Any release of a hazardous substance to the environment, whether air, water or ground, must be reported to the Engineer immediately. When releases resulting from Contractor action occur, the Contractor shall take proper precautionary measures to counter any known environmental or health hazards associated with such release. These would include remedial procedures such as spill control and containment and notification of the proper authorities.

6.2 Air Pollution

6.2.1 The Contractor, depending on the type and quantity of materials being used, may be required to have an emergency episode plan for any releases to the atmosphere. The Contractor shall also be aware of local ordinances affecting air pollution.

6.2.2 The Contractor shall take all necessary measures to limit pollution from dust and any wind blown materials during the Works, including damping down with water on a regular basis during dry climatic conditions.

6.2.3 The Contractor shall ensure that all trucks leaving the Site are properly covered to prevent discharge of dust, rocks, sand, etc.

6.3 Water Pollution

6.3.1 The Contractor shall not dispose of waste solvents, petroleum products, toxic chemicals or solutions in the city drainage system or watercourse, and shall not dump or bury garbage on the Site. These types of waste shall be taken to an approved disposal facility regularly, and in accordance with requirements of relevant Authorities. The Contractor shall also be responsible to control all run-offs, erosion, etc.

6.4 Solid Waste

6.4.1 General Housekeeping

(a) The Contractor shall maintain the site and any ancillary areas used and occupied for performance of the Works in a clean, tidy and rubbish-free condition at all times.

(b) Upon the issue of any Taking-Over Certificate, the Contractor shall clear away and remove from the Works and the Site to which the Taking-Over Certificate relates, all Contractor's Equipment, surplus material, rubbish and Temporary Works of every kind, and leave the said Works and Site in a clean condition to the satisfaction of the Engineer. Provided that the Contractor shall be entitled to retain on Site, until the end of the Defects Liability Period, such materials, Contractor's Equipment and Temporary Works as are required by him for the purpose of fulfilling his obligations during the Defects Liability Period.

6.4.2 Rubbish Removal and Disposal

(a) The Contractor shall comply with statutory and municipal regulations and requirements for the disposal of rubbish and waste.

(b) The Contractor shall provide suitable metal containers for the temporary storage of waste.

(c) The Contractor shall remove rubbish containers from site as soon as they are full. Rubbish containers shall not be allowed to overflow.

(d) The Contractor shall provide hardstandings for and clear vehicle access to rubbish containers.

(e) The Contractor shall provide enclosed chutes of wood or metal where materials are dropped more than 7 metres. The area onto which the material is dropped shall be provided with suitable enclosed protection barriers and warning signs of the hazard of falling materials. Waste materials shall not be removed from the lower area until handling of materials above has ceased.

(f) Domestic and biodegradable waste from offices. canteens and welfare facilities shall be removed daily from the site.

(g) Toxic and hazardous waste shall be collected separately and be disposed of in accordance with current regulations.

(h) No waste shall be burnt on Site unless approved by the Engineer.

6.4.3 Asbestos Handling and Removal

The Contractor shall comply with all local regulations regarding the handling of asbestos materials. In the absence of local regulations. relevant International Standards shall apply.

6.4.5 Pest Control

The Contractor shall be responsible for rodent and pest control on the Site. If requested. the Contractor shall submit to the Engineer. for approval. a detailed programme of the measures to be taken for the control and eradication of rodents and pests.

6.5 Noise Control

6.5.1 The Contractor shall ensure that the work is conducted in a manner so as to comply with all restrictions of the Authorities having jurisdiction. as they relate to noise.

6.5.2 The Contractor shall. in all cases. adopt the best practicable means of minimizing noise. For any particular job. the quietest available plant/and or machinery shall be used. All equipment shall be maintained in good mechanical order and fitted with the appropriate silencers. mufflers or acoustic covers where applicable. Stationary noise sources shall be sited as far away as possible from noise-sensitive areas. and where necessary acoustic barriers shall be used to shield them. Such barriers may be proprietary types. or may consist of site materials such as bricks or earth mounds as appropriate.

6.5.3 Compressors. percussion tools and vehicles shall be fitted with effective silencers of a type recommended by the manufacturers of the equipment. Pneumatic drills and other noisy appliances shall not be used during days of rest or after normal working hours without the consent of the Engineer.

6.5.4 Areas where noise levels exceed 90 decibels. even on a temporary basis. shall be posted as high noise level areas.

7 Additional Requirements for Work in Public Areas

7.1 General

7.1.1 These additional requirements shall apply to all works carried out in Public Areas.

7.1.2 Public Areas are defined as areas still used by or accessible to the public. These include public roads and pavements, occupied buildings and areas outside the Contractor's boundary fencing.

7.1.3 All work in Public Areas shall be carried out to minimise disturbance and avoid dangers to the public.

7.1.4 Before commencing work, the Contractor shall ensure that all necessary resources, including labour, plant and materials, will be available when required and that the works will proceed without delays and be completed in the shortest possible time. Periods of inactivity and slow progress or delays in meeting the agreed programme for the works, resulting from the Contractor's failure to provide necessary resources or other causes within the control of the Contractor, will not be accepted. In the event of such inactivity, slow progress or delays, the Contractor shall take immediate action to rectify the situation, including all possible acceleration measures to complete the works within the agreed programme. Details of the actions and acceleration measures shall be submitted to the Engineer. If the Engineer is dissatisfied with the Contractor's proposals, the Contractor shall take such further actions or measures as required by the Engineer. All costs incurred shall be the responsibility of the Contractor.

7.2 Method Statement

7.2.1 The Contractor shall submit to the Engineer a method statement for each separate area of work in Public Areas. The Method Statement shall include:

(a) a general description of the Works and methodology of how it will be carried out.

(b) details of the measures and temporary works to minimise disturbance and safeguard the public. These shall include temporary diversions, safety barriers, screens, signs, lighting, watchmen and arrangements for control of traffic and pedestrians and advance warning to be given to the public.

(c) details of temporary reinstatement and maintenance of same prior to final reinstatement.

(d) for works involving long lengths of trenches or works to be completed in sections, the lengths or sections of each activity (eg up to temporary reinstatement, temporary reinstatement, final reinstatement) to be carried out at any one time.

(e) details of the availability of necessary resources (labour, plant, materials, etc) to complete the work.

(f) a programme showing start and completion dates and periods for all activities of each length or section, including temporary works, and the works overall.

(g) such further information as necessary or required by the Engineer.

7.2.2 The Contractor shall not commence work, including temporary works, until approval of the Contractor's Method Statement by the Engineer.

7.2.3 Method Statements shall be updated based on actual progress or as and when required by the Engineer.

7.3 Closure of Roads, Etc

7.3.1 The closure or partial closure of roads, pavements and other public areas will only be permitted if approved by the Engineer and Relevant Authorities. The Contractor shall detail for each closure the extent of area to be closed, the reasons and duration of the closure and, where appropriate, proposed diversions.

A sample Street Closure Permit is given in Annex 2.

7.4 Trench and Other Excavations

7.4.1 The requirements covering trench and other excavations will depend on the location and type of the excavation and the potential risks to the public.

7.4.2 The following guidelines apply particularly to trenches but shall also apply to other types of excavations:

(a) before commencing work the Contractor shall:

- notify the Engineer on the location and duration of the work. An excavation permit signed by the Engineer must be issued in accordance with Sub-Clause 5.15.1 before excavation proceeds in any work location.;

- obtain permission from relevant authorities including the police when required. The Contractor's attention is drawn to the requirements of Legislative Decree No 68 dated 9 September 1983, issued by the President of the Republic of Lebanon, and in particular to the provisions therein regarding prior notification by the Contractor to and the issue of excavation licenses by the Director of Roads or the Head of the Municipal Authority concerned, as applicable, before the commencement of excavations within the limits of streets, roads and other areas defined under the said Decree.

- erect all temporary works such as barriers, warning signs, lighting, etc:

- have available adequate materials for temporary supports to sides of excavations and necessary labour, plant and materials to complete the work within the shortest possible time;

(b) in carrying out the works the Contractor shall, unless otherwise permitted or required by the Engineer:

- not open more than one excavation within a radius of 250 metres;
- limit the length of trench excavation open at one time to 150 metres;
- maintain and alter or adapt all temporary works including supports to sides of excavations;
- remove all surplus excavated material the same day it is excavated;
- complete the works, including final reinstatement within ten days;
- where final reinstatement is not achieved within the required time, to carry out temporary reinstatement;
- ensure that any temporary reinstatement is maintained at the correct level until final reinstatement is achieved.

7.4.3 The above guidelines shall not relieve the Contractor of his obligations and responsibilities.

7.5 Safety Barriers

7.5.1 Safety barriers shall be provided to the perimeter of work areas and to trench and other types of excavations and to existing openings such as manholes, drawpits and the like. When exposed to the public, safety barriers shall be provided to both sides of trenches and around all sides of openings.

7.5.2 The Contractor shall provide details of the type or types of safety barriers for each excavation for the approval of the Engineer prior to commencing work. No work shall commence until the safety barriers are in place.

7.5.3 The type of safety barrier used shall be appropriate to the particular location and the potential risks to the public. Examples of different types of safety barriers are given below:

- Type 1 - excavated material;
- Type 2 - non-rigid barrier of rope or florescent tape strung between metal rods driven into the ground;
- Type 3 - rigid barrier of timber, steel or concrete. Such barriers could be in the form of horizontal rail(s) or sheet material secured to posts driven or concreted into the ground.

7.5.4 The following are guidelines on the type of safety barriers that could be used in differing situations. They apply particularly to trenches but also apply to other types of excavations, existing openings and to the perimeter of work areas:

- areas not subject to vehicular traffic - Types 1 or 2;
- roadways (low traffic speed) - Types 1 or 2;
- roadways (high traffic speed) - Types 1 or 3.

7.5.5 The above examples of the types of barriers and the guidelines on situations in which they could be used shall not relieve the Contractor of his obligations and responsibilities.

8 Contractor's Site Check List

8.1 A sample Contractor's Site Check List is included in Annex 3. This is included to assist contractors should they wish to introduce such a system as part of their site management procedures. The list is not exhaustive and further items will need to be added by the Contractor.

8.2 The list is issued for guidance only, and does not, in any way, revise or limit the requirements covered elsewhere in these Regulations.

Annex 1

Sample Excavation Permit

To: .... (Engineer)

From: .... (Contractor) Date: ....

CDR Contract No: ....
Request for Excavation Permit No: ....

Please give approval for excavation to proceed in the following area:

Work to start on:

Existing services have been checked and identified by:

Drawings ≠ Physical Survey ≠

Catscan ≠ Trial Holes Excavation ≠

Signed (Contractor): ....

Approval of Engineer

The above excavation may proceed. subject to the following:

Services to be maintained:

Services to be isolated before work proceeds:

Other matters:

Signed (Engineer): ....

Date: ....

Annex 2

Sample Street Closure Permit

To: .... (Engineer)

From: .... (Contractor) Date: ....

CDR Contract No: ....
Request for Street Closure Permit No: ....

Please give approval for the closure of the following street(s) from .... to .... (*dates*)

Street(s):

Reasons:

Proposed diversions:

Signed (Contractor): ....

Approval of the Engineer

The above street(s) may be closed for the periods stated subject to the following conditions:

Approval has been given by relevant authorities and the police:

Other:

Signed (Engineer): ....

Date: ....

Annex 3

Sample Contractor's Site Check List

Safe Access:

- arrangements for visitors and new workers to the site
- safe access to working locations
- walkways free from obstructions
- edge protection to walkways over 2m above ground
- holes fenced or protected with fixed covers
- tidy site and safe storage of materials
- waste collection and disposal
- chutes for waste disposal. where applicable
- removal or hammering down of nails in timber
- safe lighting for dark or poor light conditions
- props or shores in place to secure structures. where applicable

Ladders:

- to be used only if appropriate
- good condition and properly positioned
- located on firm. level ground
- secure near top. If not possible. to be secured near the bottom. weighted or footed to prevent slipping
- top of ladder minimum 1 metre above landing place

Scaffolding:

- design calculations submitted
- proper access to scaffold platform
- properly founded uprights with base plates
- secured to the building with strong ties to prevent collapse
- braced for stability
- loadbearing fittings. where required
- uprights. ledgers. braces and struts not to be removed during use
- fully boarded working platforms. free from defects and arranged to avoid tipping or tripping
- securely fixed boards against strong winds
- adequate guard rails and toe boards where scaffold 2m above ground
- designed for loading with materials. where appropriate
- evenly distributed materials
- barriers or warning notices for incomplete scaffold (ie not fully boarded)
- weekly inspections and after bad weather by competent person
- record of inspections

Excavation:

- underground services to be located and marked and precautions taken to avoid them
- adequate and suitable timber, trench sheets, props and other supporting materials available on site before excavation starts
- safe method for erecting/removal of timber supports
- sloped or battered sides to prevent collapse
- daily inspections after use of explosives or after unexpected falls of materials
- safe access to excavations (eg sufficiently long ladder)
- barriers to restrict personnel/plant
- stability of neighbouring buildingsrisk of flooding
- materials stacked, spoil and vehicles away from top of excavations to avoid collapse
- secured stop blocks for vehicles tipping into excavations

Roof work:

- crawling ladders or boards on roofs more than 10 degrees
- if applicable, roof battens to provide a safe handhold and foothold
- barriers or other edge protection
- crawling boards for working on fragile roof materials such as asbestos cement sheets or glass. Guard rails and notices to same
- rooflights properly covered or provided with barriers
- during sheeting operations, precautions to stop people falling from edge of sheet
- precautions to stop debris falling onto others working under the roof work

Transport and mobile plant:

- in good repair (eg steering, handbrake, footbrake)
- trained drivers and operators and safe use of plant
- secured loads on vehicles
- passengers prohibited from riding in dangerous positions
- propping raised bodies of tipping lorries prior to inspections
- control of on-site movements to avoid danger to pedestrians, etc
- control of reversing vehicles by properly trained banksmen, following safe system of work

Machinery and equipment:

- adequate and secured guards in good repair to dangerous parts, eg exposed gears, chain drives, projecting engine shafts

Cranes and lifting appliances:

- weekly recorded inspections
- regular inspections by a competent persons
- test certificates
- competent and trained drivers over 18 years of age
- clearly marked controls
- checks by driver and banksman on weight of load before lifting
- eficient automatic safe load indicator, inspected weekly, for jib cranes with a capacity of more than one tonne
- firm level base for cranes
- sufficient space for safe operation
- trained banksman/slinger to give signals and to attach loads correctly, with knowledge of lifting limitations of crane
- for cranes with varying operating radius, clearly marked safe working loads and corresponding radii
- regularly maintenance
- lifting gear in good condition and regularly examined

Electricity:

- measures to protect portable electric tools and equipment from mechanical damage and wet conditions
- checks for damage to or interference with equipment, wires and cables
- use of the correct plugs to connect to power points
- proper connections to plugs: firm cable grips to prevent earth wire from pulling out
- "permit-to-work" procedures, to ensure safety
- disconnection of supplies to overhead lines or other precautions where cranes, tipper lorries, scaffolding, etc might touch lines or cause arcing

Cartridge operated tools:

- maker's instruction being followed
- properly trained operators, awareness of dangers and ability to deal with misfires
- safety goggles
- regular cleaning of gun
- secure place for gun and cartridges when not in use

Falsework/formwork:

- design calculations submitted
- method statement dealing with preventing falls of workers
- appointment of falsework coordinator
- checks on design and the supports for shuttering and formwork
- safe erection from steps or proper platforms
- adequate bases and ground conditions for loads

- plump props. on level bases and properly set out
- correct pins used in the props
- timberwork in good condition
- inspection by competent person. against agreed design before pouring concrete

Risks to the Public:

- ientify all risks to members of the public on and off site. eg materials falling from scaffold etc.. site plant and transport (access/egress) and implement precautions. eg scaffold fans/nets. banksmen. warning notices etc
- barriers to protect/isolate persons and vehicles
- adequate site perimeter fencing to keep out the public and particularly children. Secure the site during non-working periods
- make safe specific dangers on site during non-working periods. eg excavations and openings covered or fenced. materials safely stacked. plant immobilised. ladders removed or boarded

Fire - general:

- sufficient number and types of fire extinguishers
- adequate escape routes. kept clear
- worker awareness of what to do in an emergency

Fire - flammable liquids:

- proper storage area
- amount of flammable liquid on site kept to a minimum for the day's work
- smoking prohibited: other ignition sources kept away from flammable liquids
- proper safety containers

Fire - compressed gases. eg oxygen. LPG. acetylene:

- properly stored cylinders
- valves fully closed on cylinders when not in use
- adopt "hot work" procedures
- site cylinders in use outside huts

Fire - other combustible materials:

- minimum amount kept on site
- proper waste bins
- regular removal of waste material

Noise:

- assessment of noise risks
- noisy plant and machinery fitted with silencers/muffs
- ear protection for workers if they work in very noisy surroundings

Health:

- identify hazardous substances, eg asbestos, lead, solvents etc and assess the risks
- use of safer substances where possible
- control exposure by means other than by using protective equipment
- safety information sheets available from the supplier
- safety equipment and instructions for use
- keep other workers who are not protected out of danger areas
- testing of atmosphere in confined spaces: provision of fresh air supply if necessary. Emergency procedures for rescue from confined spaces

Manual handling:

- avoid where risk of injury
- if unavoidable, assess and reduce risks

Protective clothing:

- suitable equipment to protect the head, eyes, hands and feet where appropriate
- enforce wearing of protective equipment

Welfare:

- suitable toilets
- clean wash basin, hot/warm water, soap and towel
- room or area where clothes can be dried
- wet weather gear for those working in wet conditions
- heated site hut where workers can take shelter and have meals with the facility for boiling water
- suitable first aid facilities

Work in Public Areas

- all risks to the public identified
- method statement approved
- road closures approved
- temporary diversions in place
- safety barriers erected/maintained
- safety signs and lighting installed/maintained
- labour, materials, plant and other resources sufficient to meet programme

- temporary reinstatement completed and properly maintained
- permanent reinstatement completed at earliest possible date

Part II

Supplementary Safety, Health and Environmental Regulations

Clause No.

Sub-Clause 3.2.2 of Part I specifies deductions in USD. If the currency of payments for a contract is NOT USD, one of the following two alternative Sub-Clause should be included in Part II.

Alternative 1 should be included when the currency of payments is specified in the Contract (eg Lebanese Pounds). The amounts included in Alternative 1, for D1, D2 and D3, should be stated in the appropriate currency of payment based on the equivalent in that currency of the USD amounts in Part I.

Alternative 2 should be included when the currency of payments is not known at time of preparing the bidding documents (eg in the CDR Standard Bidding Documents for Smaller Contracts, the payment currency or currencies are specified by the Bidder as part of his Bid).

If the currency of payment is USD, neither of the alternatives need to be included in Part II.

Alternative 1

3.2.2 Delete text, and replace with the following:

The basic deduction from payment for each classification in Sub-Clause 3.2.1, is as follows:

for D1 - ______________ *[insert currency and amount]*;
for D2 - ______________ *[insert currency and amount]*;
for D3 - ______________ *[insert currency and amount]*.

Alternative 2

3.2.2 Add second paragraph as follows:

The deductions in paragraph 1 of this Sub-Clause, shall be in the currency or currencies to be paid to the Contractor. The amount in each currency shall be based on the USD amounts in PART I and the exchange rates for the payment currency or currencies stated in the Contract.

APPENDIX 4

ECONOMIC ANALYSIS

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1. INTRODUCTION

1.1 The Greater Beirut Area Transportation Plan (GBATP)

Seventeen years of war in Lebanon has had grave negative consequences on the economic development of the country: including destruction of buildings and infrastructure networks. accumulated delay of public investments. and lack of town planning to name a few consequences.

For Greater Beirut inhabitants. traveling in the city is a costly experience in terms of time and money. Bad traffic conditions form a stumbling block towards developing economic interactions among business activities and they seriously handicap the rejumping of the economy.

Urgent measures should be taken to re-establish acceptable traffic conditions in Beirut in order not to annihilate the first benefits of the reconstruction works. They should be completed by a long-term policy that will enable Greater Beirut to meet its future travel needs. Towards this effort. in 1994 the Council for Development and Reconstruction (CDR) commissioned the joint venture of TEAM-IAURIF-SOFRETU to produce a long-term transportation plan for Greater Beirut (GBATP).

1.1.1 Study Area

The study area of the Transportation Plan includes the territories spreading from Nahr el-Damour to the South to Nahr el-Kalb to the North. below an average 400 m altitude. It covers 23000 ha. It does not include the entire influence area of the Metropolitan region (Jounieh coastal corridor and urbanized mountain areas of Bikfaya. Broummana and Aley). but it nevertheless shelters the bulk of it.

Collecting recent and reliable data about Greater Beirut population and urban economy is a prerequisite task of any planning activity. Preparation of the transportation plan has necessitated the execution of numerous surveys of traffic. trips. and land use in the metropolitan region. A large scale socio-economic survey has thus been carried out. comprising a sample of 4300 households of Greater Beirut.

Greater Beirut was populated by 1.165.000 inhabitants in 1994. with only some 400.000 of them within Municipal Beirut. The population of the metropolitan region has not increased during the 1984 - 1994 period.

Due to the destruction of Downtown Beirut and to war years insecurity. new business and commercial centers have developed outside the city. and suburban areas have been intensely urbanized.

1.1.2 Travel Characteristics

With 1.500.000 motorized person trips executed every day in Greater Beirut Area (900.000 of which by inhabitants of the Region). Greater Beirut is a metropolitan area where people do not travel very much (0.76 daily motorized trips per inhabitant instead of 1.2 twenty five years ago) and mainly for work (55% of these trips are executed for this purpose). Although the city has been reunited. trip patterns are still affected by the former polarization that was prevailing during the war: only 10% of daily motorized person trips of Greater Beirut Area residents have crossed the former demarcation line in 1994.

One quarter of the households have no car, half of them own one car, and the last quarter owns at least 2 cars. Motorization rate appears quite high in Greater Beirut even if very strong contrasts can be observed among the different neighborhoods of the city.

In 1994, less than 1% of trips were served by the Public Transportation Company. Automobile use is prominent, with 90% share of the total trip market (71% for private cars, 19% for taxi-services). Traffic volumes along a number of road axes are very high (180,000 vehicles per day in Antelias along North coastal highway).

A high level of congestion is observed on most links of the urban road network. Variation in traffic flow in Greater Beirut during the period 7:00 am to 7:00 pm is quite low, indicating that traffic on many streets reaches a level close to its capacity, and stays near it for most hours of the day. Similarly, day-to-day variability in peak hour traffic volumes is limited.

A speed-delay survey conducted on major arterial streets in the Greater Beirut Area encompassed 27 routes of a total length of approximately 250 kilometers. The results indicate generally low speeds with a wide variability in average speeds. Observed average speeds ranged from 6.5 kph to 31.0 kph. Speeds of less than 20 kph were observed on more than 70% of the route sections on which surveys were conducted.

The same survey provided values of delays as a proportion of travel time. Results indicated that delays ranged from 1% to 51% of total route travel time. Moreover, delays of more than 20% of the total travel times were observed on more than 35% of the route sections surveyed. Low speeds and delays are caused by four main factors, namely: intersections, street congestion, illegal parking, and unorganized buses and taxis making frequent stops.

An analysis of main intersections in GBA indicated that in 1994, out of 127 intersections in the Beirut City, 46% of which were operating at a Level-of-Service (LOS) D or worse (average individual vehicle stopped delay exceeds 25 seconds), and out of 100 intersections in the suburbs, 75 were operating at a LOS D or worse.

Beirut suffers from a severe parking problem which renders all attempts to ease traffic congestion futile. Curb-sides are all occupied by parking vehicles: double parking, over the side-walk, along street corners, and improper parking in general is a preponderant situation. Street capacities are consumed by parked vehicles. Sight lines around corners are obstructed, and pedestrians are denied the benefits of sidewalks.

Greater Beirut road network is very deteriorated: carriage-ways are in poor condition and are invaded by chaotic parking, intersections without signals, lack of network hierarchy. If better managed, the network can cope with much higher traffic volumes than it accommodates today.

1.1.3 An Immediate Action Plan (IAP) to Respond to Urgent Needs

The methodology used to prepare the Immediate Action Plan (IAP) has relied on a functional analysis of the network and on a set of network simulations allowing to test various alternatives. It has led to an optimum network utilization ensuring the best efficient use of the existing network.

Immediate measures are concentrated on a limited number of corridors that accommodate the main part of the traffic. The basic network candidate for traffic management measures is 200 km long (107 km in Municipal Beirut, 93 km in suburbs).

A clear hierarchy will be established among the various streets according to their role (through traffic versus local access). The circulation plan will be reviewed to increase network capacity.

The main intersections of the built-up area will be signal controlled. Parking will be prohibited along a number of major axes and systematically banned in the vicinity of intersections.

A signing plan will guide drivers and facilitate traffic management.

Grade separations will be executed on a limited number of intersections whose level-of-service cannot be sufficiently improved relying on less drastic measures.

Proposed traffic improvement measures integrate the proposals made for restructuring the bus network. Bus transit will directly benefit from the new street organization.

A large public information campaign will be launched. since an active participation of users is one of the main conditions to make the Immediate Action Plan a success. It will be followed. after some time. by an enforcement of control measures.

The present scattering of responsibilities is a serious handicap to successful implementation of an overall traffic policy. A close coordination of responsible government and municipal departments. will have to be ensured. Municipal technical departments in charge of traffic management will be set up. trained. and developed.

Traffic improvement in Greater Beirut Area cannot be obtained without setting up an efficient mass transit system. Many users have no cars. and taxi-services cannot answer mass transit needs. Reliance on the automobile solely will progressively increase congestion.

The transport supply provided by the public transport company (OCFTC) in 1994 was reduced to nearly nothing. Many buses have been damaged during the war and a part of the depots faced the same situation. Only 25 buses carrying every day less than 20.000 passengers were operating in 1994. Later in 1996 about 200 new buses were added. and ridership has risen to about 50.000 daily. A number of privately operated buses currently provide transport services. but without any coordinated planning or any system integration.

More expensive and a source of permanent congestion due to their anarchical and uncontrolled "modus operandi". taxi-services (a traditional jitney service in Beirut) have quickly grown in number. They provide the main supply for mass transit trips.

Captive users of public transport are confronted with a restricted transport supply and a low level-of-service. and this can partially explain the low level of trips per person observed in Greater Beirut.

Restarting a modern mass transit system necessitates:

- Institutional Measures:

  Only a Metropolitan Transport Authority is able to plan. organize. and control a renewed mass transit system: Selecting the lines to serve. the level-of-service to ensure. and the operators. Controlling the quality of service is undoubtedly under the responsibility of public authorities. and a specialized body should be instituted to assume this role. Conversely. network operation itself should be largely open to competition. But this is not contradictory with the maintaining and the upgrading of a public transport company. The target should be to provide users with a good service at the lowest cost.

- Technical Measures:

  Future mass transit network should be designed as a coherent system including trunk bus lines (13 of which are proposed in the Immediate Action Plan along the heaviest demand corridors), complementary feeder bus lines and taxi-services lines. Taxi-services will continue to play an important role in the short-term to meet present needs, but they should be strictly organized and controlled (stations and lines).

The implementation of a trunk bus network in Greater Beirut will necessitate the operation of about 400 buses, to equip 3 depot-garages, and to set up all complementary facilities.

1.1.4 A Long-Term Plan to Answer Future Needs

1.1.4.1 Challenges of the Future

Beirut revival as a large international metropolis necessitates to plan a transportation system well fitted to this ambition.

In 2015 (retained study horizon) Greater Beirut will be populated with about 2 million inhabitants who will benefit from an income level and a vehicle ownership rate much higher than today.

Beirut Central District (BCD) would have been rebuilt and it would have recovered its former role of largest service and business center of Greater Beirut Area. Other secondary centers would have been developed in the outskirts of Beirut, allowing to reorganize and restructure Beirut suburbs. The division of the city into two parts would have disappeared. Exchanges would have been re-established with neighboring countries creating intense goods and people flows.

Trip frequency rate of Greater Beirut residents shall grow by more than twice during the next 20 years and reach an average value of 1.75 daily motorized trips per person in 2015, without however reaching the trip frequency rate currently observed in large metropolises of the developed countries (close to 2).

Combining all these trends, trip demand should reach nearly 5 million daily motorized person trips in Greater Beirut Area by 2015, that is more than 3 times the present value. Half of these trips will be internal to the dense urban agglomeration (inside future Beirut Périphérique Boulevard). A third of which will concern exchanges between Beirut urban agglomeration and the external area and they will have to be accommodated along a number of corridors specially constrained by topography and land use.

1.1.4.2 Options for the Future

Facing the huge future needs, Greater Beirut possesses a number of characteristics liable to orient decisions regarding transport systems, notably the choice between road and mass transit.

- Beirut urban agglomeration is very dense in the city itself, as well as in its suburbs. Today residential densities exceed 500 inhabitants/ha in some neighborhoods. This high density may present difficulties in searching for road alignments and liberating the necessary right-of-way, but it also satisfies a prerequisite for setting up a rapid mass transit system.
- Greater Beirut Area owns an urban and natural heritage comparable to that of many large world cities. Mountains are at the door of the built-up area. Network

alignments would have to integrate this constraint and be respectful of the environment.

In order to highlight possible network structure alternatives and to assess their performance. two contrasted scenarios have been constructed. the first privileges road network development. and the second integrates the construction of a rapid mass transit system in dense areas.

These scenarios have been tested and operation simulations have been carried out. highlighting peak hour traffic on road network. load on mass transit lines. and average access time by each to the poles of the Metropolitan Region. Construction cost of proposed networks has been estimated. An optimal scenario has been defined. based on both technical and financial considerations. in a manner which allows to maximize the respective advantages of the two tested scenarios.

Computer simulations demonstrate that. in the absence of a modern mass transit system. meeting future travel needs will remain an illusion. Devoted to serve the dense areas of the Metropolitan Region in the first place. a rapid mass transit network is necessary to solve future trip problems of Greater Beirut Area.

1.1.4.3 Long-Term Transit Network

The long-term mass transit network should provide all inhabitants of the dense agglomeration with a mass transit line on its own right-of-way less than 1 km from home. It will thus supply an attractive alternative to the automobile in addition to captive riders. and public transport will ensure an easy access to the large development poles of this area (BCD. Airport. etc.). The proposed network should enable mass transit (taxi-services excluded) to capture about 26% of total daily motorized trip market.

The long-term mass transit network includes:

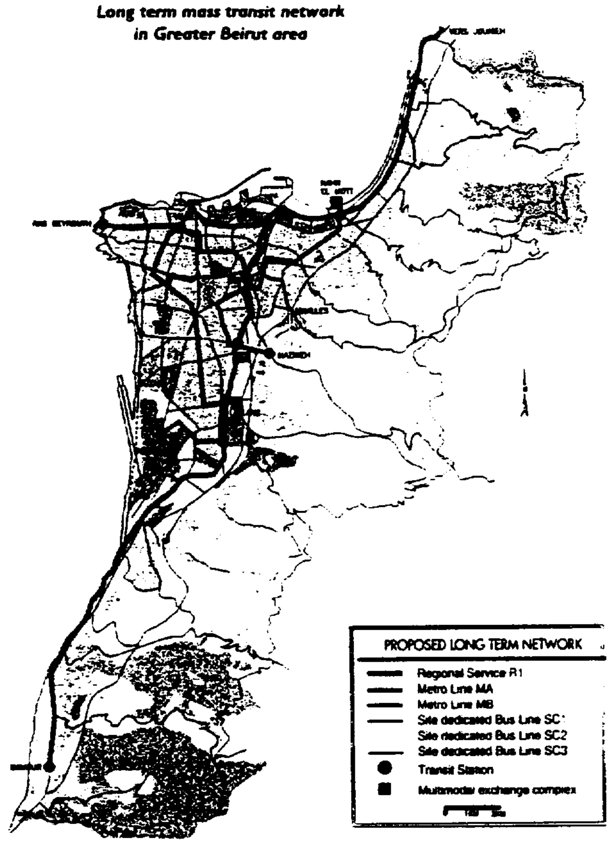
- A regional commuter service line that will use the rehabilitated railway line Saida-Beirut-Tripoli. from Damour to Jounieh (38 km).
- Two modern metro lines ensuring the basic backbone of mass transit. servicing the interior of the dense Beirut urban agglomeration.
    * An East-West line (MA) linking Ras Beirut to NBT station. via Hamra and BCD. and extended to the South (Hazmieh) and to the East (Nahr el-Mott). It will be 17 km long.
    * A North-South line (MB) from the Lebanese University and Airport to St. Michel Terminal (15 km) via south suburbs and BCD.
- Three bus lines on their own right-of-way ensuring the secondary servicing of the urban agglomeration and totaling 28 km.
- A complementary bus network.
- Multimodal exchange stations located along the boundaries of the urban agglomeration. close to Beirut Périphérique Boulevard (Nahr el-Mott. Laylaké).

With all its components fully integrated with each other and the street network. future mass transit network would allow to carry nearly 500 million passengers per year. with line loads compatible with the selected technologies (15.000 passengers per direction at peak hour on metro lines for instance).

Mass transit investment cost has been estimated at US$2.5 billion. with US$1.7 billion of which for the two metro lines.

Implementing such a network (over a 20 year duration), will necessitate both an institutional reorganization (strengthening of the Metropolitan Transport Authority proposed in the Immediate Action Plan) and resort to new financing sources. The private sector could notably be invited to participate in the building and operation of the metropolitan network, as practices in many large world metropolises.

Figure 1-1
Long term mass transit network in Greater Beirut area



1.1.4.4 Long-Term Road Network

Complementary to mass transit, the long-term road network has three main targets:

- Ensure the connection between Greater Beirut and its national and international sur.
- Open up and improve the accessibility of Beirut suburbs.
- Serve the large development poles of Greater Beirut Area (BCD, Airport, Port, etc.).

The long-term road network is a hierarchical and meshed network composed of motorways expressways and urban boulevards. It is organized around a major axis: Beirut Périphérique Boulevard (BPB). The basic future road network is 248 km long. It includes:

- Boulevard Périphérique located along the limits of the urban agglomeration extending from Khaldeh to Antelias (18 km).
- Five long-distance motorways linking Beirut to the rest of the country: two to the North (A1, A2) one to the east (Damascus Motorway), two to the South, existing

coastal motorway (A3) and a new mountain highway linking Choueifat to Damour.

- Seven urban penetrators ensuring the primary linking of the urban agglomeration with BPB.
- A network of expressways (23 km) and urban boulevards (122 km) ensuring the secondary servicing of Greater Beirut Area.

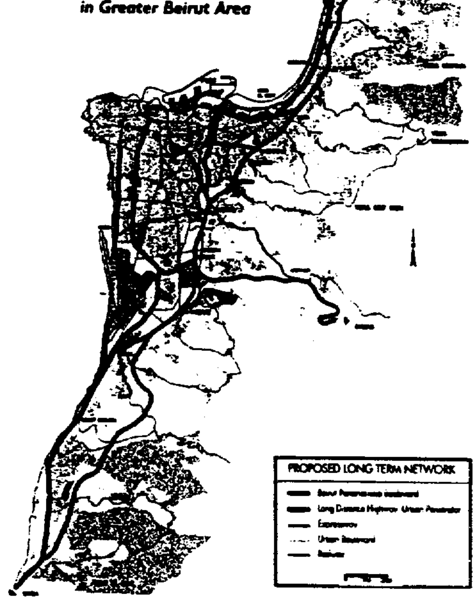
Half of the proposed road network is composed of already existing roads or an upgrade of existing ones, while the other half includes entirely new roads whose right-of-way was previously reserved in most of the cases.

While the overall operation of the proposed long-term road network is expected to be nearly satisfactory (average saturation rate of 1.06 at peak hour), a number of roads would however experience severe overloading (Périphérique Boulevard, North Motorway for instance).

The investment cost of the long-term road network has been evaluated at US$ 4 billion, 75% of which will be devoted to motorways. Land expropriation will be quite costly: it will represent more than half of the total cost of the program.

The size of the needs will impose searching for new financing sources. A number of intercity motorways that parallel existing roads could be entrusted to private investors as BOT projects but such a formula cannot be applied to the Boulevard Périphérique the backbone of the metropolitan road network, for which no alternative route exists.

Figure 1-2
Long term road network in Greater Beirut Area



1.1.4.5 Goods Transport

Goods transit function has been essential to ensure Beirut's development and prosperity. This traditional rule is presently threatened by the emergence of new rival harbors along the

Mediterranean sea. The setting up of infrastructure and facilities enabling to receive and distribute goods flows is quite vital for the metropolitan region. if it wants to have an important role in the exchange of good flows that will irrigate the development of the hinterland.

The road network proposed in the long-term plan will contribute in a strong manner to improve the connection between Greater Beirut national and international surroundings. In addition to the rehabilitation of the coastal railway. it will create optimal conditions to recover the former role of Beirut as a gate to the Middle East.

This. however. depends to a great extent on the development of port infrastructure whose attractiveness is presently quite limited by its meager resources. Extensive upgrading and equipping are underway. and a container terminal is under construction. All these projects will make of Beirut one of the large exchange and transit centers of the sub-region.

A link is still missing in the complex line of goods transport. Consolidation. break bulk. storage and delivery are presently scattered and organized on very fragmented basis. The gathering of these functions should be proposed in specialized areas: "goods logistic platforms" or "cargo villages".

The implementation of these new facilities will be possible to be taken in charge by private operators. The government will keep the control of site selection and primary servicing.

1.1.4.6 The Parking Master Plan

The current parking conditions in most parts of GBA. and especially in Municipal Beirut. are over-congested. This over-congestion of parking is the main reason for traffic problems. and have downgraded the quality of urban life. The current parking space deficit is huge with strict application of the current building laws and a sizeable shift by 2015 to public transit. this deficit will not drop without other targeted measures.

The causes of this serious problem were diagnosed to include:

- Deficient urban planning and building code regulations.
- Absence of mass transit and heavy reliance on the automobile.
- The low cost of vehicle operation (including parking) perceived by users.
- The enforcement is sporadic. moody. inconsistent and not uniformly applied.

The priority in dealing with the parking problem is to organize and regulate on-street parking.

Assuming that building laws will be continuously adjusted and enforced to account for actual parking generation of each land use. then new construction will not contribute to compounding the problem. But relying solely on this mechanism will not be effective and visible except in the very long-term.

The additional parking spaces needed have to be in public parking: i.e. facilities dedicated to parking or part of buildings open to use by other than the building occupants.

- Building dedicated parking structures of specified locations.
- Encouraging providing public parking as part of new buildings.
- Applying stricter parking requirements for all buildings and especially for commercial and office uses. This translates to a lower apartment area threshold for requiring a second parking space. and requiring one parking space per 25 sqm of office or commercial floor area.

1.1.5 The First Stage of Implementation

1.1.5.1 The 2005 Horizon

The Transportation Plan has been studied for horizon 2015. Identifying a first stage of implementation (10 years) is necessary. This first stage should be defined in coherence with long-term proposals and it should also integrate most of the on-going projects.

In 2005. Greater Beirut would be populated by 1.6 million inhabitants and the average trip frequency rate per person would be 1.17. Overall GBA trip demand would border 3 million motorized person trips at that time. with a structure close to the long-term one.

The projects liable to be carried out in a first stage of implementation have been selected after a number of simulations permitting to test various mass transit network assumptions and according to a multicriteria prioritization analysis of proposed long-term roads. under the constraint of a total investment budget.

1.1.5.2 Components of the First Stage

The first stage of implementation of the long-term Transport Plan includes:

Regarding Mass Transit

* the regional commuter railroad service.
* the construction of a first metro line (North South line MB).
* the development of two bus lines on their own right-of-way. a first one following approximately the route of MA metro line and therefore preconfiguring the future long-term service. a second one following SC 2 line:
* a complementary bus network. developing and completing the Immediate Action Plan proposals.

Regarding Roads

* most of the roads proposed in the long run will be carried out in the medium-term but with reduced geometric characteristics on some sections. Périphérique Boulevard. a really prioritary project. will be open over its entire alignment and the five intercity motorways will be built (some of them being entrusted to private investors).

The mass transit network proposed for the first stage (rail. metro. bus) will allow to capture 15% of the total trip market. It will carry about 160 million passengers but the load on rapid mass transit lines will. however. not exceed 10.000 passengers in the peak hour on the heaviest loaded sections.

1.2 Status of the Implementation of GBATP

1.2.1 Immediate Action Plan (IAP)

The GBTP study was completed in 1995. After its completion. CDR commissioned TEAM International to produce the tender documents for implementing some of the proposals of the Immediate Action Plan. These tender documents covered the scope of traffic management and were ready by early 1997. The tendering did not take place till now due to lack of funding.

The bus transportation aspects of the IAP were covered in a technical assistance to the Office of Railroad and Public Transport (OCFTC) performed by the jventure of TEAM-IAURIF-SYSTRA-SEMVAT.

This technical assistance detailed the implementation of restarting bus transport services. The bus network was defined. depots rehabilitation needs were detailed. scheduling of operations was prepared. marketing and public information campaigns were designed. and training of bus drivers was performed. Many of the recommendations of the technical assistance were not implemented due to the lack of funds and follow up. Currently the 200 buses of OCFTC are thinly spread over Greater Beirut and are providing with some private operations (some times competing on the same line) a less than satisfactory level of service.

It is quite obvious that the traffic congestion and chaotic parking conditions in Greater Beirut are negating the possibility of providing a good level-of-service bus transport. Buses are not operating according to schedule nor using bus stops (that are occupied by parked cars). They are operating very much like a jitney service. stopping anywhere to drop or pick a passenger.

1.2.2 Road Network Proposals

The CDR commissioned the location studies of some of the roads proposed by the GBATP. These included the South Mountain Motorway and the Metn Roads.

Other components of the road network. mostly the committed projects including the penetrators. are being progressively completed.

The Périphérique and the Northern Entrance are still being under consideration as to their implementation under a BOT approach.

1.2.3 Mass Transit Proposals

Mass transit proposals did not receive any serious attention till the last quarter of 1999. The Ministry of Transport received a grant from US Trade and Development Agency for conducting a feasibility study for a proposed Beirut Suburban Mass Transit Line from Jounieh to Jiyeh. The feasibility study will examine the technical. economic. and financial feasibility of developing this transit corridor. Based on the financial feasibility. an optimal set of public - private financing and operating options will be identified.

1.3 The Case for Beirut Urban Transport Project (BUTP)

1.3.1 Prevailing Conditions

Four years after the Greater Beirut Area Transportation Plan (GBATP) was completed. the following conditions prevail:

1. The proposed Immediate-Action Plan (IAP) did not go into implementation. due to the lack of funding.
2. Traffic congestion is becoming more serious along major corridors. Junctions of major corridors constitute bottlenecks. with delays of 10. 15. and 20 minutes or more on some approaches.
3. Street intersections are not signal controlled. Thus policemen are required to organize traffic at intersections during the heavy traffic period (7Am - 7PM).
4. Police manual control of intersections is only possible in an isolated manner. without any coordination between adjacent intersections.
5. On-street parking remains chaotic. With policemen busy with intersection control. not enough enforcement of parking regulation is done. Street capacities are taken up by parked and double-parked vehicles. Pedestrians are forced to the traveled lanes by cars parked on sidewalks. While on-street parking is not duration-

controlled and is still provided at no cost to parkers. we find off-street paid parking facilities operating at less than capacity.

6. All the streets of Greater Beirut lack proper signing and lane-marking.

7. Some of the road sections that were constructed and opened to traffic recently are not providing the full advantage of the added capacity. due to lack of control and absence of enforcement.

8. Bus transportation. whether publicly or privately owned. is being operated more like a jitney-service: no published schedules. no reliable frequencies. boarding and alighting of passengers in the traveled lanes.

9. There is no entity responsible for the traffic engineering function in Greater Beirut. in spite of the dire need for that.

10. The road construction program. which was partly committed prior to the formulation of GBATP (and was eventually incorporated in it) was partly built. yet with considerable delays due to the lack of funds. Now sections that are not contracted yet. stand to be subject to an unlimited delay.

11. The large motorway projects. namely the Périphérique and the Northern Entrances. once were considered for development as toll facilities along the BOT project. now have been indefinitely delayed.

12. Recently there was a positive step towards implementing the suburban rail transit line proposed by the GBATP. A grant from the USTDA to the Ministry of Transport was made towards conducting its feasibility studies.

1.3.2 Issues of Urban Transport in Greater Beirut

The underlying issues of urban transport in Greater Beirut include the following:

1. The traffic engineering function is totally absent.

2. The existing street network is not being efficiently managed. It lacks signal intersection control. and most other traffic control devices.

3. On-street parking management is virtually absent. On-street parking is free. even in business areas. and there are no limitations on the parking duration.

4. In the absence of traffic signals. the available police resources are being consumed by the requirement of intersection control. leaving enforcement needs unsatisfactorily attended.

5. Bus public transport is not able to present itself as an efficient reliable alternative to the private car. The difficulty of maneuvering large buses on congested streets is making bus trip times excessive. and the laxity in enforcing on-street parking regulations are working against public transport attractiveness.

6. Until the mass transit component of the GBATP is implemented (which is a necessity. especially beyond 2010 as revealed by the analyses of the GBATP). there is the need to implement traffic management measures which address the basics of traffic engineering coupled with public education and stepping up of enforcement.

1.3.3 Salient Features of Required Actions - BUTP

The Beirut Urban Transport Project. BUTP. is the first step towards implementing the Greater Beirut Area Transportation Plan.

The traffic problems of Greater Beirut are intertwined. A series of diligent efforts over an extended period of time are required to improve urban transport in the GBA: primarily to bring conditions to a tolerable level to start with. while continuing to implement measures that improve on the current conditions and eventually meet future needs. The required efforts are mutually supportive rather than mutually exclusive.

The sequencing of effort should be directed at introducing a gradually increasing level of sophistication. To start with. the effort should be directed at making better use of the existing road network through traffic management. Traffic management should be coupled with public awareness campaigns and strict enforcement. Traffic management should include both moving (traffic) and stationery vehicles (parking).

Re-establishing the fluidity of traffic flow will give bus transit (coupled with transport policy instruments) the chance to provide an acceptable level-of-service. a prerequisite for attracting ridership.

The required interventions can be classified according to various criteria. In an oversimplified taxonomy. one can sort all required interventions according to two criteria. Each criterion in fact implies a combination of characteristics.

Interventions may be classified according to their investment needs. At one end are capital intensive (hard) projects on the other interventions of merely regulatory (soft) nature. According to this criterion. one can list the following types of interventions. from the most capital intensive to the more regulatory in nature:

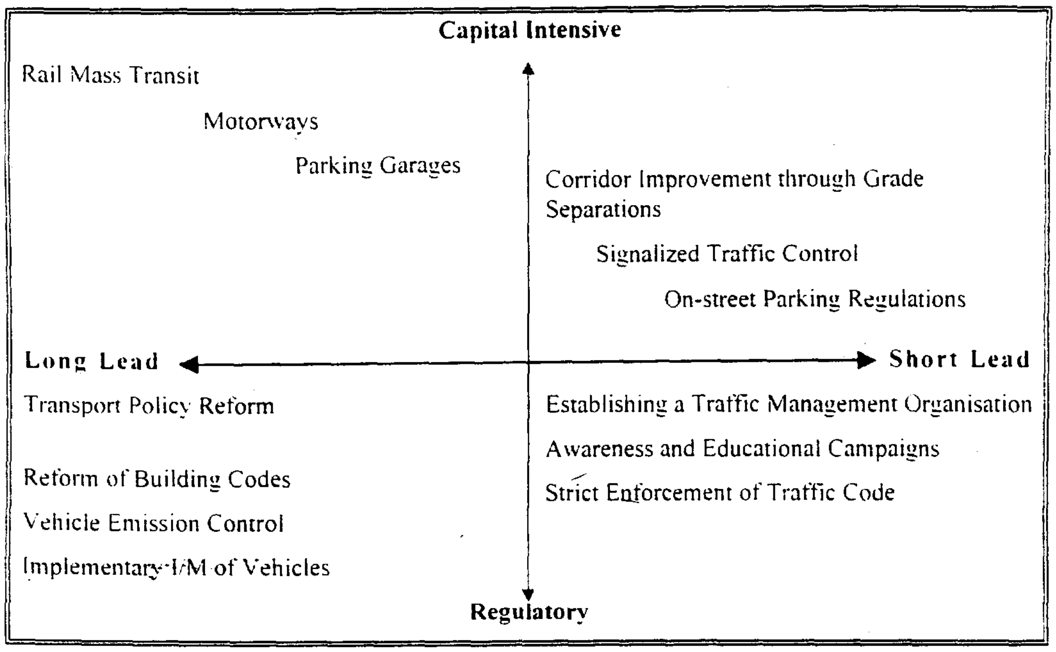
Rail Mass Transit
Expressways and Motorway
Parking Garages
Grade Separation of Intersections
Signalized Traffic Control
On-street Parking Regulation.

Another criterion. is the lead time required prior to the start of implementation of a specific intervention. The lead time is governed by various factors. such as:

* Pre-construction Contract Activities: feasibility studies. preparation of preliminary engineering. detailed design. and contract document. tendering:
* Securing Fin: (the bigger the investment the more difficult to secure its financing needs):
* Liberating the required Right-of-way:
* Complexity of Institutional and Legislative Requirements:
* Interdependencies: the viability of certain interventions is dependent on the satisfaction of certain conditions (e.g. the viability of a suburban rail line depends on the availability of feeder bus services. park-and-ride. etc.).

The figure below depicts a taxonomy of the various interventions proposed by the GBATP according to the 2 criteria identified above.

Figure 1-3: Taxonomy of Greater Beirut Area Transportation Plan (GBATP) Interventions



It is proposed that the BUTP shall include interventions that are characterized by:

- moderate investments (the entire budget is about US$100 m)
- amenable to immediate implementation
- mutually supportive interventions. with limited pre-requisites outside the scope of BUTP
- interventions that are themselves pre-requisite for the success of the other components of GBATP.

The proposed Beirut Urban Transport Project includes 3 components:

- Traffic Management Program
- Parking Improvement Program
- Corridor Improvement Program.

They all belong to the right-handside of the figure above. They are characterised by their modest investment needs and they are amenable to immediate implementation. Above all they are pre-requisites for implementing the other components of the GBATP. The proposed components of the BUTP are mutually supportive among themselves and with the other components of the GBATP. In particular they are not mutually exclusive with the other required interventions, that are more capital intensive or those that require policy reforms.

1.4 Strategic Alternatives

The GBATP evaluated two contrasting scenarios of transport patterns which included the use of a heavy mass transport network and a road oriented network. and proposed a compromise of the two for identifying the components of the proposed long-term. medium-term. and immediate action plans. During the modeling effort for the BUTP. an updating of the 1994 base-year conditions was conducted and a 1998 base year model was calibrated. The policy. economic. and travel observed trends between 1994 and 1998 were taken into consideration in the preparation of the travel forecasts. The main features of the strategic alternatives considered and those adopted are outlined below.

1.4.1 Tested Scenarios of the GBATP: Issues of the Future

Two main points feature the future issues of transport systems in the GBA:

- The large extent of needs that will arise to nearly 5 million daily-motorized person trips in 2015 (compared to 1.5 million today). The scale of issues will change.
- The requirement of a complete policy review to meet this demand in an acceptable manner regarding economic viability and protection of urban and natural environment. Public transport ensured in 19% of trips in 1994, but in the absence of any mass transit system, the main part of this market was actually being served by taxi-service (17%). This situation cannot last in the future.

These considerations have guided the choice of the methodology used to prepare the Long Term Transportation Plan. Two contrasted transport supply and modal split scenarios have been elaborated:

- *Scenario A:* foresees the creation of a "heavy" mass transit network in Beirut Urban Agglomeration (BUA)[1]. It is associated to modal split assumptions privileging public transport use for trips inside BUA.
- *Scenario B:* proposes a road-oriented network, inside and outside the BUA. It is associated to a modal split assumption privileging private car use.

The analysis of operating simulations of these two Scenarios highlight their potential, limits and "effectiveness". It enables to compare their capabilities to meet future trip demand in the GBA and build the optimal network of the Long Term Transportation Plan.

Scenario A

The main characteristic of Scenario A is to provide all BUA population with a "heavy" mass transit system located less than 1 km from their dwelling unit. The network proposed to reach this target includes:

- The Saida - Tripoli railway line, operated as a Regional Metropolitan line inside GBA (38 Km from Jounieh to Damour).
- -Six urban metro-type lines inside BUA (66 km in total).
- A complementary bus network ensuring a feeder structure towards the "heavy" mass transit network and servicing outlying areas.

Regarding road network, Scenario A has two main characteristics:

- It includes the whole projects presently studied or launched by Lebanese authorities (CDR, CEGP, SOLIDERE), but with some capacity reductions compared to their original design.
- It foresees the construction of new roads between the Boulevard Périphérique and the South, North and East Entrances of the Metropolitan Region (where future demand will be large and impossible to meet by only public transport).

Daily modal split associated to these network assumptions is as follows:

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[1] Beirut Urban Agglomeration (BUA) includes Beirut City and the continuous urban fabric surrounding it that spreads from Antelias to the North to the Lebanese University to the South. It sheltered about 1 million inhabitants in 1994, 84% of GBA population. It will still shelter 75% of which in 2015.

Table 1-1:

Scenario A: Market Share of Transit in Percent Railway, Metro, and Bus

Origin	Destination					
	MB	NS	CS	MS	EA	Total
MB[2] - Municipal Beirut	75	60	40	15	15	56
NS - Near Suburbs	60	35	15	5	12	30
CS - Coastal Suburbs	40	15	15	5	7	17
MS - Mountain Suburbs	15	5	5	5	2	-
EA - External Area	15	12	7	2	3	11
Total	56	30	17	7	11	33

According to these modal split assumptions, the overall market share of Public Transport will be 33% of daily-motorized person trips executed in GBA in 2015.

Scenario B

Scenario B has been built as an extension of existing trends. Relying on an intense use of private car, it privileges the development of the road network, mainly by the strengthening of the infrastructure network already included in Scenario A[3]. It will notably consist in:

- The completion, without any capacity reduction, of the works presently launched in Beirut and suburbs.
- The enlargement or the strengthening of some of the roads presently designed as an urban boulevard into an expressway (Beirut Corniches, Sin El Fil, Chiah, Airport Boulevard).

With regards to Mass Transit, Scenario B proposes, as Scenario A, the re-use of Saida-Tripoli Railway operated as a Regional Metro inside Greater Beirut but it does not include any other "heavy" mass transit lines. Basic mass transit system will consist of a bus network serving the whole built-up area and well connected to the Railway line. Taxi-service will still play a significant role in this Scenario inside and outside Beirut Urban Agglomeration. The daily modal split table associated to Scenario B is as follows:

Table 1-2:

Scenario B: Market Share of Mass Transit in Percent Railway and Bus

Origin	Destination					
	MB	NS	CS	MS	EA	Total
MB - Municipal Beirut	37	25	12	4	6	25
NS - Near Suburbs	25	17	8	4	7	15
CS - Coastal Suburbs	12	8	8	4	3	8
MS - Mountain Suburbs	4	4	4	4	2	4
EA - External Area	6	7	3	2	3	5
Total	25	15	8	4	5	16

In Scenario B, the overall market share of Public Transport (railway and bus) will border 16%

[2] BUA is the addition of MB and NS.

[3] The opening of new road breakthroughs inside the existing urban fabric appears very difficult, and Scenario B infrastructure uses the right-of-way of the roads proposed in Scenario A.

of total trips executed in GBA in 2015.

1.4.2 Evaluation Criteria

The two basic Scenarios have been tested and evaluated by means of indicators measuring network productivity. investment cost. and coherence with GBA regional planning strategy. These indicators (average trip duration. average speed. saturation rate) have been calculated from the trip assignment simulations. More than their absolute value. much depending on simulation. an ordinal comparison was taken into account to orient the choices of the Long Term Transport Plan. Selected indicators are the following:

- Private Vehicular Trips: consistency of cost of construction of the network. saturation rate of road network along the main geographical cuts that structure GBA motorized trips. average trip duration and speed according to the type of road and its location. averaaccess time to the main GBA poles and trip duration between these poles.
- Mass Transit Trips: consistency and cost of Mass Transit Network. average trip duration. traffic and load of Mass Transit lines. average access-time to the main GBA poles and trip duration between these poles.

1.4.3 GBATP Adopted Scenario

Targets

The Long Term Transportation Plan prepared from the compared diagnosis of Scenarios A and B has four main targets:

- It aims at meeting trip needs in GBA by year 2015. Future demand has been estimated to about 5 million motorized trips per day. which is more than 3 times the existing demand.
- It aims at giving back Beirut its former role of the Metropolis of the Middle East by means of a modern road and transportation system. A good accessibility. internal as well as external. contributes much to the attractivity of a city and its development.
- It endeavors to protect urban and natural environment by limiting new road breakthroughs that could destroy existing neighborhoods or valuable landscapes: and by developing a land saving environmentally friendly Mass Transit System liable to meet the huge number of trips generated in the dense built-up area.
- It seeks to be realistic. economically and financially sustainable and commensurate with financing capabilities of Lebanon.

The network proposed by the Long Term Transportation Plan associates in a close and complementary way. a Mass Transit System devoted to first serve the dense areas of BUA and the coastal corridors and a road network devoted to reunify Beirut suburbs and ensure good connections between GBA and the rest of the country.

Modal Choice

Modal choice table adopted in the Long Term Plan relies on a number of assumptions regarding the future behavior of travelers. given a certain transport supply. It has been built from the knowledge of similar ratios observed in metropolises of the same size. morphology and economic level. The Mass Transit Network proposed in the Long Term Plan expresses a compromise between the basic target of Scenario A (providing all BUA inhabitants with a metro-like line less than 1 km from their dwelling unit) and the concern of optimizing and diminishing the cost of this network when the possible ridership of some tested lines was modest. The final modal split table, close to that of Scenario A, is nevertheless at a lower level (regarding mass transit use), given the poor BUA servicing provided by the proposed long term network.

Table 1-3:

GBATP Adopted Scenario Market Share of Transit in Percent Railway, Metro, and Bus

Origin	Destination					
	MB	NS	CS	MS	EA	Total
MB - Municipal Beirut	60	50	35	10	15	42
NS - Near Suburbs	50	30	15	5	10	27
CS - Coastal Suburbs	35	15	15	5	5	15
MS - Mountain Suburbs	10	5	5	2	2	5
EA - External Area	15	10	5	2	3	10
Total	**42**	**27**	**15**	**5**	**10**	**26**

According to these assumptions, the overall mass transit market share (taxi services excluded) will be 26% of daily motorized person trips in GBA in 2015.

1.4.4 BUTP Adopted Scenario

The observed growth in population, employment, and general economic growth realized after 1996 is slower than the prevailing outlook of 1994 - 1995. Accordingly, it was decided to adopt the 2015 person trip matrix developed by GBATP to reflect 2020 conditions. That is the slow economic growth would result in delaying the growth in trips over the study horizon such that the level of trip-making expected to be achieved in 2015 would now be delayed till 2020. The resulting area-wide annual average trip growth over the period 1998-2020 is 3.3%.

Forecasting vehicular trips requires adopting a specific modal split scenario. The modal split scenario adopted in 1995 for 2015 trips consisted of a marked shift towards public transport. The public transport is an essential component of the GBATP. It included plans for re-operating the coastal rail line as a commuter service between Jubail and Damour, introducing two metro-lines, in addition to expanding bus services, both on dedicated ROW and on city streets. The progress of projects during the period 1995 - 1998 clearly show that the shift towards public transportation recommended by GBATP will not be realized by 2015, as no action was taken during the past few years towards preparing for launching rail and heavy mass transit projects. Consequently, a more realistic scenario was adopted regarding modal split. Trips between various sub-areas within GBA would have different proportions of the trips served by public transport (entirely bus), with an overall average of 16 percent.

Table 1-4:
BUTP Adopted Scenario Market Share of Transit in Percent Buses Only

Origin	Destination				
	BUA %	CS %	MS %	EA %	Total %
BUA - Beirut Urban Agglomeration	25	10	4	6	20
CS - Coastal Suburbs	10	8	4	3	8
MS - Mountain Suburbs	4	4	4	2	4
EA - External Area	6	3	2	3	6
Total	**20**	**8**	**4**	**6**	**16**

It should be noted that BUTP includes the recommendations of the Immediate Action Plan proposed by the GBATP in 1995 plus some grade separations that were envisioned in 1995 to be part of the Medium-Term Plan. Limits on the size of investments and the horizon year (2004) for completing the construction of the BUTP components oriented its attention solely to traffic management, parking improvement, and spot improvements that will produce the decrease in the level of congestion required to operate bus services of acceptable level-of-service.

It should be noted that the results of the forecasts done for BUTP show that the traffic volumes expected in 2015, with all the proposed improvements in place, will reach the capacity of the highway network at most of the locations. The mass transit component of the GBATP deserves immediate attention. Studies and designs must be started immediately, at least to conserve and preserve the required right-of-way for permanent way, terminals, stations, and park-and-ride facilities.

1.5 The No-Action Alternative

This section presents the consequence of the no-action alternative, relevant to each of the proposed BUTP components.

1.5.1 Traffic Management Component

This Component includes revising the circulation plans, spot improvement of some intersections, installing traffic signals on more than 200 intersections, controlling the signals from a Traffic Control Center, that can also perform surveillance functions, and can be upgraded later to perform many other ITS functions. This component includes also setting up a Traffic Management Organization (TMO). The impacts of the no-action alternative relative this component include:

1. Un-signalized busy intersections need excessive numbers of policemen to control, preventing them from being deployed to more serious duties. Policeman, if well trained, may perform very well at an isolated intersection, but can not coordinate intersections along a corridor or on a network.
2. Without signals, delays are higher at intersections, the value of time of traveler is considered in the economic analysis.
3. Stop-go conditions due to traffic congestion will cause more emissions, this is simulated in the EIA.
4. Well equipped signalized intersections increase traffic safety, especially for pedestrians. Gaps between platoons permit safer mid-block crossing of pedestrians, and signal timing will give protected movements to pedestrians at location of heavy pedestrian traffic.
5. Establishing a TMO will provide a traffic engineering unit that can sustain the proposed improvements, and plan for the requirements of the future.

1.5.2 Parking Component

It was demonstrated by studies and surveys done for the GBATP and the BUTP that chaotic parking is the major cause for traffic congestion in the City. Chaotic parking has also downgraded the quality of life and forced the pedestrians from the sidewalk to the traffic lanes. This not only jeopardized the safety of pedestrians but also discouraged walking trips that could be substantial for short-distance trips in the city. The GBATP and BUTP studies have also shown the need to increase the off-street parking supply. This may prove to be an expensive endeavor due to high land prices. and more over the use of off-street facilities is doubtful if the lack of enforcement of on-street parking regulation persists. The orientation of the BUTP parking component is to regulate on-street parking by making it timed and for-a-fee in business areas. and to step-up enforcement of parking restrictions. These measures are required to correct the perception of the cost of owning and operating a vehicle. Once illegal parking becomes costly due to strict enforcement. car owners will start accepting using off-street car parks. The financial viability of car parks will generate the interest of investors in them. The no-action alternative as far as parking is simply to condone and accept the current situation which means:

1. Streets will be used for parking and not for circulation. thus requiring expensive investment in new roads.
2. Intersections with parked vehicles at their corners can not perform properly. and the proposed signalization will not result in the expected benefits.
3. Pedestrian safety will be jeopardized and walking as a transport mode will be discouraged.
4. If on-street parking continues to be free and improper parking in not sanctioned. off-street parking will continue to be under used and financially non feasible.
5. Improper on-street parking will also interfere with the operation of Bus Public Transport. Standard city buses will find it extremely difficult to negotiate the streets. and the bus stops occupied by parking vehicles will force the bus to stop in the traveled lane. thus increasing the congestion.

The no-action alternative of the proposed parking component is an implied condoning of the existing unacceptable parking chaos. whose cost on the society in term of reduced street capacity. reduced intersection capacity. and the general deterioration of quality of urban life is very high. On the other side. organizing on-street parking is a very cost-effective intervention.

1.5.3 Grade Separation Component

It was demonstrated that some intersections are over congested and signal control can not handle the intersecting traffic volumes. Travel delays in cities are generally most critical at intersections. Grade separation is the only alternative for such cases (having exhausted demand management. such as increasing the share of public transport). The no-action alternative is quantified in the economic analysis and EIA. The impacts of the base case (no-action) are compared to those of the proposed improvement for several time reference years. The economic returns of the construction of groups of grade separations are calculated in terms of IRR. The reduction in the IRR due to excluding one of the grade separations from the BUTP demonstrates the marginal benefit of it. Thus it is a test of the economic feasibility of the no-action alternative. Environmentally the results of the simulations of the levels of emission and noise at each intersection. with and without the proposed grade separation demonstrate the demerits of the no-action alternative.

1.6 What About Public Transportation?

The GBATP (TEAM International-IAURIF-SOFRETU. 1995) demonstrated that by the year 2010 the level of congestion of the street network will start reaching intolerable levels on certain corridors. in spite of all the committed additions to the road network. The trips generated by the forecasted level of development cannot possibly be served without a well developed public transport system. Accordingly. the GBATP proposed substantial public transport investments. which included the commuter rail line between Jbail and Damour. two rail transit metro lines. and a well developed bus service. part of which on its own right of way. An Immediate Action Plan (IAP) which was proposed within the GBATP, included traffic management schemes that comprised intersection improvements and the installation of traffic signals. It also envisioned restarting public bus services.

The Joint Venture of TEAM International-IAURIF-SYSTRA-SEMVAT did in fact help in 1996-1997 the Office of Rail Road and Public Transport (OCFTC) to restart bus transport services. Over 200 new buses were put in service covering the GBA. Unfortunately, the required conditions for expanding and improving the services were not made available to the OCFTC. More importantly, the re-organization of the OCFTC into a regulating agency rather than a transit operator as recommended by the consultants was not implemented. Currently, some 200 buses of the OCFTC are running on the streets, providing a low level of service. Transit routes are not publicized, schedules and frequencies are not known nor adhered to, and ridership is still low (1,300,000 per month). The same routes are also being served by a privately owned bus company and by multitude of driver-owner run buses of all colors and makes. All are competing with each other on the same routes and operate in a manner similar to the taxi-service (shared taxi) system. The result is a low level of service, ruinous competition, and more traffic congestion.

The BUTP seems, at a first glance, to be auto-oriented if seen in isolation from the GBATP. But, in fact, its three components which are addressed at reducing the level of congestion, are prerequisite for the efficient operation of a bus transit system. Without organizing on-street parking, reducing the traffic congestion, and enforcing traffic regulations good bus transport is difficult to provide.

The above should not be understood that further technical support to public transport is not needed at the moment. On the contrary technical assistance is required for transforming OCFTC into a regulating authority, responsible for planning services, defining operational requirements, and controlling the provision of services by private operators. Moreover, serious detailed planning for the rail transit should commence now, in order to be able to meet the 2010 target. The feasibility study of the suburban transit corridor (Jounieh – Jiyeh) which is due to commence in early 2000 is a step in the right direction.

2. BUTP PROJECT DESCRIPTION

The Beirut Urban Transport Project includes 3 components:

- Traffic Management Program
- Parking Improvement Program
- Corridor Improvement Program.

2.1 Traffic Management Program

This component is composed of the following elements:

- Installation of traffic signals covering 211 intersections in Greater Beirut, 123 of which lie within the municipal limits of Beirut.
- Installing a pilot video surveillance system (CCTV) along 4 corridors, as part of a master plan to cover other corridors in the future. The selected corridors are the Northern Entrance (Corridor No. 19), the Southern Entrance (Corridor No. 8), the Eastern Entrance along Damascus Road (Corridor No. 5), and Corniche El Mazraa (Corridor No. 1).
- Establishment of a Traffic Control Center (TCC), which is the communication hub connecting all traffic control sub-systems and from which monitoring, control, and intervention can be managed. The TCC functions should be possible to expand in the future for including parking guidance, public transportation monitoring, variable message signs, electronic toll collection, environmental monitoring, etc.

Figure 2-1 depicts the Greater Beirut Traffic Management System.

2.1.1 Traffic Signals

2.1.1.1 Geographic Scope

Based on the circulation plan for Greater Beirut produced in 1995, and which is continuously being updated, traffic signals are to be installed at all major intersections. Around 30 of these intersections were equipped with signals, as part of roadway projects that were implemented by the CEGPVB during the last 3 years. Downtown Beirut, being currently rebuilt by SOLIDERE, some thirty of its intersections were recently equipped by signals.

Figure 2-2 shows the location of the intersections at which signals are to be installed. Some of these locations require minor civil works for adjusting the directional islands on them. Some others coincide with intersections candidates for receiving a grade separation on them (see Section 2.3 of this report); with the grade separation there is still the need for a traffic signal to control turning movements at grade.

2.1.1.2 Technical Features

In order to appreciate the type of controllers proposed for these installations, highlights of the technical specifications are included below. Detailed technical specifications are under preparation as part of the procurement documents.

The proposed traffic signal controller shall be capable of recording traffic flows at the approaches of an intersection by means of detectors, deriving the traffic density from measured values. All detectors at the intersection should be capable of being defined as local

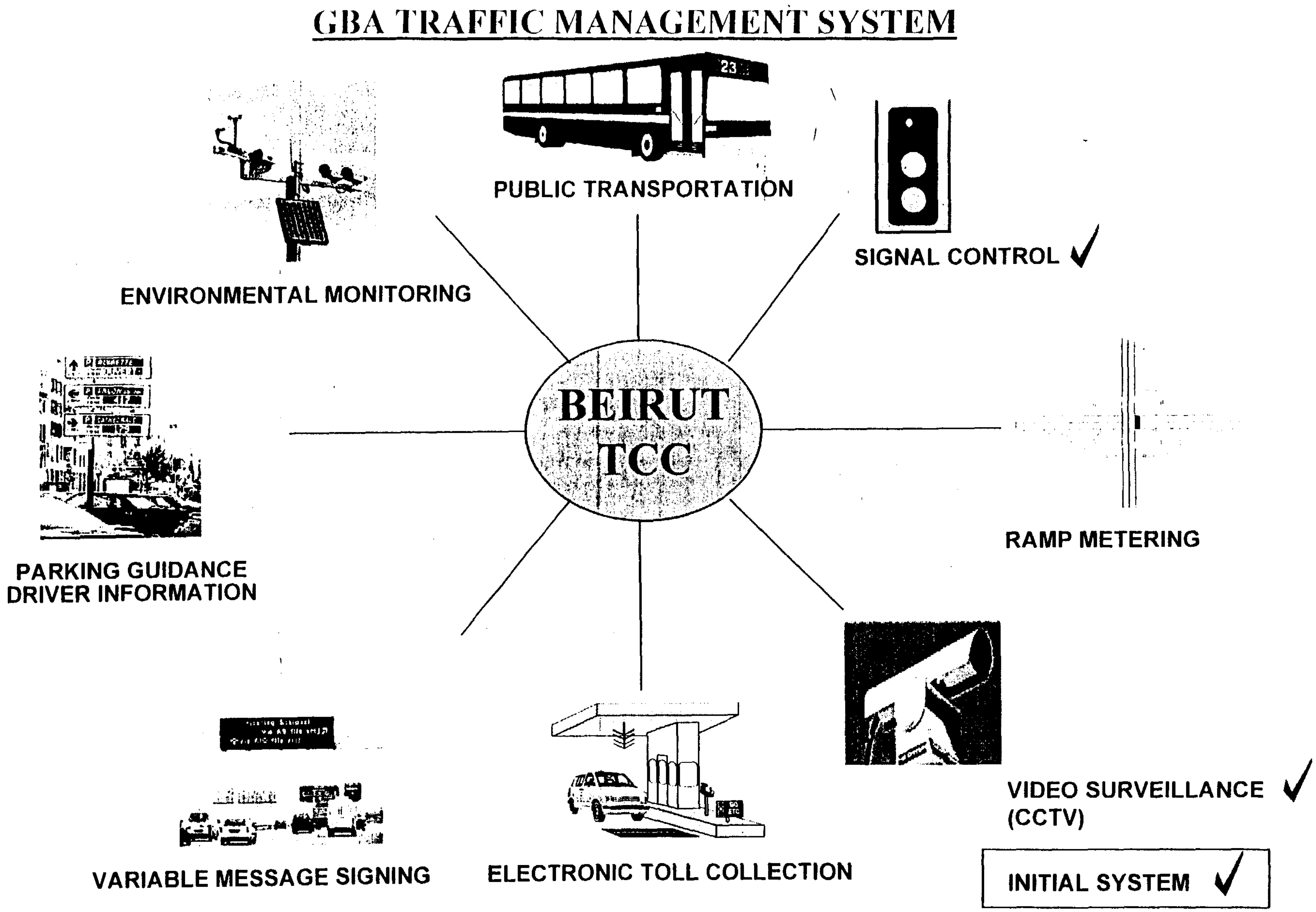
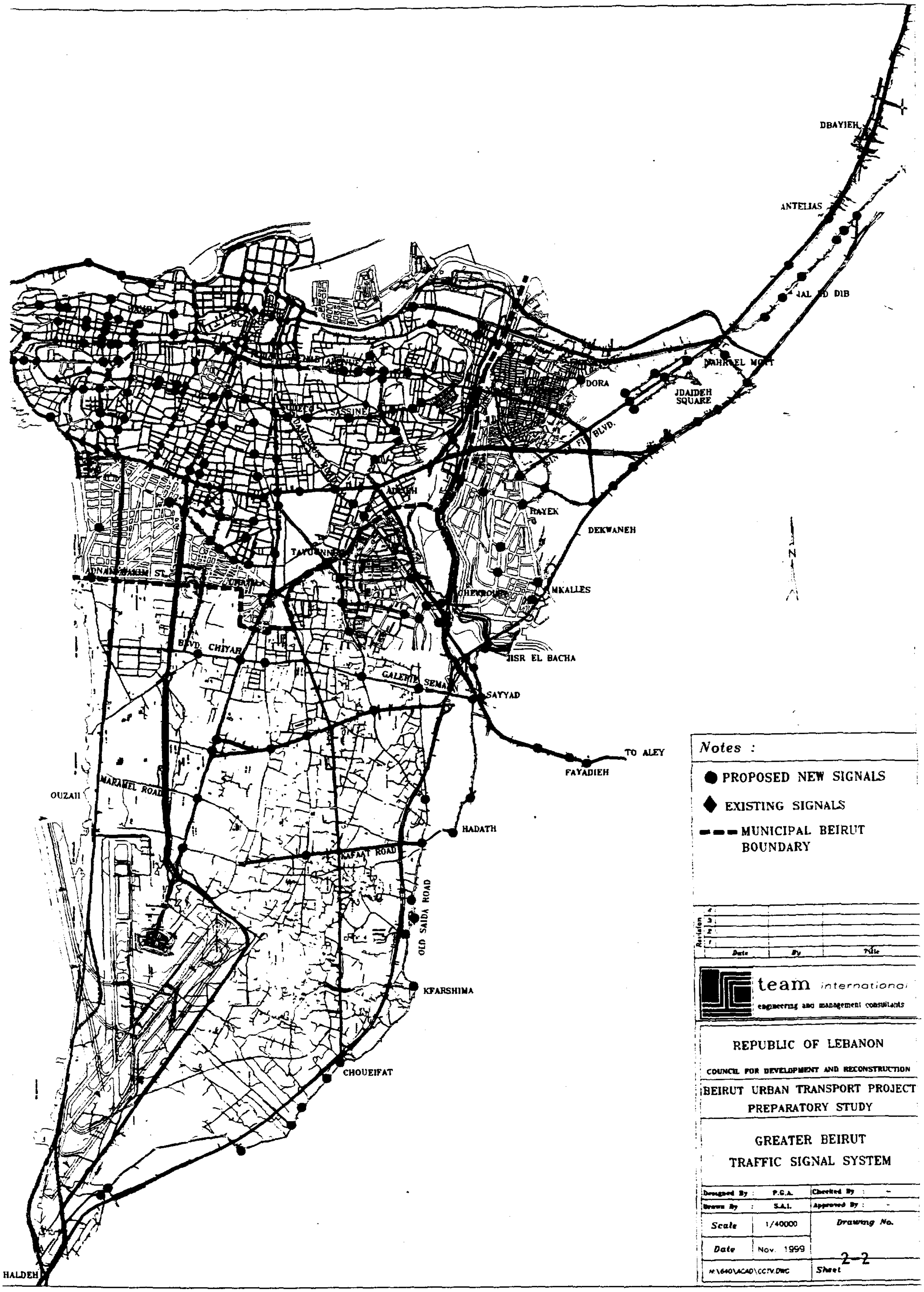


Figure 2-1: Greater Beirut Traffic Management System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and system detectors. Information from the local and system detectors should be processed in the local controller.

The traffic controller shall be capable of automatically generating stage transitions in isolated mode, and changing inter-green times in a centralized system. The controller shall be capable of:

- early phase termination,
- phase skipping or omitting, and
- automatically generating cycle lengths based on previous detector inputs.

To achieve an optimum performance and cost effectiveness for all the installed traffic control equipment, use up to three different controller models (from the same controller family or series) and cabinet types based on each intersection phasing complexity and space availability is acceptable.

Design Requirements

The local controller shall be a 16-bit microcomputer system or better and with a 16-bit data bus or better designed for traffic signal control. The hardware shall include the microprocessor, memory, operator interface, input/output (I/O) circuits, and power supply. All logical functions necessarily external to the microprocessor shall be performed by solid-state devices. The proposed traffic controller shall be currently functioning and communicating in the proposed traffic adaptive (real-time) Urban Traffic Control (UTC) system.

Controller Memory

Random Access Memory (RAM) shall be provided with battery backup power sufficient to maintain full memory without loss of any programmed data for a minimum of 30 days.

Number of Phases

Controller cabinets shall have backwiring for the required number of phases and overlaps. The controller shall be capable of expanding to accommodate additional phases by adding extra modules to the controller housing.

Radio Interference Suppressers

All traffic signal controllers, flashers, or other current -interrupting devices shall be equipped with radio interference suppressers installed at the input power point.

Power Requirements

The normal power requirement anticipated is 220 volts with some locations at 110 volts.

Over-current Protection Device

The local controller and related equipment shall be protected from electrical power surges and lightning. A transient voltage protection device connected to the controller power circuitry for protection against voltage abnormalities of less than ½ cycle duration.

The local controller shall be capable of automatic reorientation in the event of a mains supply interruption and the subsequent resumption of power services.

Traffic Count Data Collection

The controller shall be able to collect traffic count data from induction loops and store thisdata for later retrieval. The controller should have enough memory to store at least 14 days hourly traffic counts. In case of a power failure the traffic data stored in the controller shall not be lost but backed up through a backup battery mechanism.

Stage Sequences

The phases of a local controller shall be assigned to stages. Each local controller shall have the capability of its stage sequence being selected depending on vehicle detection and/or through central computer control.

Controller stage and interval sequence circuitry shall be assigned so that computer commands cannot alter fixed interval sequences or user prohibited stage change sequences.

Interval Setting and Controls

An integral keyboard and associated display shall be provided on the front panel of the Controller for setting the timing of each interval or period. as well as each programmable parameter. The controller should also accept the downloading of signal timing from a laptop computer via a serial cable connection or from a remote location via a modem.

The front panel of the Controller shall have displays to indicate the operational status of all phases and stages as well as all sequences. timing and operation parameters. Indications to be displayed shall include. but not limited to. the following:

- Phases in service.
- Phase next.
- Status indicators.
- Initial interval.
- Vehicle interval.
- Yellow change interval.
- Red change interval.
- Maximum gap termination.
- Vehicle call status.
- Pedestrian call status; and
- All data concerning Standby Coordinated Mode.

Additional Functions

The local Controller shall be capable of providing additional traffic control functions. Additional capabilities which shall be provided by the local Controller include. but are not limited to. the following:

- Volume density operation conforming to NEMA Standards TS-1 and TS-2 or approved equivalent.
- Parallel stage streaming conforming to UK Department of Transport Specifications MC 0141. 1984. latest version or approved equivalent.
- Pedestrian recall and rest in walk.
- Vehicle recall for minimum green interval.
- Vehicle recall for maximum green interval.
- Vehicle detector memory circuit enable.
- Vehicle detector memory circuit disable.
- Special facility control.
- Vehicle and Rail-Road Pre-emption.
- Phase Omits.
- Multiple Priority Pre-emption.
- Coordination and telemetry capability; and

- Controller should be able to control other controllers for arterial or grid system coordination.

Manual Control

Facilities shall be made available to allow manual control of the local controller under emergency conditions. This also includes the ability to manually set the signal in flashing mode. A manual control indicator shall be provided.

A special panel, without accessing the interior of the controller housing, should facilitate special functions for manual control.

Operational Modes

Each Controller shall have the following operational modes:

(a) Adaptive control.
(b) Standby
(c) Isolated
(d) Flashing
(e) Manual
(f) Local Preemption.
(g) Traffic Responsive
(h) Time base Coordination.

2.1.1.3 Size of Installations

The signal components will include about 190 controllers, with the majority are 8-phase controllers, with some requiring up to 18 phases. Some controllers will serve two adjacent intersections. The enclosed Table 2-1 summarizes the quantities of the major items by corridor.

2.1.2 CCTV Surveillance

The proposed CCTV for the Greater Beirut Area (GBA) is designed for surveillance and monitoring of the traffic conditions. The initial CCTV system will cover key corridors in GBA. These are:

1) Northern Entrance
2) Southern Entrance
3) Eastern Entrance
4) Corniche El Mazraa.

It is envisioned that the CCTV system will expand geographically and will also be utilized by other agencies. It is therefore necessary to design a CCTV system that is robust and scalable.

In order to provide for such a system the proposed GBA CCTV system will be based on MPEG-2 digital video. MPEG-2 uses coding and decoding techniques to convert analog video signal into digital video streams. In addition the video stream is compressed to use less bandwidth on the communication medium. The compression is a very important feature of MPEG-2 since the savings in the communication requirements could be substantial since analog video transmission would require very large bandwidths. Also MPEG-2 is a proven computer industry and international standard that is compatible with most new personal

TABLE 2 - 1
TRAFFIC SIGNAL COMPONENT - SUMMARY BILL OF QUANTITIES

Item \ Corridor		Cor 1	Cor 2	Cor 3	Cor 4	Cor 5	Cor 6	Cor 7	Cor 8	Cor 9	Cor 10	Cor 11	Cor 12	Cor 13	Cor 14	Cor 15	Cor 16	Cor 17	Cor 18	Cor 19	Cor 20	Cor 21	Cor 22	Cor 23	Cor 24	Total
300mm Signal Head		155	32	82	20	36	40	6	14	10	12	17	1	6	8	21	4	29	41	2	27	9	43	3	10	628
200mm Signal Head		184	39	163	19	87	83	34	30	33	35	19	114	14	24	74	16	37	64	26	70	13	93	20	46	1337
Pedestrian Head		173	54	193	30	76	63	42	49	36	58	24	153	14	16	72	16	36	56	16	90	8	68	16	42	1401
Loops		246	59	191	27	118	146	30	32	27	48	17	101	10	27	89	15	45	86	23	102	20	113	17	39	1628
Poles Type 1		130	25	129	12	60	64	26	21	20	31	12	88	6	15	44	6	14	25	20	53	6	50	17	24	898
Poles Type 2	W / 5	0	0	10	0	0	2	0	0	0	0	0	0	1	0	3	0	2	6	0	0	1	5	1	0	31
	W / 8	29	10	16	2	12	7	2	5	5	0	1	0	2	1	6	2	1	12	1	6	4	15	0	2	141
	W / 10	40	7	14	6	6	15	1	2	0	6	6	0	0	9	4	0	13	8	1	8	0	9	0	3	158
Control Cabin		28	7	22	4	11	11	6	6	3	7	2	18	2	3	9	2	6	11	3	9	3	11	3	5	192
Electricity Meter		28	7	22	4	11	11	6	6	3	7	2	17	2	3	9	2	6	11	3	9	3	11	3	5	191
Junction Boxes		199	45	163	22	94	94	32	28	26	37	19	96	9	20	62	9	31	57	23	72	13	83	18	32	1284
Cond Trench & Back	(U.R)	2362	497	1570	245	854	888	259	268	182	386	235	816	100	515	589	92	325	579	192	782	160	862	122	281	13161
	(U.S)	2710	547	1932	265	1383	1775	429	378	310	500	190	1516	120	261	849	125	360	923	243	865	185	1041	244	425	17576
Wire Cables m	Signal	11144	1655	6809	571	3499	3510	894	499	1771	1348	877	3491	180	786	3834	235	898	1905	703	3216	313	3740	487	1229	53594
	Loop	12810	2154	8627	673	6574	7737	589	610	1771	1677	688	3461	156	936	5177	407	1675	3509	741	4063	650	5538	424	1232	71879
Push Button		184	39	163	19	87	83	34	30	33	35	19	114	14	24	74	16	37	64	26	70	13	93	20	46	1337
Flasher		8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8

computers. The CCTV will be transmitted over a fiber optic communication network using Asynchronous Transfer Mode (ATM) networking technology.

It is anticipated that approximately 25 CCTV sites will be installed along the corridors listed above. Each field site will include the following:

1. High-resolution color camera mounted on 15 meter poles with a pan, zoom, and tilt unit.
2. Camera control cabinet containing: Control receiver, MPEG-2 CODEC, Power Supply & fiber-optic transmission units
3. Cabling

At the Traffic Control Center (TCC) the following equipment will be required:

1. Fiber-optic communication units
2. MPEG-2 CODEC devices
3. Video &control Switch
4. Video control computer and equipment
5. Computer display and video wall

MPEG-2 video can be transmitted to other locations besides the TCC by adding ATM switches at the desired site. Figure 2-3 shows a schematic diagram of the proposed CCTV system.

2.1.3 Traffic Control Center

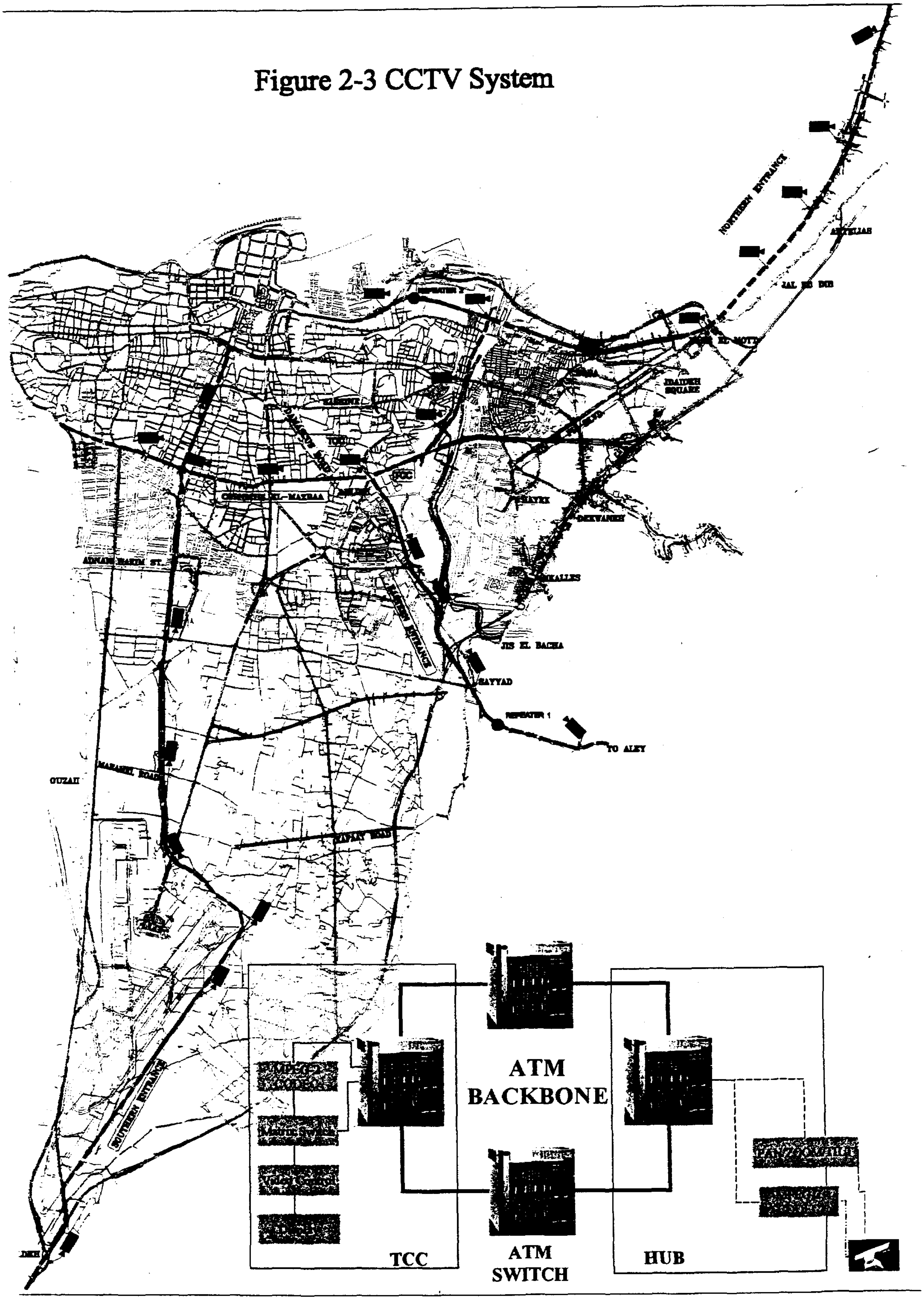
The proposed TCC will act as the communication hub connecting all the traffic devices and from which control, monitoring, and intervention is managed. The TCC will house proposed Signal Control equipment, video control equipment, and future traffic applications such as parking management, variable message control (VMS), etc.

The proposed TCC for the Greater Beirut Area (GBA) will consist of the following components:

1. Cable racks and communication electronics
2. Video displays and video wall
3. Several computer systems for the proposed traffic applications (refer to Figure 2-4)
4. Local Area Network (LAN) cabling and equipment connecting all the TCC computer devices
5. Un-interruptible Power Supply (UPS) and HVAC system
6. Furnishings including workstation units
7. Signal test bed simulator

The TCC will also include facilities such as a conference room, kitchen/break room, offices, utility room, and a viewing gallery.

Figure 2-3 CCTV System



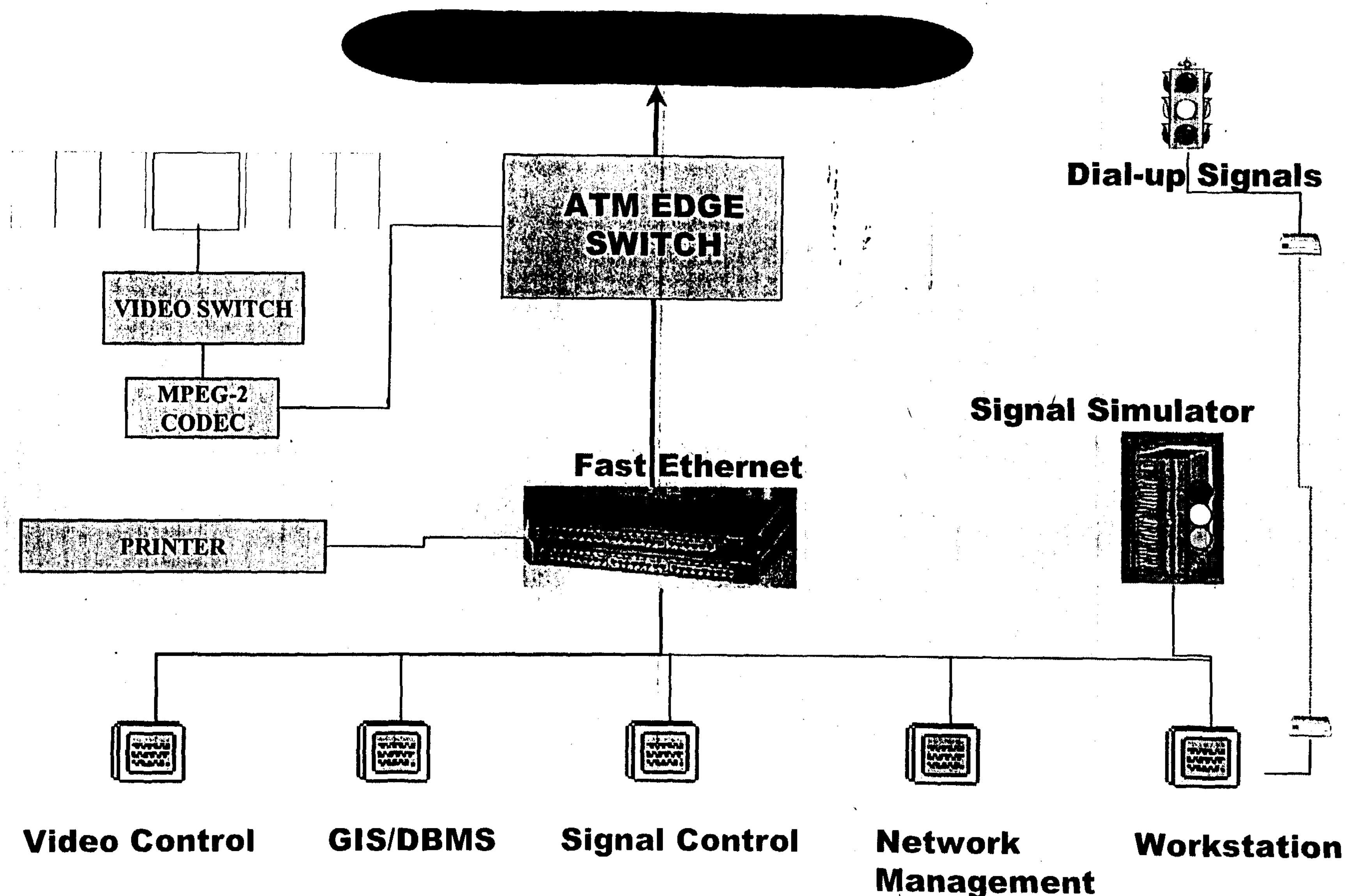


Figure 2 - 4 GBA Traffic Control Center

2.1.4 Revisions Under Consideration of Communications and CCTV Systems

The traffic management system which includes signal control. CCTV surveillance. and associated communications are being revised to reflect a shift from a digital fiber optic communication medium to a two distinct wireless microwave systems. one for CCTV and another for the signal system. The main objective of this change is to reduce overall system cost including capital. operation. and maintenance costs.

The main difference between the old system versus the proposed communication system is listed below:

	Old	Under Revision
Signal System	Leased Lines	2.4 GHZ Radio Modems + Leased Lines
CCTV System	Fiber Optic Mpeg 2 CODEC	23 GHZ Microwave Radio Analog Video

For a detailed look at the proposed systems. refer to the Signals & Traffic Control Center Technical Specifications (Deliverable 27).

The overall system cost should be reduced due to the elimination of a major trenching and cable effort as proposed earlier. In addition. switching from a digital Mpeg-2 CODEC to an analog video should also reduce the overall CCTV system cost. This should have a positive impact on the Internal Rate of Return (IRR) for the traffic management system element.

2.2 Parking Improvement Program

Initially it was proposed that the project would support the construction of a series of underground garages in central Beirut. It was anticipated that this would include the preparation of site specific environmental assessments since these garages would be constructed under established public parks and would have significant construction period impacts. Following field based engineering and environmental evaluations. the proposed construction of underground parking facilities has been dropped from the proposed Project. The other activities in the component only concern non-structural measures for parking management and support for procurement and installation of parking meters for on-street parking. The work conducted prior to this reorientation for the parking component is nevertheless presented in this report for future reference in case an underground parking facility is proposed.

2.2.1 Zone Selection

The parking program was subjected to a site selection process to identify parking site locations that will be most suitable for the purpose of the project. In this regard. a detailed field survey and analysis were conducted with several goals in mind including:

- reduction of the number of circulating vehicles. especially those who are looking for a parking space: thereby reducing the extents of harmful emissions into the atmosphere;
- saving the motorist time:
- allowing efficient use of existing parking spaces:
- directing flows of traffic in surveyed zones and thereby improving the operations

of intersections:
- speeding public transport:
- enhancing traffic and pedestrians safety; and
- making the surveyed zones more attractive to shoppers and visitors.

Survey Zone Selection

The surveyed zones were selected in accordance to several criteria namely. areas that are primarily commercial and serve beyond their district boundaries: corridors affected by on street parking (fluidity in vehicle circulation); and on street continuous commercial shops

Based on these goals and criteria, the study covered 16 zones. Figure 2-5 is a Key Map. which shows the location of the studied zones within GBA. Table 2-2 lists the zones by number. name. and general characteristics. In each zone. field surveys included three major components:

- A detailed inventory of on-street parking, in which the number of available spaces. the number of parked vehicles and their status (legal. illegal. on the sidewalk, etc.) was noted for every segment of the street network.
- A detailed inventory of off-street public parking, noting their capacity and degree of saturation. and the fees collected. Temporary parking lots programmed to be constructed during the coming three years were identified to estimate the resulting decrease in available parking space.
- A detailed survey of buildings to identify vacant floor space and its corresponding parking demand when occupied.

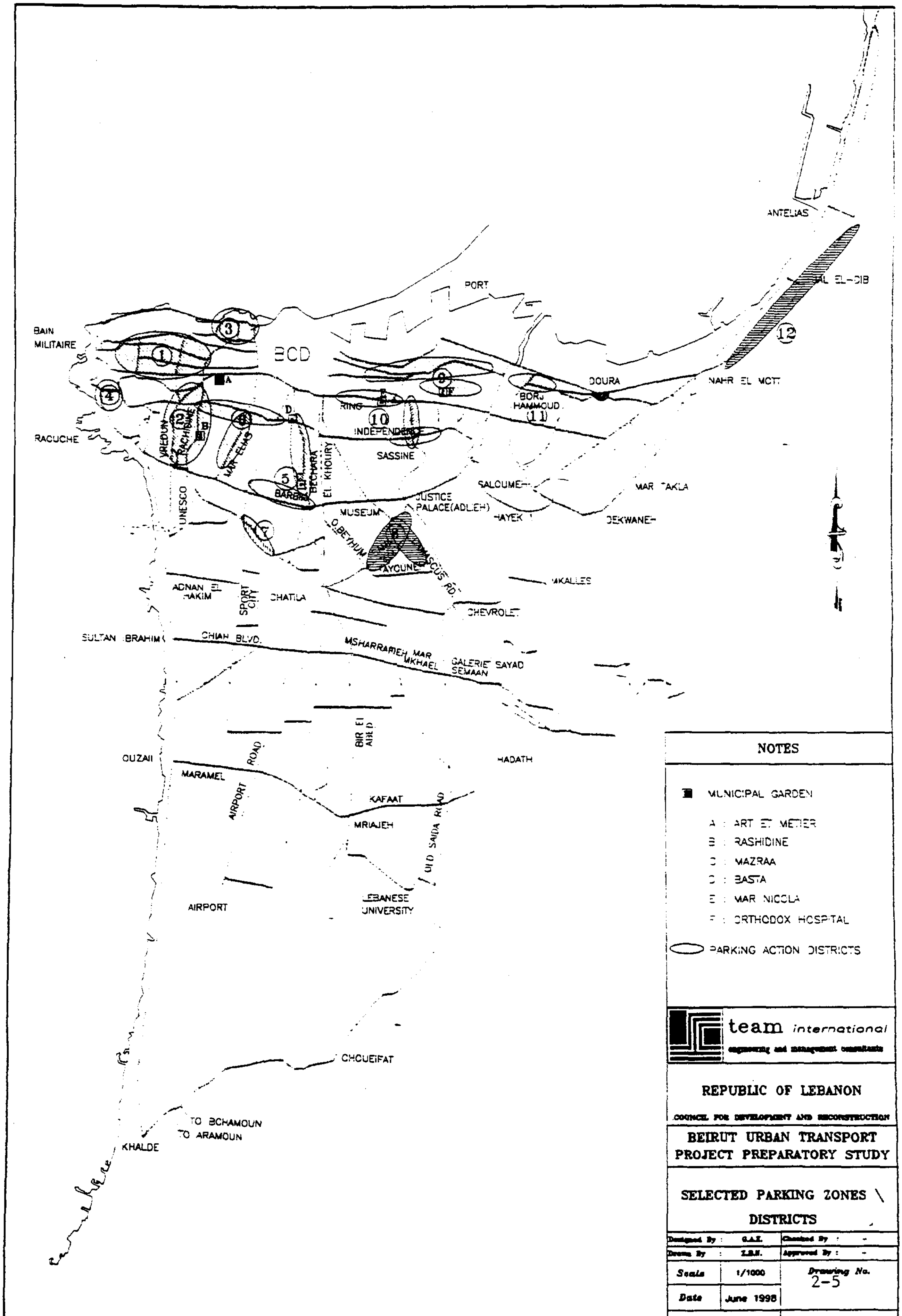

ANTELIAS
PORT
BAIN MILITAIRE
BCD
DOURA
NAHR EL MOTT
BORJ HAMMOUD
RACUCHE
RING
INDEPENDENCE
SASSINE
UNESCO
VREDUN
RACHIDINE
MAR ELIAS
BECHARA EL KHOURY
BARBIR
MUSEUM
JUSTICE PALACE(ADLEH)
SALOUMEH
MAR TAKLA
HAYEK
DEKWANEH
TAYOUNE
DAMASCUS RD.
ADNAN EL HAKIM
SPORT CITY
CHATILA
CHEVROLET
MKALLES
SULTAN IBRAHIM
CHIAH BLVD.
MSHARRAFIEH MAR MKHAEL
GALERIE SEMAAN
SAYAD
BIR EL ABED
OUZAII
MARAMEL
ROAD
AIRPORT
KAFAAT
MRIAJEH
OLD SAIDA ROAD
HADATH
AIRPORT
LEBANESE UNIVERSITY
CHOUEIFAT
TO BCHAMOUN
TO ARAMOUN
KHALDE
NOTES
MUNICIPAL GARDEN
A : ART ET METIER
B : RASHIDINE
C : MAZRAA
D : BASTA
E : MAR NICOLA
F : ORTHODOX HOSPITAL
PARKING ACTION DISTRICTS
team international
engineering and management consultants
REPUBLIC OF LEBANON
COUNCIL FOR DEVELOPMENT AND RECONSTRUCTION
BEIRUT URBAN TRANSPORT PROJECT PREPARATORY STUDY
SELECTED PARKING ZONES \ DISTRICTS
Scale 1/1000
Drawing No. 2-5
Date June 1998
Sheet 1 of 14

Table 2-2: Summary of Potential Impacts of Surveyed Zones

Zone No	Zone Name	Main Characteristics	Relieved Corridor	Municipal Land
1	Hamra	• commercial + business area high quality shops • presence of educational institutions (AUB, LAU, IC, SMOC etc.)	Hamra - Emile Eddé - Sadat - Rome - Abdul Aziz - Bliss - Sidani Souraty	None
2	Verdun - Rachidine	• residential turning to commercial and business oriented area	Verdun - Rachidine	Tallet al-Khayyat public garden - Lot 248 - 263 - 266 - 506 Mseitbeh A 2565 m^2
3	Ain Mreisseh St Georges	• tourism oriented activities, mainly hotels and restaurants	Avenue de Paris - Minet El Hosn - Ghraham - John Kennedy - Ibn Sina (proposal for a 550-space parking under ROW)	None
4	Raouché	• tourism oriented activities, hotels, furnished apartments restaurants and offices buildings	Charles de Gaulle Street - Australia Street	None
5	Basta-Mazraa - Barbour	• commercial & business axes • jewelry souks • medium quality shopping area	Gregarious Haddad - Barbour - Ouzaii Street - Basta	Mar Mikhael - Mazraa vacant lot used as a parking Basta public garden A 1760 (state owned)
6	Mar Elias-Independence	• commercial & business street high quality shops • residential and commercial - moderate shopping	Mar Elias Street - Independence - Othman Bin Affan Street - Gazaer	None
7	Arab University	• university oriented shops & services • dense residential area	Omar Farroukh	Old Raml prison A 14500 m^2 (state owned)
8	Furn El-Chebbak - Sami Solh	• commercial street low to medium shops	Rue de Damas - Sami Solh Ave	None
9A 9B	Nahr Street Mdawar	• commercial street • presence of industrial spare parts commerce • public agencies EDL, Mar Mikhael terminal • residential area - hospitals nearby	Pasteur - Gouraud	Public garden lot 2200 Rmeil A 2700 m^2
10A 10B	Sassine Fouad Chehab - Akkawi	• commercial & business axes • high quality centers	Fouad Chehab - Akkawi - Gouraud Alfre Naccache - Independence	Mar Nicolas public garden - Lot 54 - 55 - 56 - 431 Rmeil A 1000 m^2
11	Borj Hammoud	• commercial street • moderate shopping	Armenia Street	None
12A 12B	Jal Al Dib Antélias	• Residential and commercial	Old Tripoli Road	
13	Sanayeh	• Residential and commercial • Lebanese University • Government offices		Sanayeh public garden

Further details on zone subdivisions, field survey methodology, and results for each zone are described elsewhere (TEAM. 1998c, d). The following paragraphs highlight the results of six of the studied parking zones because of their significance.

The survey concluded that the current parking deficit in the zones studied amounted to a total of 4707 which is expected to reach 9613 within three years with the Hamra zone presenting by far the most parking deficient zone due to its land use character. Hamra's deficiency amounts presently up to 36% and increases in the future to 41% of the deficiency of all the studied zones. Buildings that were occupied by squatters are currently being rehabilitated, thus increasing the parking deficiency considerably over the coming 3 years. This also applies to zone 3 (Ain Mreiseh - St. Georges) where many buildings are still vacant.

The current illegal on-street parking ranges from 33% to 68% of all on-street parking in the zones studied. This high percentage indicates the gravity of the problem and the ineffective enforcement. For the studied zones, illegal parking averages 49% of all on-street parking. However, in spite of the high illegal street parking, off-street parking is not fully utilized. The utilization of off-street parking varies between 12% and 58% and averages 25%. Table 2-3 presents a zone-by-zone comparison of illegal on-street parking and unutilized off-street parking.

Table 2-3: Comparison between on- and off-Street Parking

Zone No.	On-Street Parking % Illegal	Off-Street Parking % Unutilized
1	57	12
2	46	40
3	33	32
4	43	65
5	34	27
6	68	35
7	42	53
8	54	43
9a	46	32
9b	63	16
10a	45	35
10b	43	23
11	41	0
12a	56	19
12b	46	58
13	44	39
Total	49	25

Note that temporary off-street parking lots contribute currently 8059 spaces, or 75% of the available off-street parking. But the parking space availability in temporary off-street parking lots is not certain, since 24% of the available spaces were reported candidate for disappearing within a 3-year horizon. It was also observed that serious parking violations (double parking, over the sidewalk, angle parking) occur right outside public off-street parking lots with ample unoccupied space.

Based on field observations it is evident that parking regulation enforcement is the most lacking factor and is a prerequisite for any attempt for treating the parking problem. Furthermore, On-street parking control devices (parking meters or similar) shall be installed on all streets with intense commercial and business uses. In the zones covered by this project.

the amount of meter controlled parking amounts to a total of about 3500. The numbers in each zone are presented in Table 2-4 below.

Table2-4: Comparison between Authorized Available Spaces and Metered Parking

Zone No.	Zone Name	Authorized Available Spaces	Metered Parking on Major Streets According to IAP
1	Hamra	622	575
2	Verdun-Rachidine	544	387
3	Ain Mreisseh - Saint Georges	480	294
4	Raouche	385	151
5	Basta-Mazraa-Barbour	408	284
6	Mar Elias-Independence	550	296
7	Arab University	90	5
8	Furn el Chebbak-Sami Solh	144	144
9A	Nahr Street	321	321
9B	Mdawar	284	0
10A	Sassine	380	223
10B	Fouad Chehab-Akkawi	235	235
11	Borj Hammoud	112	112
12A	Jal el Dib	342	342
12B	Antelias	44	44
13	Sanayeh	892	83
Total		5833	3496

The parking component of the BUTP was initially envisioned to include the construction of underground parking garages on sites owned by the municipalities. These sites were mostly public gardens. The extensive parking surveys revealed that the available sites for building underground parking garages were not located optimally vis-a-vis the location of the parking deficit. For example Hamra. which is an area of significant parking deficit. does not comprise within its boundaries any municipal land suitable for development into off-street parking. On the other hand. if parking at the curb remains free and in the absence of any serious enforcement of parking regulations. the patronage of paid off-street parking is doubtful. This fact was well demonstrated by the parking surveys. Parking lots in some parking deficient zones were rarely full. while streets around them were packed with illegal or improper on-street parking.

As a result. the emphasis of the BUTP is being reoriented towards on-street parking. The BUTP is now addressing more in depth the organization of on-street parking. Concessions for managing on-street parking can be contracted to the private sector. The investment in off-street parking need not come from public funds. if it is a financially viable business on its own. Especially if the public parking garage is part of commercial development. or if it is not entirely underground.

2.3 Corridor Improvement Program

2.3.1 Corridor Identification

At a road intersection, type of required control varies with the volume of intersecting traffic. On low volume roads a stop sign will be sufficient. As the intersecting volumes increase a traffic signal becomes warranted. The traffic signal separates the conflicting movements in "time". Each traffic direction is given a proportion of green commensurate with its share of the total conflicting traffic. At some major intersections, where two or more multi-lane roadways intersect, traffic volumes may reach a level where, during peak-hours, signalized traffic control will result in excessive stopping delays with a resultant long queues on some or all approaches. Such situations may not be possible to treat solely by geometric improvements nor by improving the sophistication of the signal control. The next option to consider is to separate conflicting movements in "space". One of the directions can be "grade separated", i.e. its traffic will go "over" on an overpass (bridge) or "under" in an underpass (tunnel), while the other movements stay at-grade. This arrangement permits one direction of traffic to negotiate the intersection uninterrupted while other movement will intersect at-grade. The heaviest movement is usually grade-separated, so that the intersecting traffic at grade will be possible to handle by signal control. Grade separation reduces appreciably delays at intersections.

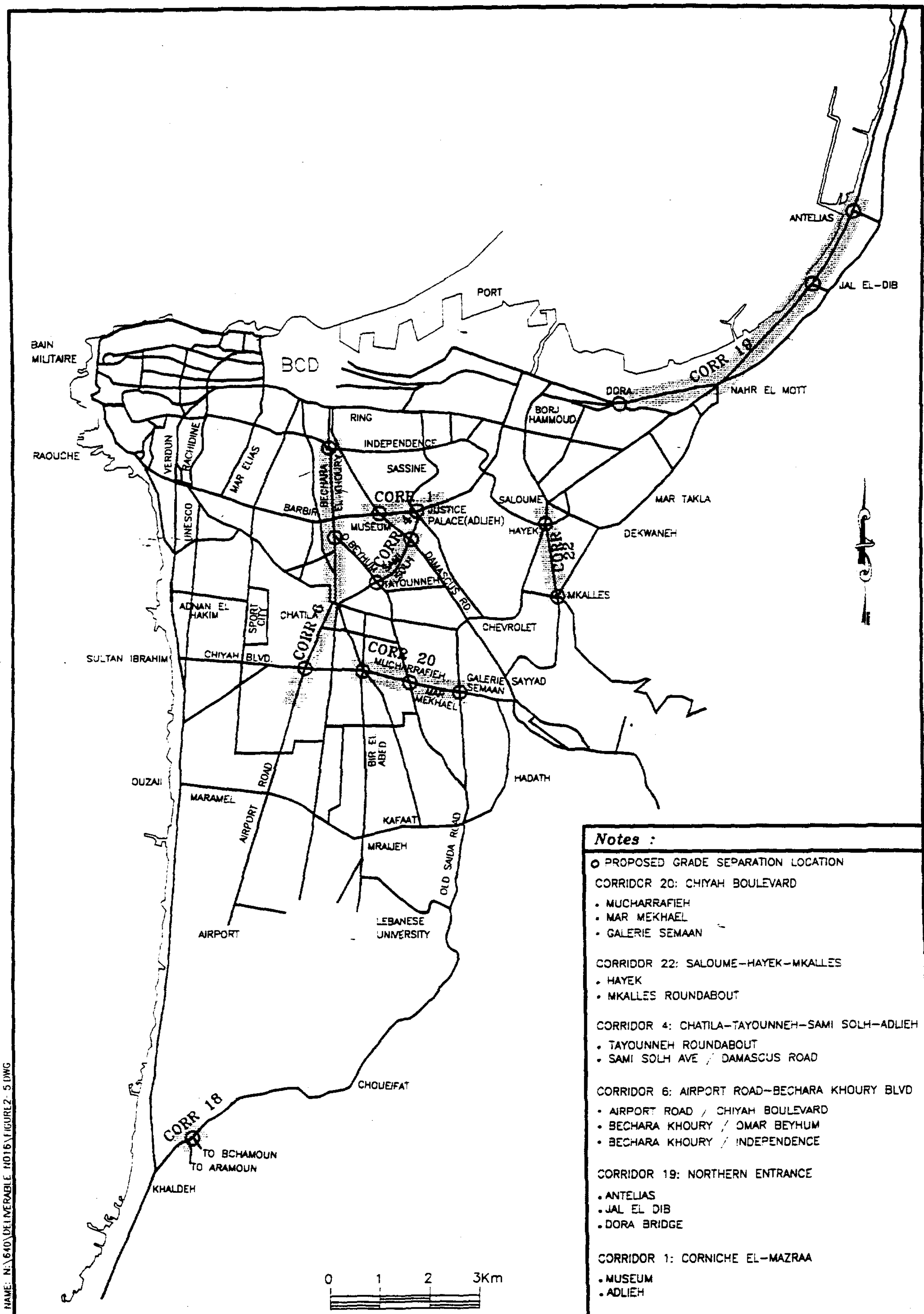
The Immediate Action Plan (IAP) of the GBATP identified some 200 intersections for being signalized. The detailed study of other intersections showed that the volumes at these intersections cannot possibly be serviced by traffic signals, at an acceptable level-of-service. About two dozen such intersections were identified for possible grade separations. During the identification of the grade separation component of the BUTP, it was decided to consider all intersections belonging to a single corridor, in order that the proposed grade separations will result in an improvement along an entire corridor, rather than transfer the bottle-neck from one location to another one downstream. Several such corridors were identified and a number of each corridor's intersections were included in the BUTP. Criteria that were applied to establish whether a grade separation at these intersections is warranted technically and environmentally included:

- Proposed configuration that will minimize traffic congestion and accommodate future demands with improved environmental conditions
- Implementation constraints
- Effects of other planned network additions and/or improvements

Intersections belonging to one corridor (Corniche el-Mazraa) were not included although they are highly congested. The reason to delay considering this specific corridor and its intersections was dictated by the Client (CDR) for the following reasons:

- The need for expensive right-of-way acquisitions
- Difficulty of maintaining traffic during construction, due to lack of paralleling routes.

Based on this process, sixteen junctions located along several main corridors, were identified for consideration by the presently proposed project (Figure 2-6). A brief descriptive summary of the corridors is included in Table 2-5 with the name of junctions considered for a grade separation.



Notes :

○ PROPOSED GRADE SEPARATION LOCATION

CORRIDOR 20: CHIYAH BOULEVARD
- MUCHARRAFIEH
- MAR MEKHAEL
- GALERIE SEMAAN

CORRIDOR 22: SALOUME-HAYEK-MKALLES
- HAYEK
- MKALLES ROUNDABOUT

CORRIDOR 4: CHATILA-TAYOUNNEH-SAMI SOLH-ADLIEH
- TAYOUNNEH ROUNDABOUT
- SAMI SOLH AVE / DAMASCUS ROAD

CORRIDOR 6: AIRPORT ROAD-BECHARA KHOURY BLVD
- AIRPORT ROAD / CHIYAH BOULEVARD
- BECHARA KHOURY / OMAR BEYHUM
- BECHARA KHOURY / INDEPENDENCE

CORRIDOR 19: NORTHERN ENTRANCE
- ANTELIAS
- JAL EL DIB
- DORA BRIDGE

CORRIDOR 1: CORNICHE EL-MAZRAA
- MUSEUM
- ADLIEH

CORRIDOR 18: OLD SAIDA ROAD
- ARAMOUN – BCHAMOUN BIFURCATIONS

FIGURE 2 – 6
LOCATION OF JUNCTIONS CANDIDATE FOR GRADE SEPARATION

Table 2-5: General Description of Corridors Under Consideration

Corridor No. and Name	*CORRIDOR DESCRIPTION*	Junction along corridor considered for grade separation
20 Chiyah Boulevard	Major East-West Corridor to the south of Municipal Beirut. Its Western extremity is its intersection with the coastal road at *Sultan Ibrahim and its* Eastern end is in Hazmieh at Sayyad Junction. This corridor is a divided urban boulevard with a right-of-way varying between 20 and 25 m. allowing at least 2 lanes of traffic each direction plus parking. At sections of which there is intensive retail activity.	• Galerie Semaan • Mar Mekhael • Mucharrafieh
22 Saloume - Hayek - Mkalles	Major corridor *running in an alignment parallel in* general to the proposed Périphérique. It lies at the edge of the plain just before the hills to the East of Greater Beirut. It is a divided urban boulevard providing two lanes at least in each direction plus parking, along its entire length. At Saloume, the junction with Sin el-Fil Blvd. and the roads to Dekwaneh and Nabaa - Borj Hammoud is currently a roundabout, at Hayek which is a multi-leg intersection where roads from Mkalles, Qalaa, Jisr el-Wati, and the road to Dekwaneh meet forming a 5-leg intersection, all are multi-lane boulevards. The corridor goes from Hayek towards Mkalles roundabout, where it forms a 5-leg roundabout when it meets the roads from Qalaa, from Jisr el-Bacha, from Mansourieh, from Tell ez-Zaatar. All intersecting roads are multi-lane divided, except Mansourieh and Tell ez-Zaatar Roads. The delays experienced at this roundabout are excessive. The proposed Périphérique alignment runs very close to the NE. The areas bordering the roundabout are mostly business (commercial and offices).	• Saloume - Hayek • Mkalles
4 Chatila - Tayouneh - Sami el-Solh - Adlieh	This is an East-West corridor running at the Southern limits of Municipal Beirut. It is also a multi-lane divided Boulevard with 3 lanes of traffic each direction. At Chatila, this corridor intersects Airport Road, and at Tayouneh it intersects Old Saida Road. Further East, it intersects Damascus Road and ends at Adlieh Junction where it meets Corniche el-Mazraa. The section between Chatila and Tayouneh is bounded at one side by the Pine Forest and residences on the other side. Sami el-Solh Avenue is a mix of land uses business at the ground level, plus residences *at the upper floors*. The section between Damascus Road and Adlieh does not have a lot of business activities at the ground level. This corridor will be attracting more traffic from two new links: Kafaat - Chatila Road and from the Northern Urban Bypass (Tahwita - Tayouneh).	• Tayyouneh • Damascus Road-Sami el-Solh
6 Airport Road - Bechara el-Khoury Blvd.	Major North-South Corridor which starts at the Airport and ends in the Beirut Central District (BCD). It is a divided boulevard with 3 lanes in each direction along most of its alignment. It runs down the middle of Municipal Beirut. The section of *this Corridor under consideration starts* at its intersection with Chiyah Blvd. (Corridor No. 20). Airport Road goes over a steel bridge overpassing Chiyah Blvd. The at-grade intersection below does not allow left turns from Chiyah Boulevard to Airport Road. The steel overpass is candidate *for replacement with a permanent bridge*. The second major intersection is Chatila (but it is not part of this project) where Airport Road meets Corridor No. 4. Further North, Airport Road meets Omar Beyhum (which is an extension of Old Saida Road) near Corniche el-Mazraa *(a Ring Road that circles* most of Municipal Beirut). At that point, two 6-lane roads meet, forcing North-South traffic through a 5-lane underpass. The next major intersection further North is Bechara el-Khoury with Independence just at the Southern limits of the BCD.	• Airport Road-Chiyah Boulevard • Bechara el-*Khoury*-Omar Beyhum • Bechara el-Khoury-Independence
19 Northern Entrance	The Northern Coastal Highway, runs into Greater Beirut from its Northern Boundary at Nahr el-Kalb through Dbayeh, Antélias, Jal el-Dib, Nahr el-Mott, and continues due West into the direction of Port of Beirut. *It is in the heaviest traveled road in* Lebanon with about 210,000 vpd. At Antélias, it intersects with the road leading to Bikfaya, and at Jal el-Dib is another T-intersection. At both locations, the Northbound traffic is grade separated over a steel bridge to allow turning under it. The *road junction at* Nahr el-Mott is not included in this project. Further West at Dora, an existing 2-lane steel bridge carries Northbound traffic and it is highly congested for an extended period of the day.	• Antélias • Jal el-Dib • Dora
1 Corniche El-Mazraa	This is an important boulevard that circles most of Beirut City. It is a 2 by 3 facility at most of its *alignment*. Many *of its intersections* with radial routes are congested, but are not included in the scope of work. The two junctions under consideration are its intersectiwith the Damascus Road near the Museum, and the Adlieh junction. The latter is a *junction of Corniche el-Mazraa* with Sami Solh and with Tahwita. The North-South traffic from Tahwita goes on a bridge. The intersection at-grade is not currently operating at a good level-of-service.	• Adlieh • Museum
18 *Old Saida Road*	Old Saida Road is a long corridor starting from Khaldeh and due North into the City of Beirut. *It intersects with Chiyah Blvd at Mar Mekhael* (see 2.1). Near Khaldeh two roads T-intersect with it: the Bchamoun and the Aramoun Roads. Traffic at those intersections experience a lot of delay. Many schools and an industrial zone are located in the hills of Bchamoun and residential areas are *mushrooming on the hills*. The proposed Périphérique alignment runs to the East of this corridor and close to this junction.	• Bchamoun-Aramoun

2.3.2 Methodology for Grade Separation Justification

The justification methodology is based on the classical capacity analysis of road junctions. This is a well established methodology where the available proposed geometry and traffic control at a certain junction are evaluated as to their traffic carrying capabilities, and certain operational parameters are estimated that describe quantitatively and qualitatively the manner the junction is expected to operate. Various levels of sophistication are available. At simple isolated junctions, the use of a tool such as HCS (Highway Capacity Software) is usually enough. At more complex configurations, or where several junctions are to be studied simultaneously (if belonging to a common corridor or pertaining to a network), TRANSYT and simulation techniques are utilized to and measures of effectiveness are calculated accordingly.

The key issue for evaluating a junction remains the traffic flows negotiating it. Traffic counts provide the situation at a time cross-section. Historic data could be useful to estimate the traffic growth over a time period. Extrapolation of historic data for estimating future traffic is most likely to be unsatisfactory in a complex urban situation. Network modeling techniques that can provide the expected traffic on each link of the network, under changing conditions of trip generation and distribution and for various scenarios of network evolution are necessary. The flowchart in Figure 2-7 depicts the adopted detailed methodology.

For the study at hand, a traffic forecasting model was developed and calibrated using EMME/2 transportation planning software, in order to assist in forecasting future traffic and in identifying the required transportation improvements for the scenarios under consideration. A detailed account of the modeling effort is reported later in this Report, entitled "Development and Calibration of a Traffic Forecasting Model".

2.3.3 Criteria for Generating Grade Separation Alternatives

Solving the problem of a congested junction via proposing a grade separation is a creative engineering design process. This complicated process involves simultaneous considerations of a multitude of factors and requires multidisciplinary expertise. In brief, criteria that guided the development of alternate design must:

1. Provide an acceptable level of service (LOS) in terms of peak hour average delay per vehicle, in the year 2010.
2. Minimize the requirement of additional right-of-way and avoid as much as possible displacing businesses and residents. Minimization of requirements for involuntary resettlement of residents, relocation of businesses and acquisition of private land.
3. Select the environment-friendly alternatives. In built-up areas underpasses are preferred to overpasses. However, avoidance of archeological and historic sites must be taken into consideration wherever necessary.
4. Important consideration should be given to the relocation requirements of people and existing major utilities.
5. Site characteristics as to topography and drainage are important considerations.
6. Short underpasses are preferred to tunnels that require mechanical ventilation, because of construction, operation and maintenance costs.

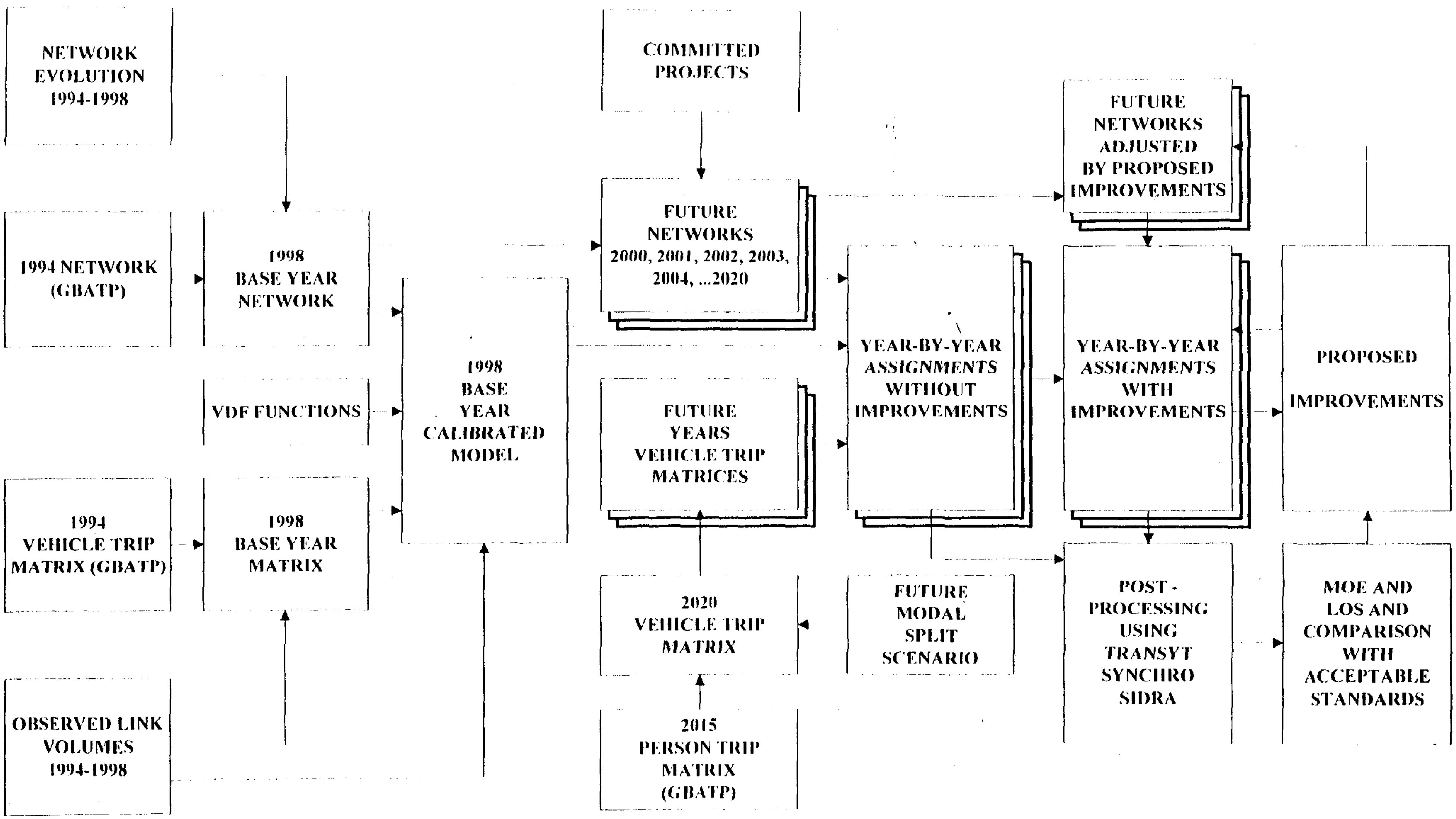


FIGURE 2-7 TRAFFIC MODELLING AND TESTING OF ALTERNATIVES

7. Preserving access to the existing land uses is an important consideration which aims at striking a balance between the interests of through traffic and local traffic, especially in dense urban areas.

8. Maintaining traffic on busy major thoroughfares during construction was a consideration in selecting the configuration of some grade separations.

9. Aesthetics and landscape preservation.

10. Value engineering judgement was exercised to reach the most cost effective design.

Based on these criteria, several design alternatives were considered at intersections proposed for a grade separation. Table 2-6 provides summary of these alternatives. The selected design at each intersection is presented in Table 2-7 alongside with its general characteristics. Note that while several alternatives were generally considered for each intersection, additional alternatives were also examined at many intersections as a direct result of the public consultation process particularly at Jal El-Dib, Antelias, and Hayek.

Table 2-6: Summary of Design Alternatives Considered for Grade Separations

Intersection	Design Alternatives Considered
Galerie Semaan	An underpass was considered as an alternative but was ruled out due to the presence of a large drainage culvert that crosses the intersection. Moreover, the grade in the E-W direction climbs up steeply after leaving the intersection towards Hazmieh, which would have required the underpass to be quite long. A grade separation in the N-S direction instead would require extensive land acquisition and result in cutting many eucalyptus trees lining Camille Chamoun Blvd.
Mar-Mkhael	A grade-separation in the N-S direction instead of one in E-W direction, would require additional right-of-way to the north of the junction, and the area is built. An underpass along the E-W direction was preferred over an overpass, in order not to disturb visually the Mar-Mkhael Church facade.
Mucharrafieh	An underpass at this location was overruled due to major utilities crossing this junction. Moreover, the grade going west is an upgrade, which makes the underpass longer and therefore a more extensive right-of-way acquisition. A grade-separation in the N-S direction does not serve the traffic effectively. The alternative of an overpass on the E-W was adopted.
Saloumeh/Hayek	No traffic management solution would be enough to handle traffic at this busy junction. Over 9 different alternatives were considered involving overpasses and underpasses in various directions. Any grade separation in the direction Saloumeh - Mkalles would become less useful after the Périphérique is put in use. The proposed overpasses connecting Qalaa and Jisr El-Wati to Dekwaneh cannot be made underpasses due to topography, existence of a major culvert at the beginning of Dekwaneh Road (SLAV), and the high probability of disturbing well preserved antiquities be buried under the Hayek – Qalaa area.
Mkalles	Separating the traffic between Mansourieh and Qalaa would allow the roundabout to operate satisfactorily. The direction Hayek - Jisr el-Bacha will be less crowded once the Périphérique is in service. The topography dictates an overpass as proposed.
Tayouneh	Originally, the solution envisioned a 3-level interchange, but traffic studies showed that it is enough to build an N-S underpass, which also can serve the Northern Urban Bypass. An overpass instead of an underpass is possible, but will cause visual intrusion on the neighboring Pine Forest.
Sami El-Solh/Damascus Road	Since traffic management solution failed, the E-W direction permits constructing an underpass within the available right-of-way. Should the traffic on Rue de Damas be made one-way, the grade-separation would not be a priority.
Airport Road / Chiyah Boulevard	A two-level grade-separation would not serve the traffic due to the heavy left turn from EB traffic in the direction of Chatila Interchange. Moreover, the restricted right-of-way between this junction and Ghobeiri precludes any full grade-separation in the E-W direction. A three-level solution was adopted, providing N-S traffic in an underpass, the E-W overpass plus a directional ramp towards Chatila was adopted.
Bechara El - Khoury / Omar Beyhum (Beit El - Atfal)	The site is constrained by the presence of the French Ambassador's Residence, the existing underpass, and the close-by Barbir overpass. Proposing a solution that minimizes disruption to traffic during construction was also important. Alternative underpasses in the E-W direction would require demolishing the existing underpass. Overpasses overlooking the French Ambassador's Residence would not be acceptable. Underpasses along Omar Beyhum Street would complicate local access. The proposed solution provides all movements uninterrupted.
Bechara El-Khoury / Independence Road	Traffic requirements and availability of right-of-way dictate the N-S direction. In such an urban setting near the Statue of Bechara el-Khoury, an underpass was the only option.
Antelias	An N-S underpass was considered as an alternative and was ruled out since the underpass roadway level will be below sea level. An E-W grade separation was also ruled out due to its negative effect on the Maritime Boulevard.
Jal El- Dib	An N-S underpass was considered and ruled out similar to Antelias. Another alternative was considered to maintain northbound and southbound traffic at grade while constructing two ramps 300m apart to provide access in and out of Jal El- Dib. This alternative was ruled out due to its negative effect on the internal roads of Jal El- Dib and also will not allow for future access to Linord from Jal El- Dib.
Dora	The existing 2-lane EB bridge is overcrowded. The proposed 2x3-lane bridge will be built as two separate adjacent structures to allow serving traffic during construction via the existing steel bridge.
Adlieh	Due to the presence of Elias el-Hrawi Bridge, whose design allows for an underpass to be constructed under it, the underpass was the only option. Traffic requirements dictated adding another underpass for the traffic in the direction of Sami el-Solh.
Museum Junction	Right-of-way availability and urban conditions dictate an underpass in E-W direction.
Bchamoun - Aramoun	A traffic management solution is not sufficient. An underpass is not technically feasible, as it would require going under a natural drainage channel. Topography dictates an overpass in the N-S direction.

Table 2-7: General Description of Proposed Grade Separations

Corridor # & Name	Junction	DESCRIPTION	EXISTING OPERATING CONDITIONS	FUTURE CONDITIONS AND PROPOSED IMPROVEMENTS
20 Chiyah Boulevard	Galerie Semaan	The Chiyah Boulevard intersects Camille Chamoun Boulevard at Galerie Semaan. Chiyah Boulevard is a major E-W corridor that connects at Sayyad in Hazmieh with the road leading to Damascus. Camille Chamoun Boulevard connects Old Saida Road with Tahwita at Chevrolet. It is a very busy intersection with heavy truck traffic. The Chiyah Boulevard from Galerie Semaan towards Hazmieh goes on a steep upgrade about 200 m to the East from Galerie Semaan. The available right-of-way of Chiyah Boulevard dictates the grade separation be along it and it carries the heaviest traffic (also to avoid cutting the Eucalyptus trees on Camille Chamoun Boulevard). Because of the topography and major underground utilities (large storm drainage channel) an overpass is much favored to an underpass. With the steep upgrade toward Sayyad, it will be very difficult to bring the underpass traffic back at-grade within a reasonable distance especially if the underpass must go below the existing drainage channel. Figure 5-16 shows the geometry of this junction and the 1998/2010 peak-hour counts at it.	Based on the 1998 traffic count at Galerie Semaan the average delay at this intersection is extremely excessive due in part to the manner it is being operated. If the signal phasing is optimized the average delay drops but it is still excessive. In the latter two cases the level-of-service is very low (worse than F). A grade separation is definitely warranted. Analyzing this same intersection after overpassing the EW WL traffic on Chiyah Boulevard and organizing the at-grade separation as proposed the intersection would operate at a LOS C (24 sec of delay).	Figure 5-16 depicts the year 2010 peak hour traffic projections for the year 2010 base case scenario (i.e. prior to any introduction of grade separations) at Galerie Semaan intersection. Analysis shows that by the year 2010 the intersection is expected to have excessive delays even a lot worse than what is occurring today. A 2x2 overpass in the East-West direction is proposed, since the Eastbound and Westbound traffic volumes are the heaviest. An underpass in lieu of an overpass at this location is not feasible. A large storm water drainage conduit (Oval Section Φ 2m) exists below Camille Chamoun Boulevard at a depth of 2 - 3 m. If an underpass is to be built there it must go below the existing conduit. The grade on Chiyah Boulevard going East toward Sayyad, is an upgrade. Trying to bring the underpass grade to the existing surface grade will be difficult requiring unacceptable steep grades and a rather long distance. Moreover, the extraction and drainage of storm water from the underpass will be costly. Due to these existing conditions an overpass was recommended instead of an underpass. With this proposed overpass, the average peak hour delay per vehicle for at-grade traffic is expected to drop to 127 sec in the year 2010.
	Mar Mekhael	Chiyah Boulevard meets Old Saida Road at Mar Mekhael. Old Saida Road, a North-South arterial that starts from Khaldeh to the South and passes through heavily populated suburbs and connects at Tayouneh with Omar Beyhum Street. The area of the intersection is flat. The South-Western corner is occupied by a gasoline station while at the North-Western corner lies the Mar Mekhael Church and Cemetery. It is proposed to depress traffic along Chiyah Boulevard (which is the heavier direction) so as not to disturb the Church with an overpass. The available ROW on Old Saida Road North of Mar Mekhael makes a grade separation along Old Saida Road impossible without expensive ROW acquisition. Figure 5-17 shows the geometry of this junction and the 1998/2010 peak-hour count at it.	Based on the 1998 traffic count at Mar Mekhael, the average delay is excessive due in great part to the way it is operated. If the signal phasing is optimized the average delay drops to 153 sec. This low level-of service is not acceptable and a grade separation is warranted. The traffic along Chiyah Boulevard is the heaviest and the right-of-way available on it is wider than on Old Saida Road especially to the North of the intersection. An underpass is tentatively proposed at that location in order not to intrude on the Mar Mekhael Church. Such a solution will provide a LOS D (32 sec delay).	Figure 5-17 Shows the year 2010 peak hour traffic projections at Mar Mekhael. Analysis shows that the intersection will operate at a very low level-of-service. A grade separation is warranted on Chiyah Boulevard since it carries the heavier traffic. A 2x2 underpass is proposed in the East-West direction in order not to intrude on Mar Mekhael Church. This solution will bring down the peak hour average delay per vehicle for at-grade traffic to 55 sec.
	Mucharrafieh	Chatila - Kafaat Boulevard added two approaches to this intersection, so it became a 5-leg intersection. The road to Bir el-Abd was made one way South to reduce the number of allowed movements, after adding the Kafaat - Chatila Boulevard. A grade separation along Chiyah Boulevard is the preferred direction because of ROW considerations. A check on existing underground utilities would favor an overpass. Figure 5-18 shows the geometry of this junction and the 1998 peak-hour count at it.	Based on the 1998 traffic count and the manner it is being currently operated the average delay is excessive (LOS worse than F). Improvement of operation at-grade would bring delay to 262 sec. This level-of-service is not acceptable and it warrants a grade separation. The heavier traffic is along Chiyah Boulevard, and the right-of-way is wider on it. A grade separation along ChiyahBoulevard is tentatively recommended. Due to underground utilities an overpass would be proposed. Such a solution will provide a LOS D (40 sec delay).	Figure 5-18 shows the year 2010 peak hour traffic projections at Mucharrafieh junction. Analysis shows that extremely high delays are expected if a grade separation is not provided. Due to heavy traffic along Chiyah Boulevard a 2x2 overpass is proposed in the East-West direction which will bring down the peak hour average delay per vehicle to 89 sec. An underpass in lieu of the overpass is not feasible due to extensive underground utilities at that location.
22 Saloume - Hayek - Mkalles	Saloume - Hayek	These two junctions constituted of Saloume Roundabout and Hayek Junction will be treated as a network, which also includes the circular road going from Hayek towards Dekwaneh Road and Sin el-Fil Blvd. No significant topographic constraints exist except that the road to Qalaa rises quickly as it leaves the Hayek Junction. The proposed solution carries traffic coming from Jisr el-Wati on an overpass that connects with a branch coming from Qalaa and both branches going to the circular road connecting to Dekwaneh and Sin el-Fil Boulevard. This solution was designed keeping in mind the possibility later to depress the N-S traffic from Saloume to Mkalles Roundabout especially if the Peripherique is not constructed. Figure 5-19 shows the geometry of this junction and the 1998 2010 peak-hour count at it.	The highly congested Hayek junction operates at a very low level-of-service, even if the intersection was reorganized. A grade separation is definitely warranted. The proposed and designed grade separation (an overpass taking Eastbound traffic from Jisr el-Wati and another one from Qalaa and both going to the Circular Road toward Dekwaneh while the road from Saloume is made one way towards Hayek). This proposed solution needs to be checked for future traffic under the two conditions of with and without the Périphérique. In the case the Peripherique was not built the traffic from Saloume towards Mkalles might need also to be underpassed at Hayek. The proposed design should allow for this eventuality.	Figure 5-19 shows the year 2010 peak hour traffic projections at Hayek - Saloume junctions. Analysis shows that both intersections, Hayek and Saloume, are expected to operate at level-of-service F by 2010. Hayek is a complicated 5-leg junction. Various possibilities of grade separations were possible to consider. After considering many alternatives, it was decided not to grade separate the traffic between Saloume and Mkalles, as it parallels the proposed Périphérique. When the Périphérique is put in service, the traffic between Saloume and Mkalles will have another alternative to take. Accordingly, an underpass in that direction was excluded. Further analysis indicated that grade separating one direction of traffic will not be sufficient. Accordingly a one-lane overpass is proposed to carry traffic coming from Jisr el-Wati and connects with another two-lane overpass branch carrying traffic from Qalaa and both branches going to the circular road connecting to Dekwaneh and Sin el-Fil Boulevard. The Saloume - Hayek road will be made one-way Southbound, while Hayek - Dekwaneh will be a one-way in the other direction (Northbound) ending at Sin el-Fil Boulevard. This proposed solution is expected to decrease the average delay per vehicle at the Hayek junction to 7 sec and at Saloume to 98 sec by the year 2010. It should be mentioned that this proposal takes into consideration that the Peripherique would be in service by the year 2004. Should the Peripherique not be constructed the design allows still for a tunnel that carries traffic coming from Saloume in the direction of Mkalles Roundabout.

Table 2-7: General Description of Proposed Grade Separations (Cont'd)

Corridor # & Name	Junction	DESCRIPTION	EXISTING OPERATING CONDITIONS	FUTURE CONDITIONS AND PROPOSED IMPROVEMENTS
22 Saloume - Hayek - Mkalles	Mkalles	It is a major junction of five roads that lead to Hayek, Qalaa, Jisr el-Bacha, Mansourieh and to Tell ez-Zaatar. The significant topographic feature is that the road to Mansourieh rises sharply as it leaves the roundabout. The vicinity of the roundabout is relatively flat and it is all built. *The traffic on this roundabout is sensitive to whether the Peripherique is built or not*, because the latter passes to the East of it, underpassing Mansourieh Road at about 130 m from the junction. The traffic in the general direction of the Peripherique is most liable to be affected by the construction of the Periphérique. *But the question of tolling complicates the* issue because the diversion from the existing road system to the Peripherique depends on the tolling system and the toll itself. One possible solution is a 2x2 underpass for the traffic between Hayek and Jisr el-Bacha, *with the possibility of overpassing the traffic between* Qalaa and the Road to Mansourieh, with the other traffic staying at grade. Figure 5-20 shows the geometry of this junction and the 1998/2010 peak-hour count at it.	The roundabout is operating at a very low level-of-service and all geometric changes at-grade with signalization (i.e. transforming the roundabout into a signalized intersection) would not bring the delay down to an acceptable level. Two grade separations were proposed. An underpass 2x2 carries the traffic between Hayek and Jisr el-Bacha and an overpass that connects Mansourieh Road to Qalaa. The other movements are served by an improved signalized intersection at-grade which incorporates a widening of Tell ez-Zaatar Road. With today's traffic the junction would operate at a LOS C (16 sec delay). This proposed solution needs to be checked against future traffic conditions and take into consideration the effect of the Peripherique.	Figure 5-20 depicts the year 2010 peak hour traffic projections at Mkalles Roundabout. Analysis shows that an average delay of 251 sec per vehicle is expected *by the year 2010*. Mkalles Roundabout is a junction where 5 roads are meeting. It is also very close to the proposed Peripherique. The Hayek - Mkalles - Jisr el-Bacha traffic will be partly diverted to the Peripherique when it is in service. This is at present the heaviest traffic direction *but grade* separating will not be warranted in the future when the Peripherique is put in service. Moreover, topography of the area favors overpassing the traffic between Mansourieh Road and Qalaa. When the Peripherique is put into service, this proposed overpass connection would be enough to relieve the congestion at this junction. All other traffic will stay at-grade and use the roundabout. This solution would bring the peak hour average delay per vehicle to only 10 sec by the year 2010. These proposals take into consideration the completion of *the Peripherique by the* year 2004. The proposed bridge layout allows an underpass carrying the traffic from Hayek towards Jisr el-Bacha at a future date, in case the Peripherique project did not materialize.
1 Chatila - Tayouneh - Sami el-Solh - Adlieh	Tayouneh	The Tayouneh Roundabout lies at the intersection of Jamal Abdel Nasser Avenue coming from Chatila *to the West and then becomes* Sami Solh to the East of Tayouneh with the Old Saida Road coming from Mar Mekhael to the South and which is called Omar Beyhum Boulevard to the North of Tayouneh. All the intersecting boulevards are multi-lane divided *with generous right-of-way*. Tayouneh is not currently heavily congested. But the new Kafaat - Chatila Road will bring more traffic to Tayouneh especially if it continues to be with no possibility of channeling its Northbound traffic to Chatila in favor of routing it to Omar Beyhum *through Tayouneh*; *the traffic at Tayouneh* will rise heavily. Moreover the Northern Urban Bypass (Tahwita - Tayouneh) will bring a significant amount of traffic to Tayouneh. The left turns between Northern Urban Bypass and Old Saida Road need to be studied within the context of *Tayouneh, because of its close proximity to it*. A complete traffic analysis of this junction must consider the above stated junctions plus the finally adopted configuration of the Chatila Interc. On the environmental side, this junction borders *the Pine Forest which is being developed* to be a major public garden. The N-S traffic along Omar Beyhum - Old Saida Road is candidate to be channeled in a 2x2 underpass whose SB roadway should extend beyond Northern Urban Bypass junction to allow the left turn from traffic coming from *Tayouneh going East on the Northern* Urban Bypass without conflict with NB coming from Mar Mekhael. Further analysis will be needed to decide whether an overpass is needed to carry the E-W traffic along Jamal Abdel Nasser - Sami Solh axis. Figure 5-21 shows the geometry of this junction *and the 1998 peak-hour count at it*	Based on a traffic assignment of the 1994 calibrated model on an updated network which includes Northern Urban Bypass and the Kafaat - Chatila Road, the Tayouneh Roundabout will not operate satisfactorily. Another test was done with the NS/SN traffic channeled via an underpass and the EW/WE traffic is kept at grade, where the junction is signalized as a pierced roundabout. This solution resulted with a good level of service.	Figure 5-21 shows the year 2010 peak hour traffic projections at Tayouneh Roundabout. Analysis shows that the roundabout is expected to operate at a very low level-of-service by 2010. A 2x2 underpass whose SB *roadway should extend* beyond Northern Urban Bypass to allow the left turn from traffic coming from Tayouneh going East on the Northern Urban Bypass without conflict with NB coming from Mar Mekhael. The NB roadway would extend from South of *Northern Urban Bypass to North of Tayouneh along* Omar Beyhum. With this solution analysis shows that the junction would operate at an acceptable level-of-service (peak hour average delay per vehicle of 56 sec). The analysis also shows that an overpass to carry E-W traffic along Abdel Nasser Avenue/Sami Solh Avenue axis *will not* be warranted by the year 2010. This proposed alternative is compatible with the revised Chatila Interchange design. Although Chatila Interchange is not within our scope, we found it necessary to have another look at it in light of the results of our modeling effort.
	Damascus Road/ Sami el-Solh	Sami Solh Avenue is a divided urban boulevard running in the general E-W direction, it *intersects* Damascus Road which is not more than two traffic lanes. The level of complexity of the intersection depends on whether Damascus Road is a one way or two-way street. No specific topographic constraints exist. There is however ROW restriction on Damascus Road. The warrants for a grade separation depends on further traffic analysis for future conditions discussed later in this report. Figure 5-22 shows the geometry of this junction and the 1998/2010 peak-hour count at it	Based on 1998 traffic counts on Sami Solh Avenue and Damascus Road, the level-of-service at this intersection is very low. Even with optimizing the signal phasing on it, the average delay per vehicle during the peak hour is still 96 sec. *However, if Damascus Road was made* one way as proposed by the Immediate Action Plan, the average delay drops to 35 sec, which is an acceptable LOS and no grade separation would be required	Figure 5-22 shows the year 2010 peak hour traffic projections at the intersection of Damascus Road and Sami Solh Avenue. Analysis shows that the average delay per vehicle is expected to be *over* 500 sec by the year 2010. However, the delay would be only about 46 sec if Damascus Road (Southern leg of the intersection) was changed to one-way Northbound as proposed by the Immediate Action Plan instead of two-way. If Damascus Road stays two-way (Southern leg), a 2x2 underpass is warranted in the E-W direction (Sami Solh Avenue). This solution will bring the average delay per vehicle to 17 sec
6 Airport Road - Bechara el-Khoury Blvd	Airport Road / Chiyah Boulevard	Airport Road is currently undergoing rehabilitation. *Currently N-S and S-N traffic are taken* on a 5-lane steel bridge to overpass Chiyah Boulevard. No topographic or ROW restrictions exist. The question arises to whether Chiyah Boulevard should be given priority. In that case an E-W underpass that keeps through traffic under Ghobeiry intersection *should be* considered because of ROW restrictions at Ghobeiry. But this alternative was excluded by CDR because of the extensive underground utilities in that area. The replacement of the existing steel bridge should be considered. The intersection under it *should allow left turns* from Chiyah Boulevard to Airport Road. Further traffic analysis is required and discussed later in this report to assess whether this junction requires any directional ramps. Figure 5-23 shows the geometry of this junction and the 1998/2010 peak-hour count at it	Since this junction has been operating with the left turns from Chiyah Boulevard to Airport Road blocked, the 1994 model was rerun with those left turns opened. The network was also updated with the Southern Entrance (Cocody Cola). The EW/WE on Chiyah Boulevard *traffic is heavier* than the NS/SN, another observation is the heavy left-turn from EB traffic on Chiyah Boulevard to NB traffic on Airport Road (this is probably a consequence of not continuing the Northern Urban Bypass till Sports City). It should be noted that the assigned *traffic* is much lower than the counted traffic because it assumes Cocody Cola is operational. If the overpass is along Airport Rd (as it is currently), the at-grade intersection under it will not satisfactorily operate due to the heavy left turns. A solution needs to be searched for the *left turns, a jug handle is a possibility* while a direct underground or bridge ramp is another	Figure 5-23 depicts the year 2010 peak hour traffic projections at the Airport Road / Chiyah Boulevard junction. It is to be noted that this intersection does not *currently allow left turns*. These left turns should be allowed in order to make it possible to restrict movements at Ghobeiry Intersection, canceling the crossing of Chiyah Boulevard at this location. This restriction is necessary as ROW constraints at Ghobeiry Intersection preclude other treatments. Analysis shows that by allowing left turns from Chiyah Boulevard to Airport Road the intersection is expected to operate at an unacceptable level of service. Grade separating only one direction of traffic will not be sufficient. For example replacement of the steel bridge by a 2x2 underpass, the average delay per vehicle is expected to be over 500 sec. However, a 2-lane overpass going Eastbound is also proposed. The 2-lane overpass will branch into two, one branch turning left (one lane) and going North to merge with Northbound traffic on Airport Road, while the other branch (two lanes) continuing Eastbound over Airport Road and connecting to Chiyah Boulevard. This solution would bring down the delays to 17 sec by the year 2010. This proposed 3-level interchange is necessary. The underpass must be N-S as there are underground utilities in the E-W direction. Furthermore, it is very essential to provide for the heavy left turn for Eastbound traffic on Chiyah Boulevard into the direction of Chatila

Table 2-7: General Description of Proposed Grade Separations (Cont'd)

Corridor # & Name	Junction	DESCRIPTION	EXISTING OPERATING CONDITIONS	FUTURE CONDITIONS AND PROPOSED IMPROVEMENTS
6 Airport Road Bechara el-Khoury Blvd	Bechara el Khoury Omar Beyhum	This junction lies at the intersection near Corniche el Mazraa of Omar Beyhum with Airport Road which is called Bechara el Khoury to the North of Corniche el-Mazraa. Bechara el-Khoury is a major N-S Boulevard with 3 lanes each direction. But when it crosses Corniche el-Mazraa, North-South traffic is channeled to an underpass with 2 lanes each direction which was built more than 30 years ago. With the traffic that may use Omar Beyhum coming from the Northern Urban Bypass and from Kalaat - Chatila and the traffic from Bechara el-Khoury desiring to go South on Omar Beyhum a traffic conflict is created due to lack of lane balance and the possibility of traffic back-up in the underpass. This junction lies in a sensitive location. It is bounded the West by a big school complex and to the East by the French Ambassador's Residence (Residence dePins) and to the South by the Pine Forest. An overpass that looks the French Ambassador's Residence is unlikely to be tolerated and any expropriation from the French owned property would take a very lengthy procedure (international agreement between Lebanon and France) and CDR would since prefer to avoid. This situation is further complicated by the Barbir Overpass which starts and ends very close to the location of this junction. The preferred solution is probably to have the underpass be along Corniche el-Mazraa. But tearing down the existing underpass may face objections. Figure 5-24 shows the geometry of this junction and the 1998 2010 peak hour count at it	Based on the 1998 counts, the intersection is operating at a very unacceptable level of service. Even with geometric improvements to provide a left turning pocket for traffic coming up from the underpass and desiring to go South on Omar Beyhum, the level-of-service would still be low and the queue risks to back up in the underpass. Several solutions are possible to consider at this location but all depend on the adopted solutions for Tayouneh and Chatila and on the role to be given to each of Omar Beyhum and Airport Road - Bechara el Khoury. The location constraints described above make this junction a difficult one to treat	Figure 5-24 depicts the year 2010 peak hour traffic projections at Bechara el Khoury and Omar Beyhum intersection. Analysis shows that by the year 2010 the intersection would have very high delays unless improvements are proposed. There are many constraints mentioned above that control the choice of a solution for this junction. In addition any solution to be proposed should be possible to construct without disrupting traffic on the intersecting two major arterials Airport Road - Bechara el-Khoury, Corniche el Mazraa. Taking all these constraints into consideration, a proposed design was formulated. The existing underpass which carries N-S S-N traffic below Corniche el-Mazraa is a 2x2 structure, 2 lanes per direction. It is proposed to use it to carry Northbound traffic only on its 4 lanes and to construct adjacent to it, to its west, another underpass which carries the Southbound traffic. In addition an underpass along Airport Road to the South of the junction will provide for the turns from Bechara el-Khoury Southbound to Omar Beyhum without conflict. This solution will limit the required additional right-of-way to be acquired from two vacant lots and will affect only one old building at the N-W corner of the intersection of Corniche el-Mazraa and Bechara el-Khoury. The proposed solution will provide an interchange without any conflicting movements
	Bechara el-Khoury Independence	The intersection of Bechara el-Khoury, a major N-S corridor with Independence a major E-W corridor, is complicated by Omar Ibn el-Khattab road that carries Southbound traffic from the same junction. Bechara el-Khoury starts on a down-grade Just to the North of the intersection which favors underpassing it. Bechara el-Khoury to the South of the intersection is constrained by high rise new buildings along its Western side and by a Mosque to its Eastern side. Minor expropriations may be required but no buildings will be affected. Further traffic analysis will confirm whether an underpass along Bechara el-Khoury will provide a solution which is valid through 2015, without another E-W grade separation (3rd level). Figure 5-25 shows the geometry of this junction and the 1998/2010 peak-hour count at it	Based on the 1998 traffic counts, the level of service will be extremely low at this intersection. In order to reach an acceptable LOS without a grade separation it was necessary to prohibit left turns from Independence to Bechara el-Khoury and to create an intersection at Damascus Road - Bechara Khoury to the North of Independence which make this alternative operationally doubtful for the future. If a 2x2 underpass is introduced along Bechara el-Khoury, the at-grade signalized intersection would operate at a level-of-service C	Figure 5-25 shows the year 2010 peak hour traffic projections at the intersection of Bechara el-Khoury and Independence Avenue. Analysis shows that an average delay of over 600 sec is expected by 2010. A 2x2 underpass along Bechara el Khoury is expected to bring down the average delay of traffic in the peak hour at the at-grade signalized intersection to 30 sec
19 Northern Entrance	Antelias		Pending more information on the design of Antelias Toll Plaza and the Boulevard Maritime at that location, the treatment at that location cannot be concluded. Removing the steel bridge thus leaving all Northbound traffic at grade may provide a better capacity for through traffic (3 full-size lanes rather than 9.0m overpass), while providing an overpass for traffic coming from Antelias over the coastal highway and dumping it on the Boulevard Maritime requires studying how to serve the traffic wishing to join the Autostrade Southbound. Another issue is the available right-of-way at Antelias near the Armenian Church, and whether this overpass can be a two-way overpass. The LOS at Antelias for the bridge through traffic is F and for the turning movements at grade is also F	Figure 5-26 shows the year 2010 peak hour traffic projections at the junction of Antelias Road and Northern Coastal Highway. Analysis shows that a delay of over 100 sec per vehicle is expected to occur by 2010 and the existing steel bridge would operate at LOS 'F'. However, the proposed solution would have the Northbound traffic at-grade while constructing a two-lane directional ramp for traffic coming from Antelias and going over the coastal highway then merging with the traffic traveling Southbound along Northern Coastal Highway. While traffic traveling Southbound and coming from Dbayeh would use the proposed Naccache interchange to access the Antelias area. With this proposal the junction would be operating without conflicting movements and the heavy Northbound traffic will have full-size lanes to accommodate it
	Jal el-Dib		A similar situation occurs at Jal el-Dib but less complicated since no toll plaza is planned there. But the entrance for Northbound traffic to Jal el-Dib might have to be channeled via a side road which is to the North of the main road to Jal el-Dib. The LOS at Jal el-Dib for the through traffic over the bridge is F and for the turning movements at grade is also F	Figure 5-27 shows the year 2010 peak hour traffic projections at the junction of Jal el-Dib Road and Northern Coastal Highway. Analysis shows delays are expected to be extremely high by 2010. The LOS of the existing bridge is expected to be F. A similar solution to the one proposed at Antelias would have the Northbound traffic at-grade while constructing a one-lane ramps for traffic coming from Jal el Dib Road going South or coming from Antelias on the Autostrade and desiring to go East. It is proposed to provide these two movements separately on two adjacent roads, one is the Jal el-Dib Road itself and the other is an adjacent parallel road. This proposal would have the junction operating without conflicting movements and the through traffic would stay at grade and use full size lanes
	Dora		CDR wishes to confirm whether the design of Dar El Handasah for the Dora Bridge will accommodate the projected traffic (i.e. is a 5 lane bridge sufficient or a 6-lane bridge is required). The LOS for the through traffic over the existing two lane bridge is currently F	Figure 5-28 shows the year 2010 peak hour traffic projections at Dora Roundabout. Analysis shows that the at-grade intersection would be operating at very low LOS with the existing two-lane steel bridge (Eastbound) it is expected to operate at LOS F. The proposed solution calls for bringing down the one-way two-lane steel bridge and replacing it with a 2x3 permanent overpass and have the at grade movements operate as a roundabout. With this solution the level-of-service of the 2x3 overpass is expected to be E or better by the year 2010 while the at-grade intersection would be operating as a roundabout with very few conflictingmovements

Table 2-7: General Description of Proposed Grade Separations (Cont'd)

Corridor # & Name	Junction	*DESCRIPTION*	*EXISTING OPERATING CONDITIONS*	*FUTURE CONDITIONS AND PROPOSED IMPROVEMENTS*
1 Corniche El-Mazraa	Adlieh	At Adlieh Junction *three major roads meet Corniche el Mazraa* with Sami el-Solh and Tahwita Currently an overpass carries the traffic from Alfred Naccache to Tahwita and vice versa The other movements are served at grade not all movements are provided Figure 5-29 shows the geometry of this junction and the 1998 2010 peak hour count at it	The peak hour average vehicle delay of 1998 traffic at the Adlieh junction is 385 seconds Even with a 2x2 underpass carrying the traffic of Corniche el-Nahr, this intersection would still operate at a level of service F (50 sec average delay) There is a heavy movement between Sami el-Solh and Corniche el-Nahr Other grade separation options need to be considered for future years traffic analysis	Figure 5-29 depicts the year 2010 peak hour traffic projections at Adlieh junction Analysis shows very high delays per vehicle are expected by 2010 *The proposed solution would be to* construct a 2x2 underpass along Corniche el-Mazraa and a one-way single lane underpass from Sami Solh Avenue to Corniche el-Mazraa going Eastbound and meeting with the two-lane *underpass* coming from Museum into a 3-lane roadway due East This proposed solution is feasible and does not interfere with the foundations of the existing President Elias el-Hrawi Bridge At the same time all movements at-grade would be permitted and junction would operate as a roundabout This solution would bring peak hour average delay per vehicle to 71 sec in year 2010
	Museum	The intersection of Corniche el-Mazraa with Damascus Road is not a very congested intersection currently TEAM International proposed an at-grade design for the Immediate Action Plan (IAP) which needs to be carefully checked The proximity to the Museum is an important constraint An overpass is excluded (i e if a grade separation proves warranted) Another constraint is the November 22 Military Parade that takes place annually at that *location Figure 5-30 shows the geometry* of this junction and the 1998 2010 peak hour count at it	Analyzing the traffic counted in 1998 and with an optimization of signal phasing, as proposed by the IAP the average delay is 47 sec This provides an acceptable LOS and no grade separation is warranted now	Figure 5-30 shows the year 2010 peak hour traffic projections at the intersection of Abdallah Yafi Avenue and Damascus Road (Museum) Analysis shows extremely high delays at this intersection by the year 2010 and even by 2005 (3720 and 2150 sec respectively) with the EW/WE traffic volumes are being the heaviest, a 2x2 underpass is proposed in the E-W direction and prohibiting Eastbound left turns in order to have a double right to get to Damascus Road Northbound It should be noted that the available right-of-way on Abdallah el-Yafi is less than significant for a 2x2 *underpass* of 3 5 *m lanes plus one ramp on* each side, 5 5 m each, plus adequate sidewalks The existing monument for the Unknown Soldier will not be touched but the garden in which it is placed will be It is proposed during final design to consider reducing slightly the main-line and ramp widths (i e 3 2 m lanes on main-line and 5 2 m ramps) With this proposed solution the average delay per vehicle is expected to be 45 sec by the year *2010 It* should be mentioned that traffic direction on Hotel Dieu Street has to be changed from one-way inbound to one-way outbound of the intersection This complies with proposals made in the Immediate Action Plan
18 Old Saida Road	Behamoun/ Aramoun	The two T-intersections of Behamoun and Aramoun Roads with Old Saida Road are very congested No physical constraints exist except the presence of a natural water course, which precludes an underpass at this location *The proposed Peripherique alignment* provides a connection with Behamoun Road The construction of the Peripherique will not significantly reduce the problem at that location because most of the traffic from and to Behamoun and *Aramoun* is origined and destined in Western Beirut and the Peripherique has no value in serving it Figure 5-31 shows the geometry of this junction and the 1998 2010 peak hour count at it	Based on 1998 traffic counts, an analysis of Behamoun and Aramoun intersection with old Saida Road shows that the average delay at both Aramoun and Behamoun intersections is 182 sec This is a very low level-of-service If additional right-of-way is expropriated to provide the required number of lanes at the approaches and the required queue storage, the intersection can operate at an acceptable LOS under coordinated signal control If future traffic shows that a grade separation is warranted it is proposed to carry NB traffic on Old Saida Road on a 2 lane overpass Turning movements will occur on a *signalized* intersection at-grade under the same controller	Figure 5-31 depicts the year 2010 peak hour traffic projections at the Behamoun - Aramoun Roads and Old Saida Road Analysis shows an expected average delay per vehicle of over 900 sec by the year 2010 A proposed solution of a 2-lane one-way overpass going Northbound on Old Saida Road would have the at-grade *signalized* intersection operating at an acceptable LOS with an expected delay of 44 sec by 2010

2.4 Description of Proposed Grade Separations by Corridor

2.4.1 Corridor No. 20: Chiyah Boulevard

It is a major East-West Corridor just to the south of Municipal Beirut. Its Western extremity is its intersection with the coastal road at Sultan Ibrahim and its Eastern end is in Hazmieh at Sayyad Junction. The major junctions on it from East to West are its intersections with:

- Galerie Semaan
- Mar Mekhael
- Mucharrafieh
- Ghobeiry
- Airport Road
- President Assad Boulevard.

The junctions being considered for grade separations are the bolded ones. Airport Road junction lies on another corridor and is dealt with separately. at Ghobeiry there is a restricted right-of-way situation which will render any solution very difficult.

This corridor is a divided urban boulevard with a right-of-way varying between 20 and 25 m. allowing at least 2 lanes of traffic each direction plus parking. At sections of which there is intensive retail activity.

2.4.1.1 Galerie Semaan Intersection

Description

Chiyah Boulevard intersects Camille Chamoun Boulevard at Galerie Semaan. Chiyah Boulevard is a major E-W corridor that connects at Sayyad in Hazmieh with the road leading to Damascus. while Camille Chamoun a N-S boulevard connects Old Saida Road with Tahwita at Chevrolet. It is a very busy intersection with heavy truck traffic.

The Chiyah Boulevard from Galerie Semaan towards Hazmieh goes on a steep upgrade. about 200 m to the East from Galerie Semaan.

The available right-of-way of Chiyah Boulevard favors the grade separation be along it. and it carries the heaviest traffic. Camille Chamoun Boulevard is less wide and is lined by Eucalyptus trees. that will be cut in case it is widened.

Because of the topography and major underground utilities (large storm drainage channel). an overpass is much favored to an underpass. With the steep upgrade toward Sayyad. it will be very difficult to bring the underpass traffic back to grade within a reasonable distance. especially if the underpass must go below the existing drainage channel.

Existing Operating Conditions

Based on 1998 counted traffic at Galerie Semaan. the average delay at this intersection. based on the manner it is being operated by policemen is extremely excessive. If the signal phasing is optimized the average delay drops. but it is still excessive. In the latter two cases. the level-of-service is very low (worse than F). A grade separation is definitely warranted.

Analyzing this same intersection after overpassing the EW/WE traffic on Chiyah Boulevard. and organizing the at-grade separation as proposed. the intersection would operate at a LOS C (24 sec. of delay) in 1998.

Future Conditions and Proposed Improvements

Analysis shows that by the year 2010. the intersection is expected also to hexcessive delays. a lot worse than what is occurring today. A 2x2 overpass in the East-West direction is proposed. since the Eastbound and Westbound traffic volumes are the heaviest. An underpass in lieu of an overpass at this location is not feasible. A large storm water drainage conduit (Oval Section Φ 2m) exists below Camille Chamoun Boulevard at a depth of 2 - 3 m. If an underpass is to be built there. it must go below the existing conduit. The grade on Chiyah Boulevard going East toward Sayyad. is an upgrade. Trying to bring the underpass grade to the existing surface grade will be difficult. requiring unacceptable steep grades and a rather long distance. Moreover. the extraction and drainage of storm water from the underpass will be costly. Due to these existing conditions an overpass was recommended instead of an underpass. With this proposed overpass. the average peak hour delay per vehicle for at-grade traffic is expected to drop to 130 sec. in the year 2010. Plans and profiles of the proposed design are shown in Figure 2-8.

Description of Proposed Grade Separation Structure

The proposed overpass consists of dual bridges. with 10 cm gap between them. carrying Chiyah Blvd. traffic over the Camille Chamoun Blvd. The bridge has 188 m. 5-span continuous superstructure with 3-40 m center spans and 2-34 m end spans. The overall deck width of each bridge is 7.50 m. with a clear roadway width of 6.80 m representing two 3.40 m traffic lanes. The superstructure is composed of 1.75 m deep pre-stressed concrete one-cell box type girder. with inclined webs. The box has a 1.60 m cantilevering arms. with tapered thickness. on each side. The bridge substructure units are of concrete and are founded on 1.20 m diameter drilled concrete piles. The piers are single round type concrete piers. The abutments are cantilever-type abutments. Each side of the abutments has 75 m long retaining walls that extend along the marginal roads adjacent to the bridge. Vertical striations finish is formed on the exposed faces of the abutments and retaining walls.

2.4.1.2 Mar Mekhael

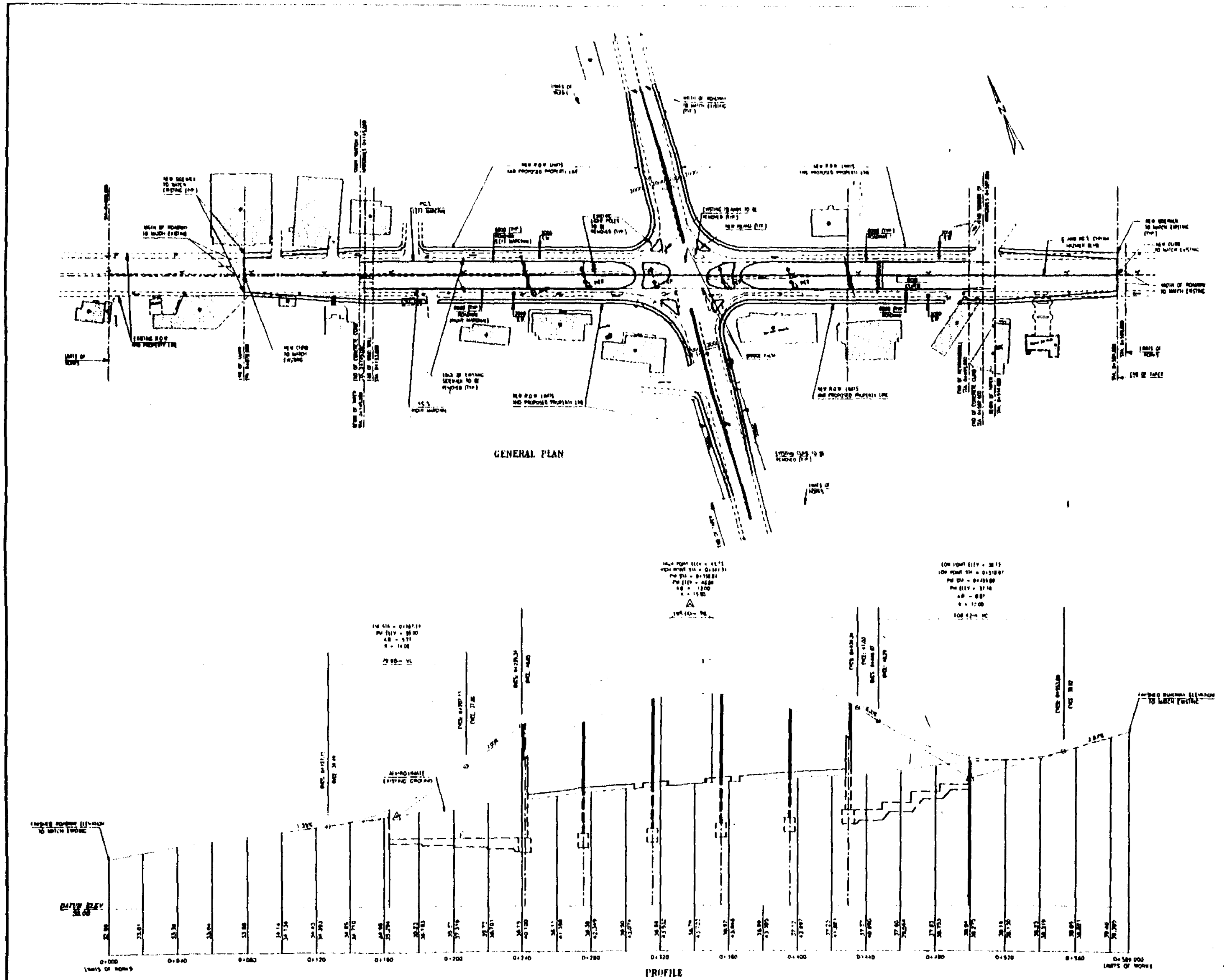
Description

Chiyah Boulevard meets Old Saida Road at Mar Mekhael. Old Saida Road. a North-South arterial starts from Khaldeh to the South and passes through heavily populated suburbs and connects at Tayouneh with Omar Beyhum Street.

The area of the intersection is flat. The South-Western corner is occupied by a gasoline station while at the North-Western corner lies the Mar Mekhael Church and Cemetery. It is proposed to depress traffic along Chiyah Boulevard (which is the heavier direction) so as not to disturb the Church with an overpass. The available ROW on Old Saida Road. North of Mar Mekhael. makes a grade separation along Old Saida Road impossible without extensive ROW acquisition.

Existing Operating Conditions

Based on 1998 counted traffic at Mar Mekhael. the observed average delay based on the manner it is operated is excessive. If the signal phasing is optimized. the average delay drops to 153 sec. This low level-of-service is not acceptable and a grade separation is warranted. The traffic along Chiyah Boulevard is the heaviest. and the right-of-way available on it is wider than on Old Saida Road. especially to the North of the intersection. An underpass is proposed at that location. in order not to intrude on the Mar Mekhael Church. Such a solution would provide a LOS D (32 sec. delay) in 1998.



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Future Conditions and Proposed Improvements

Analysis shows that by the year 2010 the intersection will also operate at a very low level-of-service. A grade separation is warranted on Chiyah Boulevard, since it carries the heavier traffic. A 2x2 underpass is proposed in the East-West direction. This solution will bring down the peak hour average delay per vehicle for at-grade traffic to 27 sec. Plans and profiles of the proposed underpass are shown in Figure 2-9.

Description of Proposed Grade Separation Structure

The proposed underpass is a 2-cell cut and cover tunnel carrying Chiyah Blvd. traffic under Old Saida Road. The overall length of the underpass is 343 m of which 111 m is covered section under the intersection. The covered section consists of two cells separated by a 0.50 m concrete wall. The clear width of each cell is 8.35 m with a roadway width of 7.50 m measured from face-to-face of curb. The minimum clear height of the cell is 5.0 m. From each side of the tunnel portals, open sections extend approximately 115 m long forming the ramps of the tunnel. The clear width of the open sections is 17.20 m measured face-to-face of retaining walls representing 2-7.50 m roadway widths in each direction separated by a 1.0 m median barrier and a 0.60 m curb on the right side of the roadway. The retaining walls of the open sections support the marginal roads adjacent to the tunnel ramps. Exposed faces of the retaining walls are formed with vertical striation type finish.

2.4.1.3 Mucharrafieh

Description

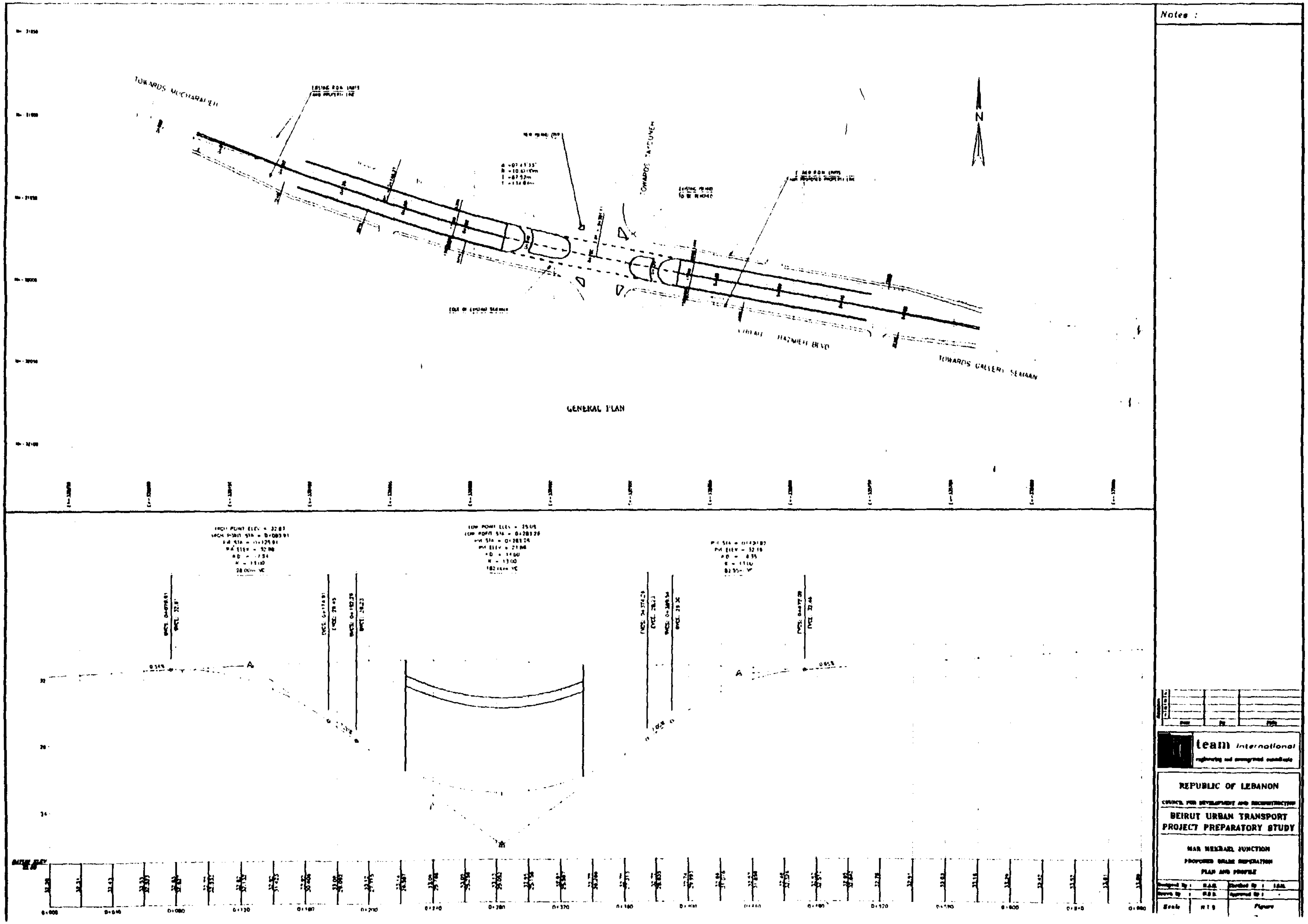
Chatila - Kafaat Boulevard added two approaches to this intersection, so it became a 5-leg intersection. The road to Bir el-Abd was made one way South to reduce the number of allowed movements, after adding the Kafaat - Chatila Boulevard. A grade separation along Chiyah Boulevard is the preferred direction because of ROW considerations. A check on existing underground utilities favors an overpass.

Existing Operating Conditions

Based on 1998 traffic counts and the manner it is being currently operated, the average delay is excessive (LOS worse than F). Improvement of at-grade operation would bring delay to 262 sec. This level-of-service is not acceptable and it warrants a grade separation. The heavier traffic is along Chiyah Boulevard, and the right-of-way is wider on it. A grade separation along Chiyah Boulevard is recommended. Due to underground utilities, an overpass would be proposed. Such a solution would provide a LOS D (40 sec. delay).

Future Conditions and Proposed Improvements

Analysis shows that extremely high delays are expected if a grade separation is not provided. Due to heavy traffic along Chiyah Boulevard, a 2x2 overpass is proposed in the East-West direction which will bring down the peak hours average delay per vehicle to 67 sec. An underpass in lieu of the overpass is not feasible due to extensive underground utilities at that location. Plans and profiles of the proposed overpass are shown in Figure 2-10.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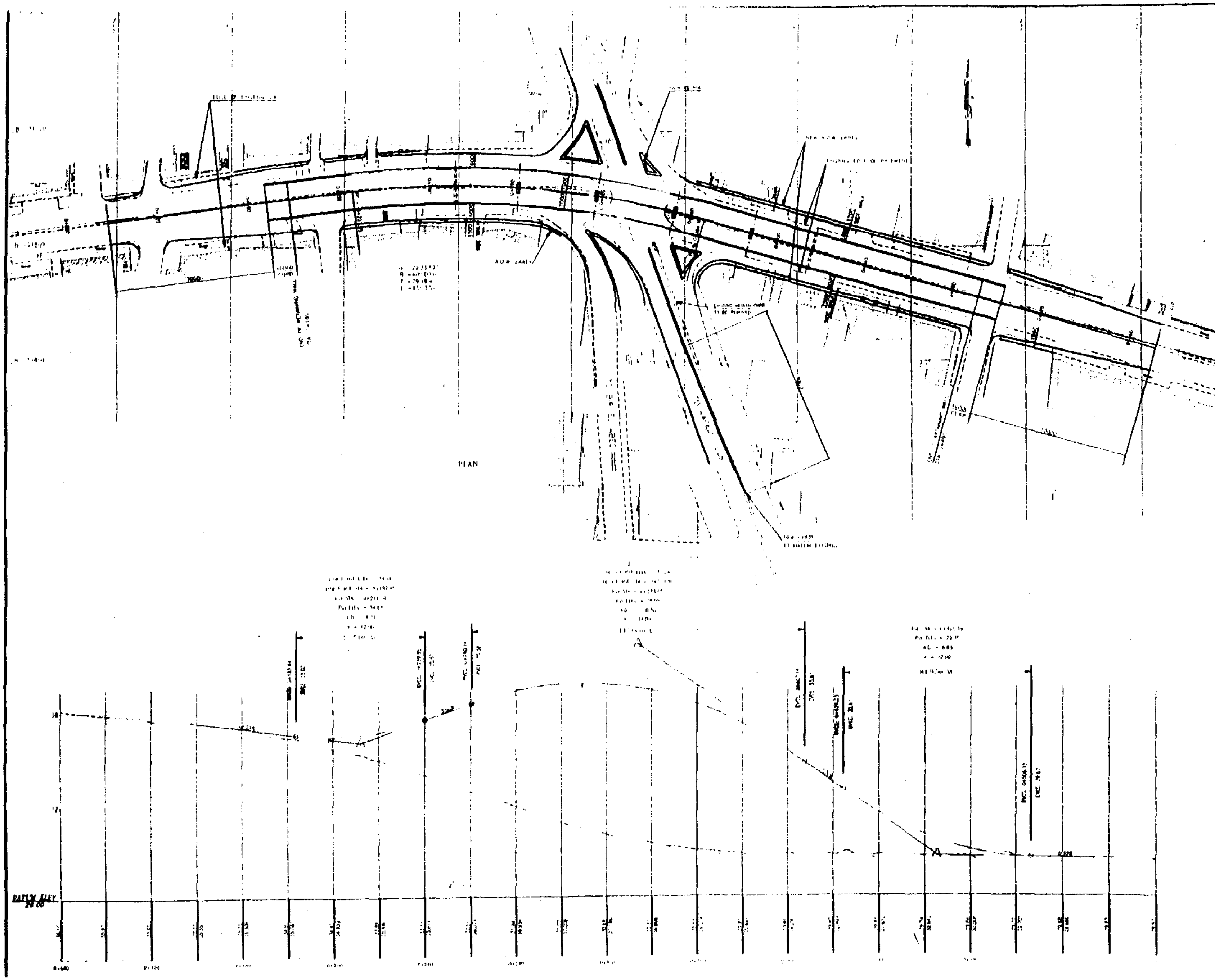

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BEIRUT URBAN TRANSPORT
PROJECT PREPARATORY STUDY

MUCHARRAFIEH JUNCTION

PROPOSED GRADE SEPERATION
PLAN AND PROFILE

Designed By :	N.A.B.	Checked By :	...
Drawn By :	...	Approved By :	
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Description of Proposed Grade Separation Structure

The Mucharrafieh bridge has a 161m. 5-span continuous superstructure carrying Chiyah Blvd. traffic over the Chatila-Kafaat Blvd. The bridge is composed of 3-35m center spans and 2-28m end spans. The overall width of the superstructure is 15.40 m carrying 4-3.50 m traffic lanes. 2 lanes for each eastbound and westbound traffic separated by a 0.50 m Jersey type median barrier. The bridge superstructure is a 1.60 m deep pre-stressed concrete. 3-cell box type girder with 3.0 m cantilevering arms on each side of the box. The substructure consists of four. concrete rigid frame type piers. Trapezoidal shaped piers with vertical striations on the exposed faces were formed to give an aesthetic look. The two concrete abutments are cantilever-type with approximately 70 m retaining walls extending on each side. Vertical striations type finish is formed on the exposed faces of abutments and wing walls. All piers and abutments are founded on cast-in-place drilled concrete piles.

2.4.2 Corridor No. 22: Saloume - Hayek - Mkalles

It is a major corridor running in an alignment parallel in general to the proposed Périphérique. It lies at the edge of the plain just before the hills to the East of Greater Beirut. It is a divided urban boulevard providing two lanes at least in each direction plus parking. along its entire length.

At Saloume. the junction with Sin el-Fil Blvd. and the roads to Dekwaneh and Nabaa - Borj Hammoud is currently a roundabout. at Hayek it is a multi-leg intersection where roads from Mkalles. Qalaa. Jisr el-Wati. and the road to Dekwaneh meet forming a 5-leg intersection. all are multi-lane boulevards.

The corridor goes from Hayek towards Mkalles roundabout. where iforms a 5-leg roundabout when it meets the roads from Qalaa. Jisr el-Bacha. Mansourieh. and Dekwaneh. All intersecting roads are multi-lane divided. except roads to Mansourieh and Dekwaneh. The delays experienced at this roundabout are excessive. The proposed Périphérique alignment runs very close to the NE. The areas bordering the roundabout are mostly business (commercial + offices).

The Saloume - Hayek is treated as one unit.

2.4.2.1 Saloume - Hayek

Description

These two junctions constituted of Saloume Roundabout and Hayek Junction will be treated as a network. which also includes the circular road going from Hayek towards Dekwaneh Road and Sin el-Fil Blvd.

No significant topographic constraints exist. except that the road to Qalaa rises quickly as it leaves the Hayek Junction. The proposed solution was selected after considering several alternatives. The proposed solution carries traffic coming from Jisr el-Wati on an overpass that connects with a branch coming from Qalaa and both branches lead to the circular road connecting to Dekwaneh and Sin el-Fil Boulevard. This solution was designed. keeping in mind the possibility later to depress the N-S traffic from Saloume to Mkalles Roundabout. especially if the Périphérique is not constructed.

Existing Operating Conditions

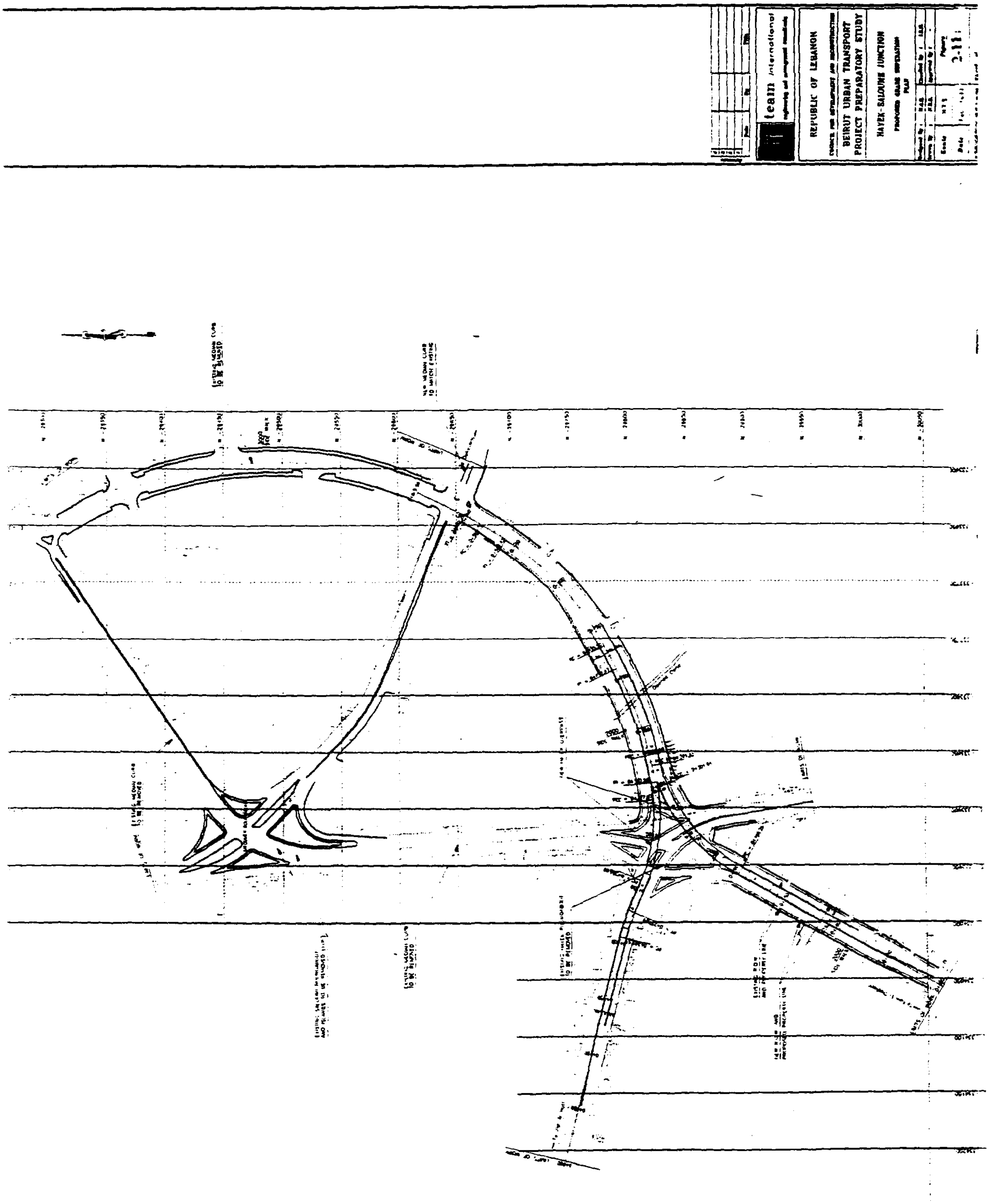
This highly congested Hayek junction operates at a very low level-of-service. even if the intersection was reorganized. A grade separation is definitely warranted. The proposed solution is a grade separation (an overpass taking Eastbound traffic from Jisr el-Wati and another one from Qalaa and both going to the Circular Road toward Dekwaneh) plus making the road from Saloume towards Hayek one way.

Future Conditions and Proposed Improvements

Analysis shows that both intersections. Hayek and Saloume. are expected to operate at level-of-service F by 2010. Hayek is a complicated 5-leg junction. Various possibilities of grade separations were possible to consider. After considering many alternatives. it was decided not to grade separate the traffic between Saloume and Mkalles. as it parallels the proposed Périphérique. When the Périphérique is put in service. the traffic between Saloume and Mkalles will have another alternative to take. Accordingly. an underpass in that direction was excluded. Further analysis indicated that grade separating one direction of traffic will not be sufficient. Accordingly. a one-lane overpass is proposed. to carry traffic coming from Jisr el-Wati. and connects with another two-lane overpass branch carrying traffic from Qalaa. and both branches go to the circular road connecting to Dekwaneh and Sin el-Fil Boulevard. The Saloume - Hayek road will be made one-way Southbound: while Hayek - Dekwaneh will be a one-way in the other direction (Northbound) ending at Sin el-Fil Boulevard. This proposed solution is expected to decrease the average delay per vehicle at the Hayek junction to 7 sec. and at Saloume to 98 sec by the year 2010. It should be mentioned that this proposal takes into consideration that the Périphérique would be in service by the year 2004. Should the Périphérique not be constructed. the design allows still for a tunnel that carries traffic coming from Saloume in the direction of Mkalles Roundabout. Plans and profiles of the proposed grade separations are shown in Figures 2-11 and 2-12.

Description of Proposed Grade Separation Structure

The overpass over the Hayek Roundabout consists of a two-lane bridge carrying traffic from Qalaa and connecting with another one-lane bridge carrying traffic from Jisr El-Wati and both forming a three-lane bridge towards Dekwaneh. The total length of the Qalaa bridge is 130 m in 7 continuos spans. The overall width of the bridge deck is 7.80 m with a clear roadway width of 7.0 m. representing 2-3.50 m traffic lanes. and 2-0.40 m curbs one at each side. The total length of the Jisr El-Wati bridge is 124 m in 6 continuous spans. The overall width of the bridge deck is 5.80 m with a clear roadway width of 5.0 m. representing one traffic lane. and 2-0.40 m curbs one at each side. The combined bridge is 58 m long in 3 continuous spans. The overall width of the bridge varies from 12.80 m to 11.30 m. representing 3-3.50 m traffic lanes and 2-0.40 m curbs one at each side. The superstructure of the three bridges is composed of a pre-stressed concrete solid slab with a depth varying from 0.90 m to 0.25 m at ends. The substructure units are all of concrete. The piers are single octagonal shape columns founded on shallow foundations for both Qalaa and Jisr El-Wati bridges and a rigid frame type founded on drilled concrete piles for the combined bridge. The abutments are cantilever-type with wing walls extending from each side along the marginal roads adjacent to the bridge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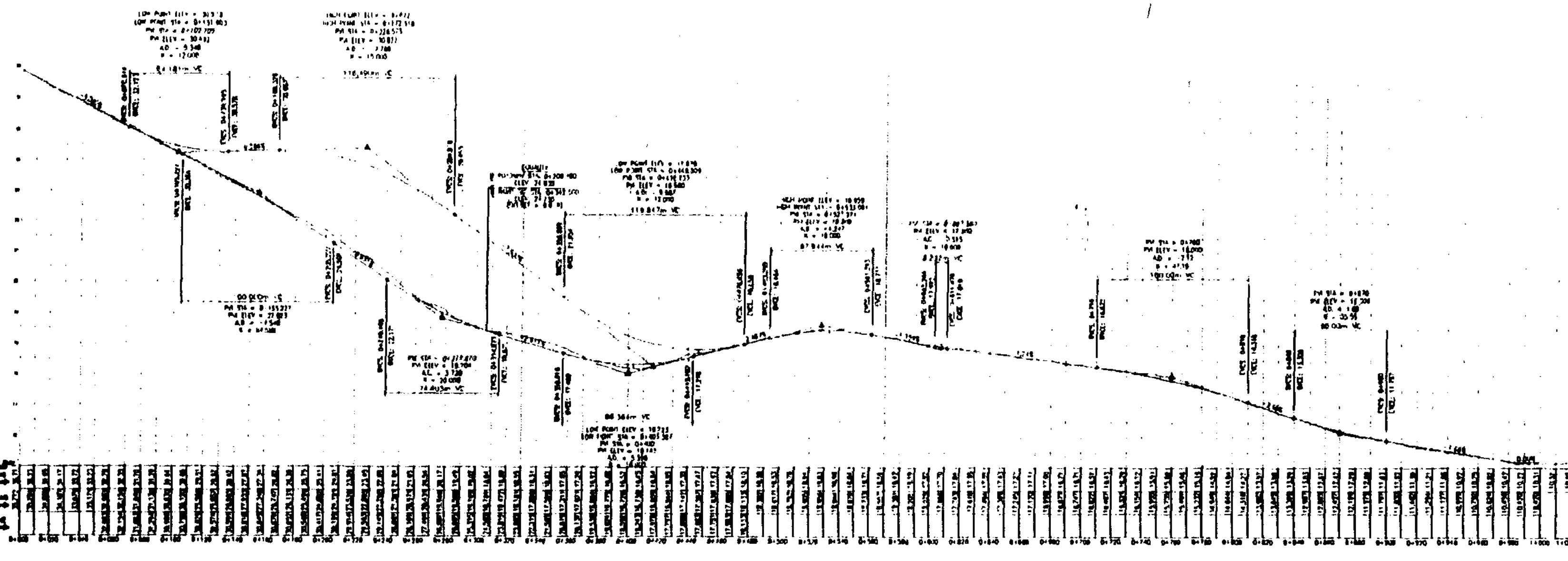
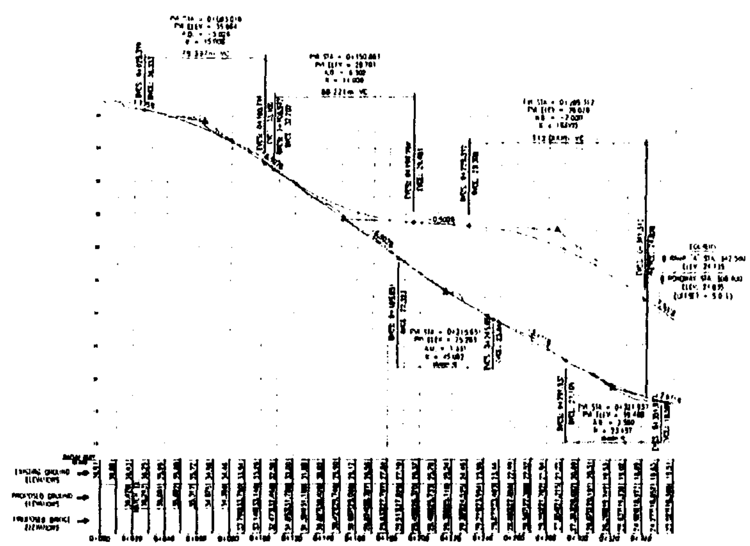


BASE LINE ROADWAY PROFILE



BASE LINE RAMP "A" PROFILE

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HAYEK-SALOUME JUNCTION

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embankment. Vertical striations type finish is formed on the exposed faces of the abutments and wing walls.

2.4.2.2 Mkalles Roundabout

Description

It is a major junction of five roads that lead to Hayek. Qalaa. Jisr el-Bacha. Mansourieh. and to Dekwaneh. The significant topographic feature is that the road to Mansourieh rises sharply as it leaves the roundabout. The vicinity of the roundabout is relatively flat and it is all built.

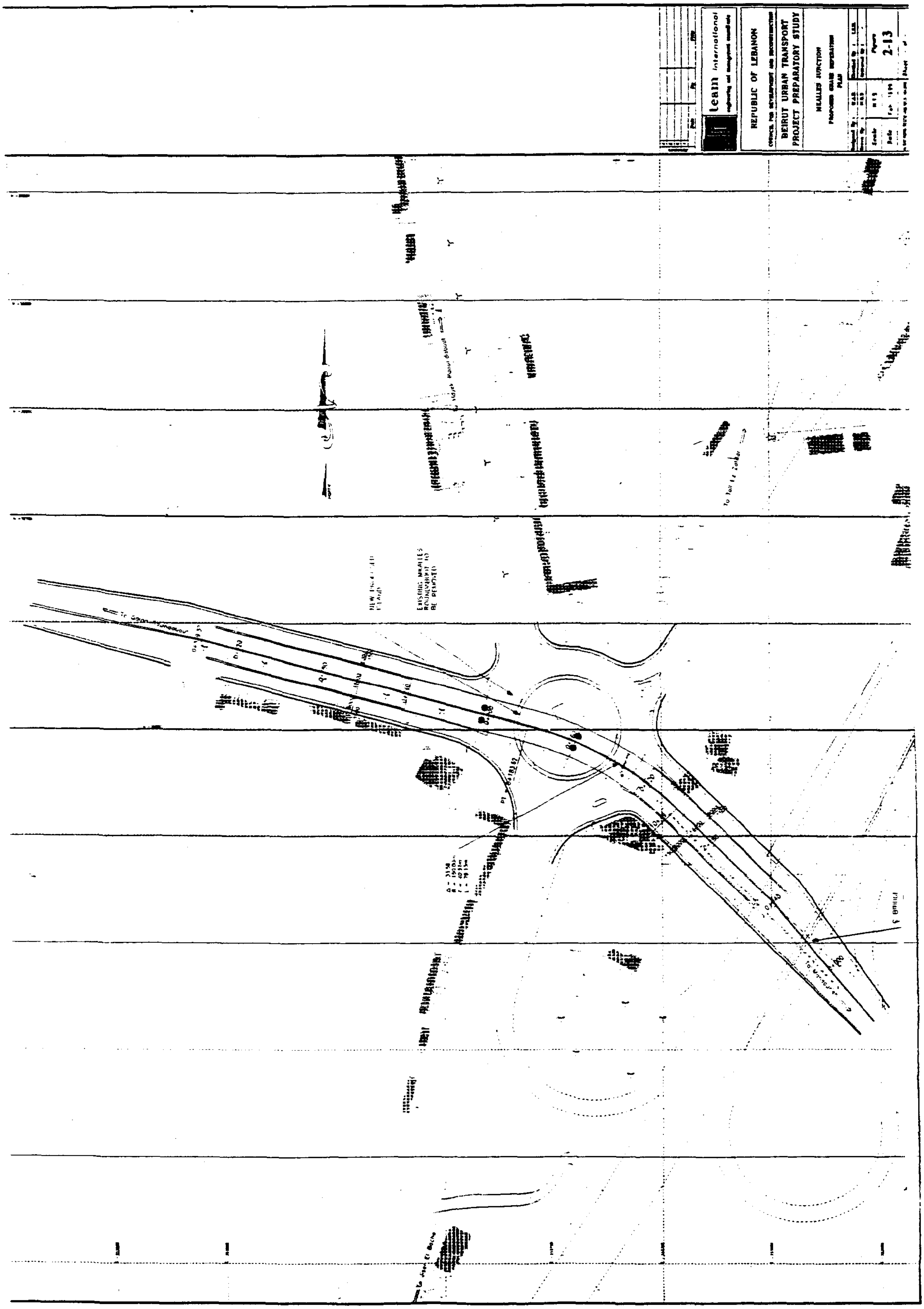
The traffic on this roundabout is sensitive to whether the Périphérique is built or not. because the latter passes to the East of it. underpassing Mansourieh Road at about 130 m from the junction. The traffic in the general direction of the Périphérique is most liable to be affected by the construction of the Périphérique. But the question of tolling complicates the issue. because the diversion from the existing road system to the Périphérique depends on the tolling system and the toll itself. One possible solution is a 2x2 underpass for the traffic between Hayek and Jisr el-Bacha. with the possibility of overpassing the traffic between Qalaa and the Road to Mansourieh. with the other traffic staying at grade.

Existing Operating Conditions

The roundabout is operating at a very low level-of-service and all geometric changes at-grade with signalization (i.e. transforming the roundabout into a signalized intersection) would not bring the delay down to an acceptable level. Two grade separations were proposed. An underpass 2x2 carries the traffic between Hayek and Jisr el-Bacha. and an overpass that connects Mansourieh Road to Qalaa. The other movements are served by an improved signalized intersection at-grade which incorporates a widening of road leading to Dekwaneh. With today's traffic. the junction would operate at a LOS C (16 sec. delay). This proposed solution needs to be checked against future traffic conditions and take into consideration the effect of the Périphérique.

Future Conditions and Proposed Improvements

Analysis shows that an average delay of 251 sec per vehicle is expected by the year 2010. Mkalles Roundabout is a junction where 5 roads are meeting. It is also very close to the proposed Périphérique. The Hayek - Mkalles - Jisr el-Bacha traffic will be partly diverted to the Périphérique when it is in service. This is at present the heaviest traffic direction. but grade separating it will not be warranted in the future. when the Périphérique is put in service. Moreover. topography of the area favors overpassing the traffic between Mansourieh Road and Qalaa. When the Périphérique is put into service. this proposed overpass connection would be enough to relieve the congestion at this junction. All other traffic will stay at-grade and use the roundabout. This solution would bring the peak hour average delay per vehicle to only 10 sec by the year 2010. These proposals take into consideration the completion of the Périphérique by the year 2004. The proposed bridge layout allows an underpass carrying the traffic from Hayek towards Jisr el-Bacha at a future date. in case the Périphérique project did not materialize. Plans and profiles of the proposed overpass are shown in Figures 2-13 and 2-14.



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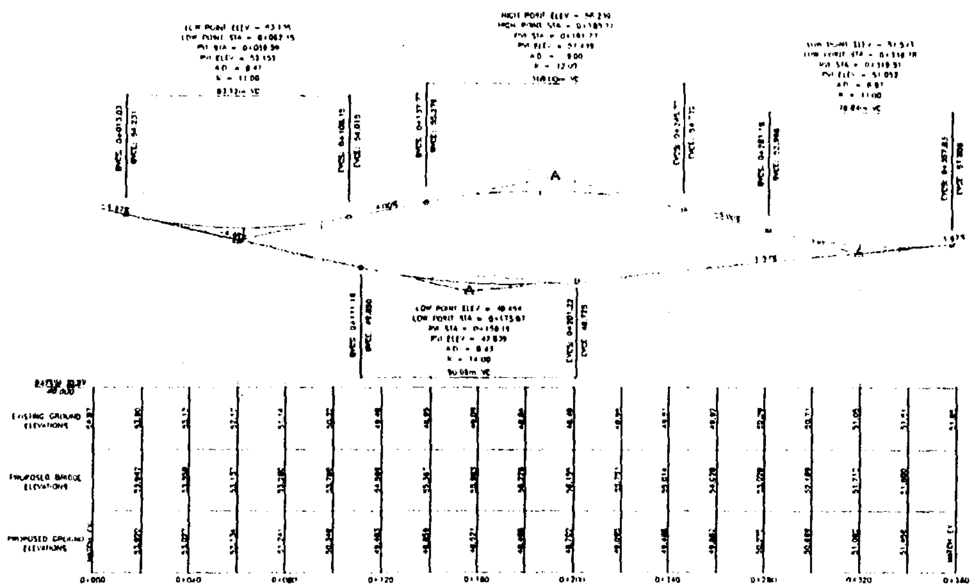
PROJECT PREPARATORY STUDY
2-13



PROFILE

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Scale N.T.S

Figure 2-14

Description of Proposed Grade Separation Structure

The Mkalles bridge is 161m long, 3-span continuous superstructure carrying Qalaa-Mansourieh traffic over the MkalRoundabout. The bridge is composed of 1-45 m center span and 2-36 m end spans. The overall width of the superstructure is 15.40 m carrying 4-3.50 m traffic lane. two lanes in each direction separated by a 0.50 m New-Jersey type median barrier. The bridge superstructure is pre-stressed concrete. 2-cell box type girder with 3.6m cantilevering arms on each side of the box. The depth of box girder varies from 1.50 m at mid-span to 2.50 m at supports. The variable section is used for aesthetics and structural efficiency. The substructure consists of two concrete piers and two abutments all founded on drilled concrete piles. Each pier consists of two round columns. one under each bearing. The two concrete abutments are cantilever type with approximately 70 m retaining walls extending on each side. Vertical striations type finish is formed on the exposed faced of columns and abutments.

2.4.3 Corridor No. 4: Chatila - Tayouneh - Sami el-Solh - Adlieh

This is an East-West corridor running at the Southern limits of Municipal Beirut. It is also a multi-lane divided Boulevard with 3 lanes of traffic each direction. At Chatila. this corridor intersects Airport Road, and at Tayouneh it intersects Old Saida Road - Omar Beyhum Street. Further East. it intersects Damascus Road and ends at Adlieh Junction where it meets Corniche el-Mazraa. The section between Chatila and Tayouneh is bounded at one side by the Pine Forest and by residences on the other side. Sami el-Solh Avenue is a mix of land uses. commerce at the ground level plus residences and offices at the upper floors. The section between Damascus Road and Adlieh does not have a lot of business activities at the ground level. This corridor will be attracting more traffic from two new links: Kafaat - Chatila Road and from the Northern Urban Bypass (Tahwita - Tayouneh).

2.4.3.1 Tayouneh

Description

The Tayouneh Roundabout lies at the intersection of Jamal Abdel Nasser Avenue coming from Chatila to the West and then becomes Sami Solh to the East of Tayouneh with the Old Saida Road coming from Mar Mekhael to the South and which is called Omar Beyhum Boulevard to the North of Tayouneh. All the intersecting boulevards are multi-lane divided with generous right-of-way. The new Kafaat - Chatila Road will bring more traffic to Tayouneh. Moreover. the Northern Urban Bypass (Tahwita - Tayouneh) will bring a significant amount of traffic to Tayouneh. The left turns between Northern Urban Bypass and Old Saida Road need to be studied within the context of Tayouneh, because of its close proximity to it.

A complete traffic analysis of this junction must consider the above stated junctions plus the finally adopted configuration of the Chatila Interchange.

On the environmental side. this junction borders the Pine Forest. which is being developed to be a major park.

The N-S traffic along Omar Beyhum - Old Saida Road is to be channeled in a 2x2 underpass, whose SB roadway should extend beyond Northern Urban Bypass junction to allow the left turn from trafcoming from Tayouneh going East on the Northern Urban Bypass without conflict with NB coming from Mar Mekhael. Tentatively an overpass could be needed to carry the E-W traffic along Jamal Abdel Nasser - Sami Solh axis, subject to detailed analysis.

Existing Operating Conditions

Based on traffic assignments using the forecast calibrated model and an updated network which includes Northern Urban Bypass and the Kafaat - Chatila Road, the Tayouneh Roundabout will not operate satisfactorily. Another test was done with the NS/SN traffic channeled via an underpass and the EW/WE traffic is kept at grade, where the junction is signalized as a pierced roundabout. This solution resulted with a good level-of-service.

Future Conditions and Proposed Improvements

Analysis shows that the roundabout is expected to operate at a very low level-of-service by 2010. A 2x2 underpass, whose SB roadway should extend beyond Northern Urban Bypass to allow the left turn from traffic coming from Tayouneh going East on the Northern Urban Bypass without conflict with NB coming from Mar Mekhael. With this solution, analysis shows that the junction would operate at an acceptable level-of-service (peak hour average delay per vehicle of 56 sec.). The analysis also shows that an overpass to carry E-W traffic along Abdel Nasser Avenue/Sami Solh Avenue axis will not be warranted by the year 2010. This proposed alternative is compatible with the revised Chatila Interchange design.Plans and profiles of the proposed underpass are shown in Figures 2-15 and 2-16.

Description of Proposed Grade Separation Structure

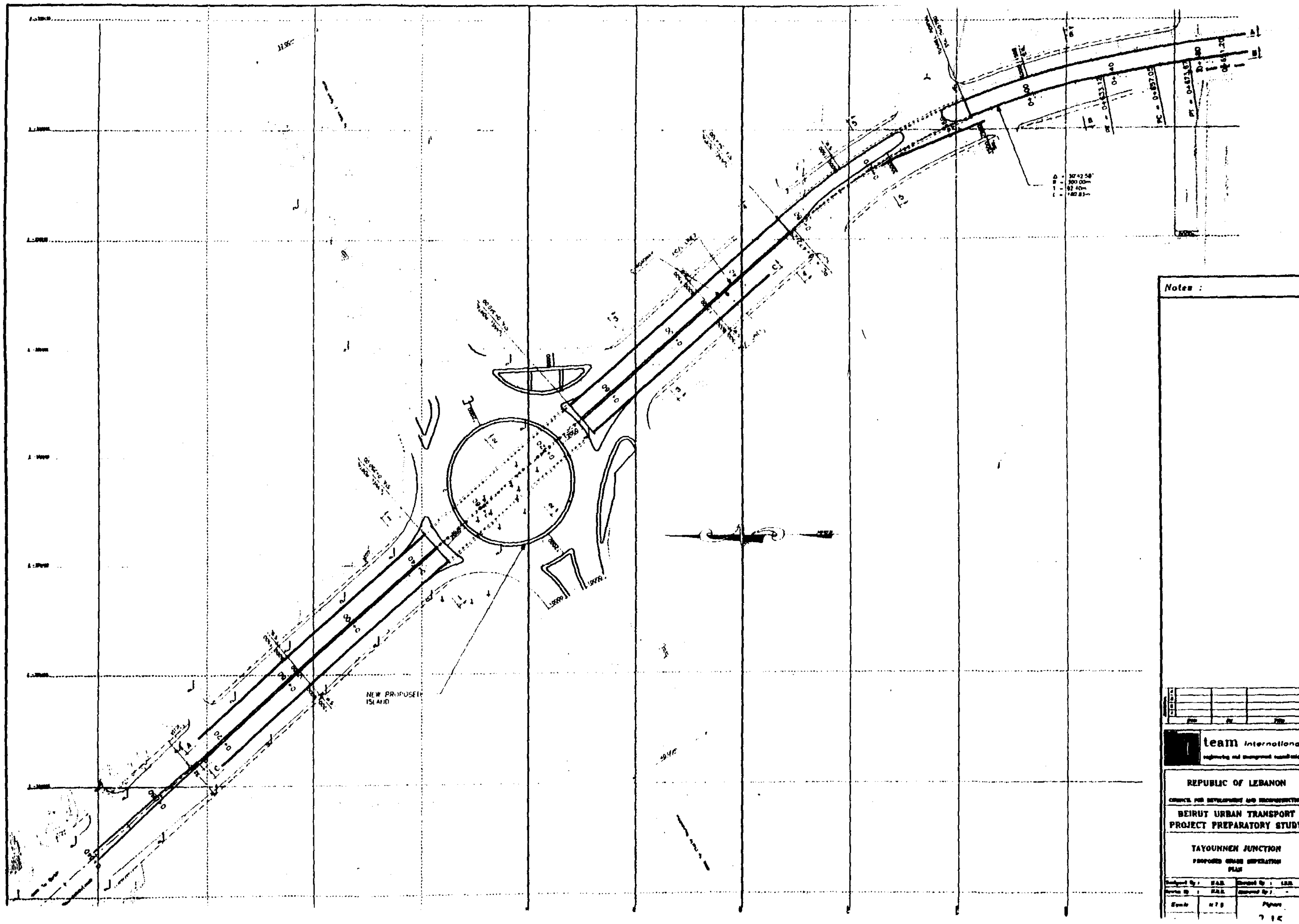
A one cell cut and cover tunnel carrying southbound traffic on Asaad Al-Asaad Street under the Rocade Urbaine Nord and continues in a depressed open section to join with a 2-cell cut and cover section under the Tayouneh Roundabout carrying both northbound and southbound traffic under Sami El-Solh Blvd. The length of the covered section of the one-cell tunnel is 100m and the length of the open depressed section between the two tunnels is 130m. The clear roadway width of both the one-cell and the open section is 7.50 m measured face-to-face of curb and representing two traffic lanes. The length of the covered section under the roundabout is 90m and it consists of two cells, one for each direction, separated by a 0.50 m concrete wall. The clear width of the cell is 8.35 m with a roadway width of 7.50 m measured face-to-face of curb. The north approach of the 2-cell tunnel consists of an open roadway section with a clear width of 17.20 m measured face-to-face of retaining walls. This width represents 2-7.50 m roadway widths in each direction separated by a 1.0 m median barrier and a 0.60m sidewalk curb on the right side of the roadway. Exposed faces of the retaining walls are formed with vertical striations type finish.

2.4.3.2 Damascus Road / Sami Sölh Avenue

Description

Sami Solh Avenue is a divided urban boulevard running in the general E-W direction, it intersects Damascus Road which is not more than two traffic lanes. The level of complexity of the intersection depends on whether Damascus Road is operated as one-way or two-way street.

Damascus Road was originally classified as an International Road. The section under consideration (i.e. at its intersection with Sami Solh Ave.) has a pavement width of 11 meters. It has been transformed to a busy shopping street lined with middle-class boutiques on both sides. One way operation on Damascus Road was tried once by Traffic Police, but the decision was reversed later due to strong objection of the shop owners.


NEW PROPOSED ISLAND
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team international
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PROJECT PREPARATORY STUDY
TAYOUNNEH JUNCTION
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0+640
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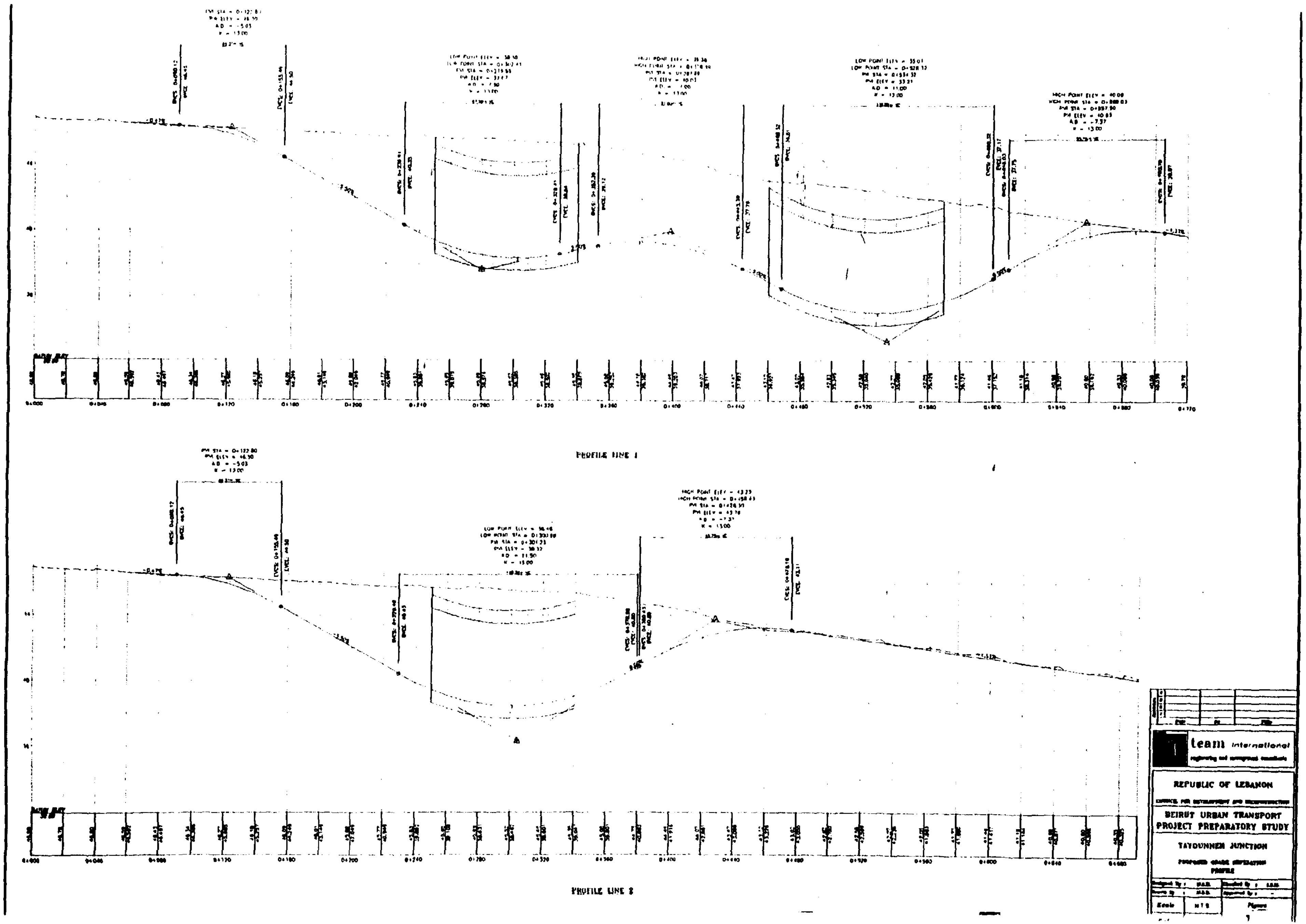
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PROJECT PREPARATORY STUDY
TAYOUNNEH JUNCTION

Moreover, the road parallel to it (Tahwita Rd.) is a new expressway which is the "New" Damascus Road. Although it is close to the "Old" Damascus Road at one end (about 70 m), the two roads diverge and reach 320 meters apart along 400 m section of their length.

Bus operation on a one-way Damascus Road (SB) and on the service road of the New Damascus Road (NB) will take the bus service away from the densely built corridor, and will strongly reduce the level-of-service of bus operation.

No specific topographic constraints exist. There is however ROW restriction on Damascus Road.

Existing Operating Conditions

Based on 1998 traffic counts on Sami Solh Avenue and Damascus Road, the level-of-service at this intersection is very low. Even with optimizing the signal phasing on it, the average delay per vehicle during the peak hour is still 96 sec. However, if Damascus Road was made one way as proposed by the Immediate Action Plan, the average delay drops to 35 sec, which is an acceptable LOS, and no grade separation would be required. But two-way operation on Damascus Road is required for better operation of bus public transport.

Future Conditions and Proposed Improvements

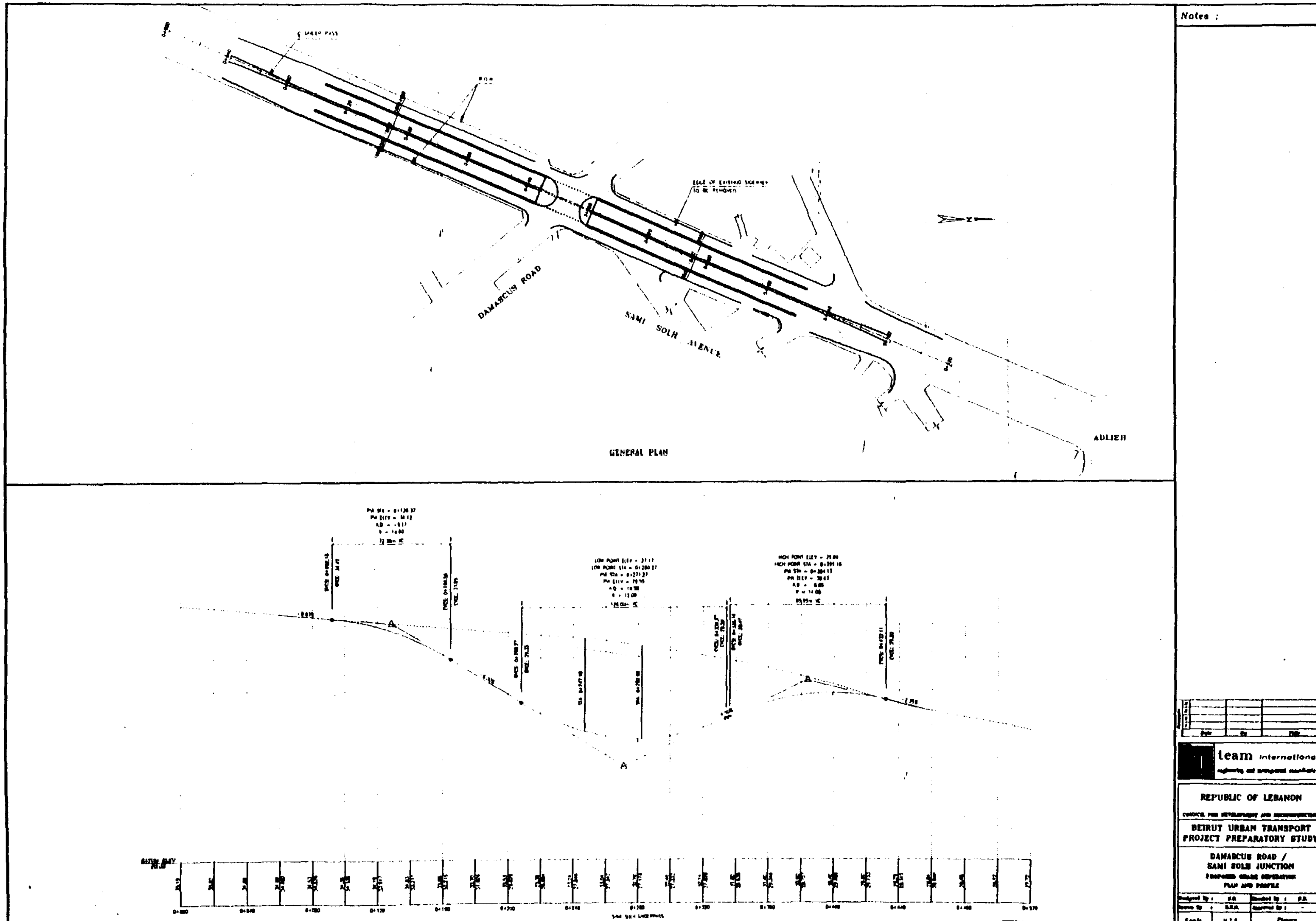
Analysis shows that the average delay per vehicle is expected to be over 500 sec by the year 2010. However, the delay would be only about 46 sec if Damascus Road (Southern leg of the intersection) was changed to one-way Northbound as proposed by the Immediate Action Plan instead of two-way. If Damascus Road stays two-way (Southern leg), a 2x2 underpass is warranted in the E-W direction (Sami Solh Avenue). This solution will bring the average delay per vehicle to 17 sec. Plans and profiles of the proposed underpass are shown in Figure 2-17.

Description of Proposed Grade Separation Structure

The proposed underpass is a 2-cell cut and cover tunnel carrying Sami El-Solh Avenue traffic under Damascus Road. The overall length of the underpass is 320 m of which 35 m are covered under the intersection. The covered section consists of two cells, one for each direction, separated by a rigid frame type pier consisting of 1.5 m x 0.40 m thick columns spaced at 4.50 m on center. The clear width of each cell is 8.40 m with a roadway width of 7.40 m measured from face-to-face of curb. The minimum clear height of the cell is 5.0 m. From each side of the tunnel portals, open sections extend approximately 140 m long forming the ramps of the tunnel. The clear wiof the open sections is 17.20 m measured face-to-face of retaining walls representing 2-7.40 m roadway widths in each direction separated by a 1.20 m median barrier and a 0.60 m curb on the right side of the roadway. The retaining walls of the open sections support the marginal roads adjacent to the tunnel ramps.

2.4.4 Corridor No. 6: Airport Road - Bechara el-Khoury Boulevard

This is a major North-South Corridor which starts at the Airport and ends in the Beirut Central District (BCD). It is a divided boulevard with 3 lanes in each direction along most of its alignment. It runs down the middle of Municipal Beirut.


Notes :
EDGE OF EXISTING SIDEWALK TO BE REMOVED
DAMASCUS ROAD
SAMI SOLH AVENUE
ADLIEH
GENERAL PLAN
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DAMASCUS ROAD / SAMI SOLH JUNCTION

The section of this Corridor under consideration starts at its intersection with Chiyah Blvd. (Corridor No. 20). Airport Road goes over a steel bridge overpassing Chiyah Blvd. The at-grade intersection below does not allow left turns from Chiyah Boulevard to Airport Road. The steel overpass is candidate for replacement due to its bad structural status. The second major intersection is Chatila (not part of this project) where Airport Road meets Corridor No. 4. Further North, Airport Road meets Omar Beyhum (which is an extension of Old Saida Road) near Corniche el-Mazraa (an intermediate Ring Road that circles most of Municipal Beirut). At that point, two 6-lane roads meet, forcing North-South traffic through a 4-lane underpass. The next major intersection further North is Bechara el-Khoury with Independence just at the Southern limits of the BCD.

2.4.4.1 Airport Road / Chiyah Boulevard

Description

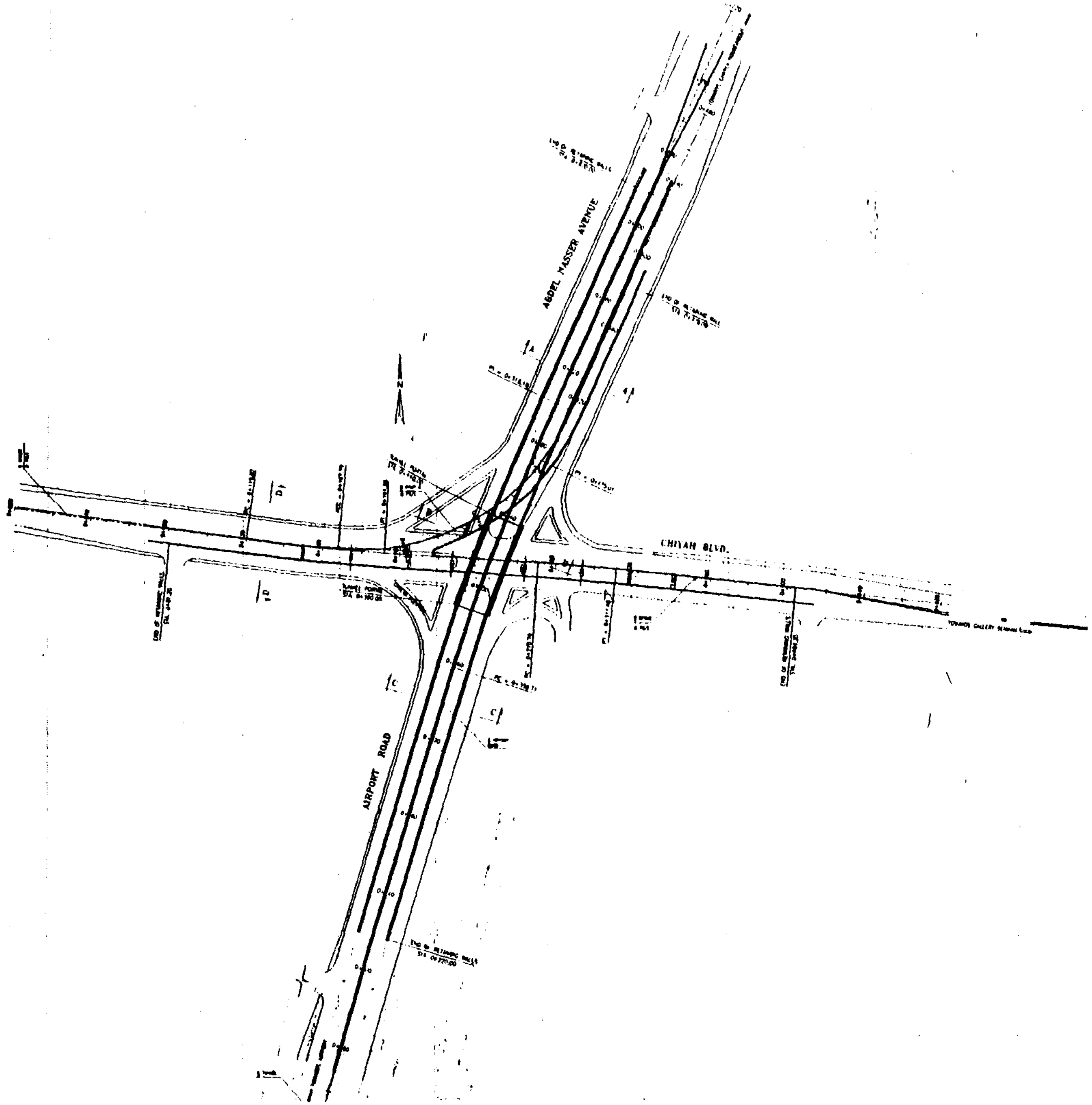
Airport Road is currently undergoing rehabilitation. Currently, N-S and S-N traffic are taken on a 4-lane steel bridge to overpass Chiyah Boulevard. No topographic or ROW restrictions exist. The replacement of the existing steel bridge should be considered. The intersection at-grade should allow left turns from Chiyah Boulevard to Airport Road.

Existing Operating Conditions

Since this junction has been operating with the left turns from Chiyah Boulevard to Airport Road blocked, the traffic model was rerun with those left turns opened. The network was also updated with the Southern Entrance (Cocody - Cola). The EW/WE on Chiyah Boulevard traffic is heavier than the NS/SN, another observation is the heavy left-turn from EB traffic on Chiyah Boulevard to NB traffic on Airport Road. If the overpass is along Airport Rd. (as it is currently), the at-grade intersection under it will not satisfactorily operate due to the heavy left turns.

Future Conditions and Proposed Improvements

It is to be noted that this intersection does not currently allow left turns. These left turns should be allowed in order to make it possible to restrict movements at Ghobeiry Intersection, canceling the crossing of Chiyah Boulevard at this location. This restriction is necessary as ROW constraints at Ghobeiry Intersection preclude other treatments. Analysis shows that by allowing left turns from Chiyah Boulevard to Airport Road, the intersection is expected to operate at an unacceptable level-of-service. Grade-separating only one direction of traffic will not be sufficient. For example, replacement of the steel bridge by a 2x2 underpass, the average delay per vehicle is expected to be over 1000 sec. However, a 2-lane overpass going Eastbound is also proposed. The 2-lane overpass will branch into two: one branch turning left (one lane) and going North to merge with Northbound traffic on Airport Road, while the other branch (two lanes) continuing Eastbound over Airport Road and connecting to Chiyah Boulevard. This solution would bring down the delays to 17 sec by the year 2010. This proposed 3-level interchange is necessary. The underpass must be N-S as there are underground utilities in the E-W direction. Furthermore, it is very essential to provide for the heavy left turn for Eastbound traffic on Chiyah Boulevard into the direction of Chatila. Plans and profiles of the proposed underpass and overpasses are presented in Figures 2-18 and 2-19.



Notes :

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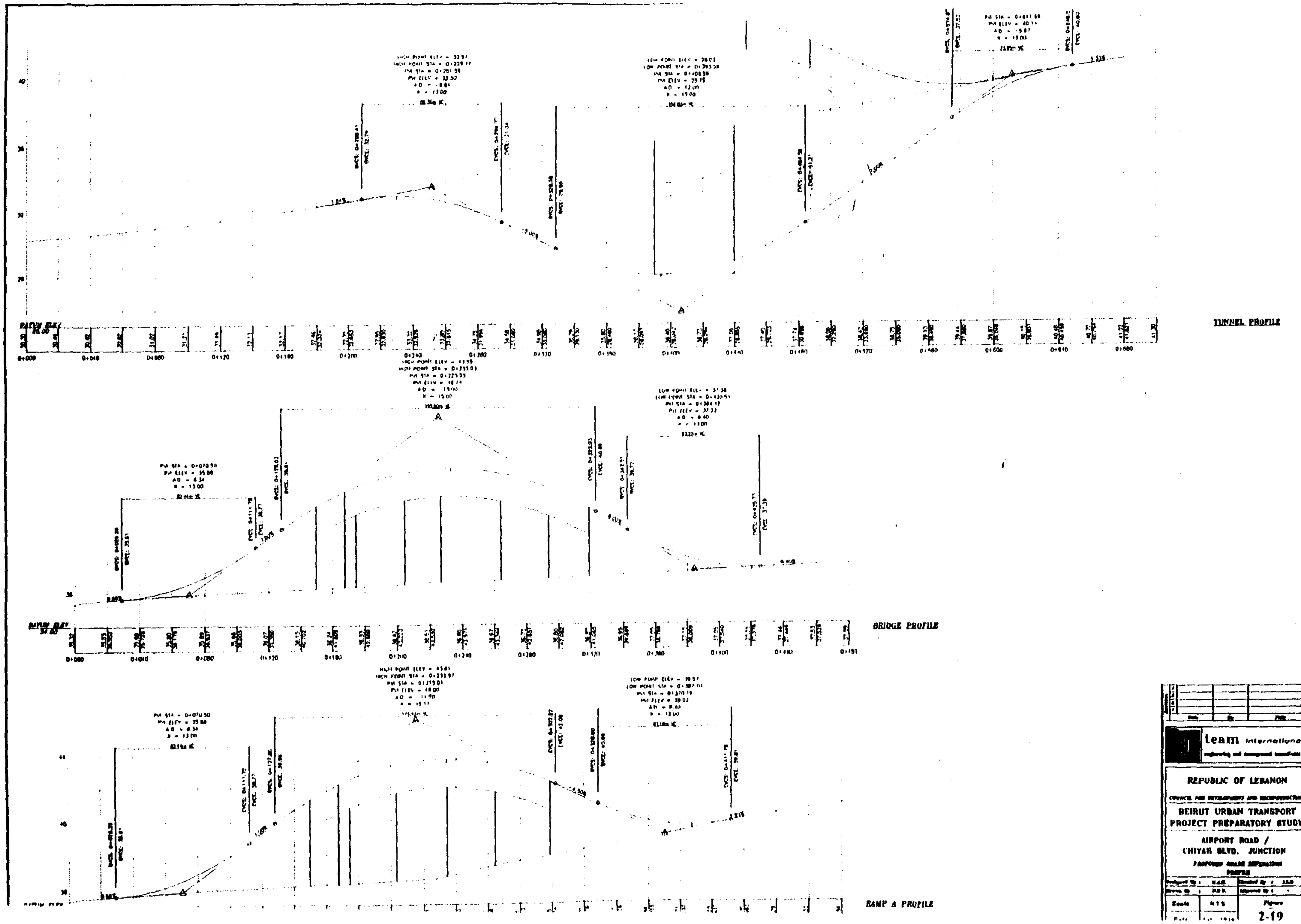
BEIRUT URBAN TRANSPORT
PROJECT PREPARATORY STUDY

AIRPORT ROAD /
CHIYAH BLVD. JUNCTION
PROPOSED GRADE SEPARATION
PLAN

Designed by :	R.A.B.	Checked by :	[illegible]
Drawn by :	R.S.S.	Approved by :	-
Scale	N.T.S.	Figure	


TUNNEL PROFILE
BRIDGE PROFILE
RAMP A PROFILE
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BEIRUT URBAN TRANSPORT
PROJECT PREPARATORY STUDY
AIRPORT ROAD /
CHIYAH BLVD. JUNCTION
Figure
2-19

Description of Proposed Grade Separation Structure

A 3-level intersection comprising of:

- A 2-cell cut and cover tunnel along Airport Road to carry northbound and southbound traffic under Chiyah Blvd. The length of the covered section is 50 m and it consists of two cells separated by a 0.50 m concrete wall. The clear width of each cell is 8.35 m with a roadway width of 7.50 m. representing two traffic lanes, measured from face- to-face of curb. The minimum clear height of the cell is 5.0 m. From the tunnel portals, two, approximately 160 m long, retaining walls extend on each side supporting the marginal roads adjacent to the tunnel ramps. Exposed faces of the retaining walls are formed with vertical striation type finish.

- A main 2-lane bridge carrying eastbound traffic on the Chiyah Blvd. with a one lane directional ramp branching left of the bridge to provide access for eastbound traffic on Chiyah Blvd. to go north towards Chatila Roundabout. The main 2-lane bridge is 171m long in six continuous spans. The central span over the intersection is 38 m long. The overall width of the bridge is 7.80 m with a roadway width of 7.0 m making 2-3.50 m traffic lanes. The directional ramp bridge has a length of 97.0 m in 3 continuous spans with a 35.0 m main span over the tunnel ramp. The overall width of the bridge is 5.80 m with a one-lane roadway width of 5.0 m measured from face-to-face of curb. The superstructures of both bridges are 1.50 m deep pre-stressed concrete. 2-cell box type girders. The exterior webs of the box girders are inclined and two longitudinal grooves are provided for aesthetics. The substructure concrete pier units are hammerhead type with a rectangular shaped column. The concrete abutments are cantilever-type with concrete retaining walls extending from each side along the marginal roads adjacent to the bridge embankments.

2.4.4.2 Bechara el-Khoury / Omar Beyhum

Description

This junction lies at the intersection near Corniche el-Mazraa of Omar Beyhum with Airport Road. which is called Bechara el-Khoury to the North of Corniche el-Mazraa. Bechara el-Khoury is a major N-S Boulevard with 3 lanes each direction. But when it crosses Corniche el-Mazraa. North-South traffic is channeled to an existing underpass with 2-lanes each direction which was built more than 30 years ago. With the traffic that may use Omar Beyhum. coming from the Northern Urban Bypass and from Kafaat - Chatila. and the traffic from Bechara el-Khoury desiring to go South on Omar Beyhum. a traffic conflict is created due to lack of lane balance and the possibility of traffic back-up in the underpass.

This junction lies in a sensitive location. It is bounded to the West by a big school complex and to the East by the French Ambassador's Residence (Résidence des Pins). and to the South by the Pine Forest. An overpass that looks the French Ambassador's Residence is unlikely to be tolerated. and any expropriation from the French owned property would take a very lengthy procedure (international agreement between Lebanon and France).

This situation is further complicated by the Barbir Overpass which starts and ends very close to the location of this junction.

The preferred solution is probably to have the underpass be along Corniche el-Mazraa. But tearing down the existing underpass may face objections. due to difficulty in maintaining traffic during construction.

Existing Operating Conditions

Based on the 1998 counts, the intersection is operating at a very unacceptable level-of-service. Even with geometric improvements to provide a left tuning pocket for traffic coming up from the underpass and desiring to go South on Omar Beyhum, the level-of-service would still be low and the queue risks to back up in the underpass.

The location constraints described above made this junction a difficult one to treat, and restricted the available options.

Future Conditions and Proposed Improvements

Analysis shows that by the year 2010, the intersection would have very high delays unless improvements are proposed.

There are many constraints mentioned above that control the choice of a solution for this junction. In addition, any soto be proposed should be possible to construct without disrupting traffic on the intersecting two major arterials: Airport Road - Bechara el-Khoury - Corniche el-Mazraa.

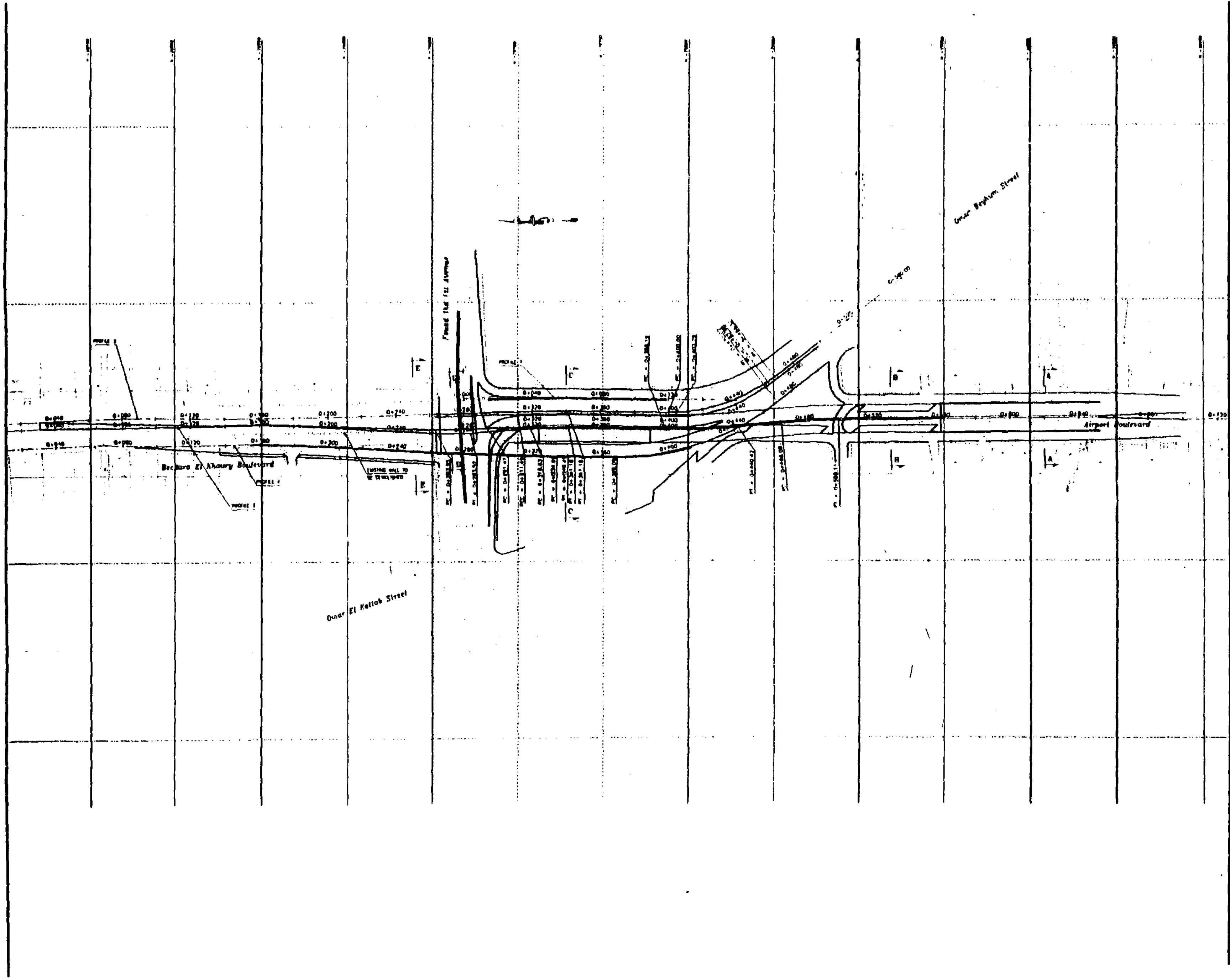
Taking all these constraints into consideration, a proposed design was formulated. The existing underpass, which carries N-S / S-N traffic below Corniche el-Mazraa is a 2x2 structure, 2 lanes per direction. It is proposed to use it to carry Northbound traffic only on its 4 lanes, and to construct adjacent to it, to its west, another underpass which carries the Southbound traffic. In addition, an underpass along Airport Road to the South of the junction will provide for the turns from Bechara el-Khoury Southbound to Omar Beyhum without conflict.

This solution would require additional right-of-way to be acquired from two vacant lots, and will affect only one old building at the N-W corner of the intersection of Corniche el-Mazraa and Bechara el-Khoury.

The proposed solution will provide an interchange without any conflicting movements. Plans and profiles of the proposed interchange are shown in Figures 2-20 through 2-22.

Description of Proposed Grade Separation Structure

A main two-cell cut and cover tunnel starting on November 22nd Avenue carrying northbound and southbound traffic under Omar Beyhum Street. The two cells will run at different profiles. The eastern cell, with 7.50 m roadway width representing two traffic lanes, carrying northbound traffic will meet up with a 2-lane depressed section ramp, 7.50 m clear roadway width representing two traffic lanes, carrying northbound traffic on Omar Beyhum Street. These 4-lane will enter through an existing 4-lane underpass below Corniche El-Mazraa. These four northbound lanes will taper down to three to match the existing condition on Bechara El-Khoury Street. A one cell, 3-lane 10.90 m clear roadway width, 73 m long, cut and cover tunnel adjacent to the existing underpass will carry southbound traffic on Bechara El-Khoury Street under Corniche El-Mazraa. These three lanes will branch into four lanes. The left two lanes will continue in a 65 m long open depressed section, 7.50 m clear roadway width, before entering a 170 m long, 2-lane western cell of the main tunnel towards November 22nd Avenue. The other two lanes will continue into an open section, 7.0 m clear roadway width, ramp to reach grade and continue on Omar Beyhum Street.



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engineering and management consultants

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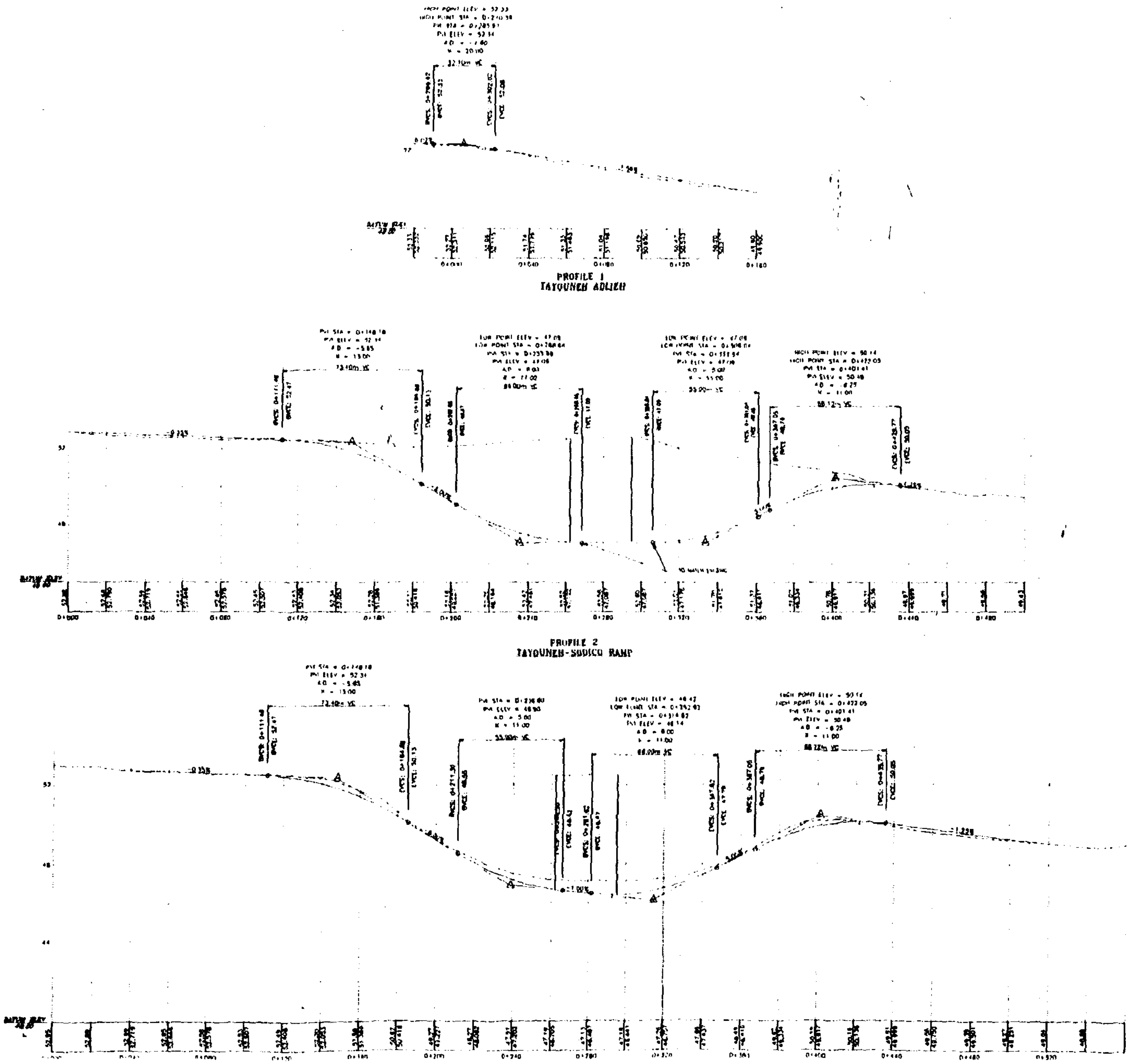
BEIRUT URBAN TRANSPORT PROJECT PREPARATORY STUDY

BECHARA KHOURY STREET/ OMAR BEYHUM JUNCTION

PROPOSED GRADE SEPARATION PLAN

Scale: N.T.S.

Figure 2-20



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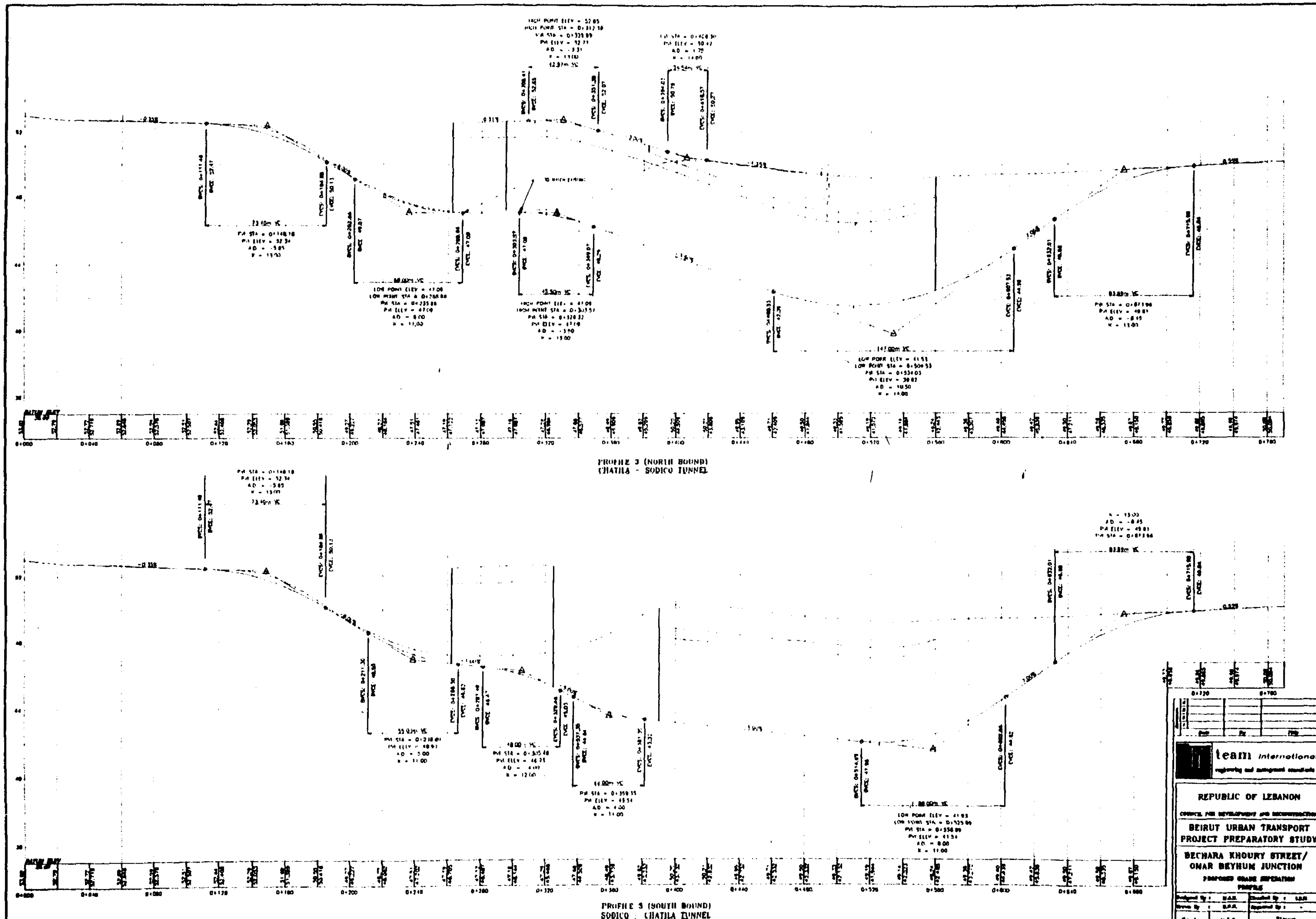
BEIRUT URBAN TRANSPORT PROJECT PREPARATORY STUDY

BECHARA KHOURY STREET/ OMAR BEYHUM JUNCTION

PROPOSED GRADE SEPARATION PROFILE

Designed By :	H.A.B.	Checked By :	[illegible]
Drawn By :	B.F.R.	Approved By :	-
Scale	N.T.S.	Figure	2.21


PROFILE 3 (NORTH BOUND)
CHATILA - SODICO TUNNEL
PROFILE 3 (SOUTH BOUND)
SODICO - CHATILA TUNNEL
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BEIRUT URBAN TRANSPORT
PROJECT PREPARATORY STUDY
BECHARA KHOURY STREET/
OMAR BEYHUM JUNCTION

2.4.4.3 Bechara El-Khoury / Independence

Description

The intersection of Bechara el-Khoury, a major N-S corridor with Independence, a major E-W corridor. is complicated by Omar Ibn el-Khattab road that carries Southbound traffic from the same junction. Bechara el-Khoury starts on a down-grade just to the North of the intersection, which favors underpassing it. Bechara el-Khoury to the South of the intersection is constrained by high rise new buildings along its Western side and by a Mosque to its Eastern side. Minor expropriations may be required. but no buildings will be affected.

Existing Operating Conditions

Based on the 1998 traffic counts. the level-of-service is extremely low at this intersection. In order to reach an acceptable LOS without a grade separation. it was necessary to prohibit left turns from Independence to Bechara el-Khoury, and to create an intersection at Damascus Road - Bechara Khoury to the North of Independence which make this alternative operationally doubtful in the future. If a 2x2 underpass is introduced along Bechara el-Khoury, the at-grade signalized intersection would operate at a level-of-service C.

Future Conditions and Proposed Improvements

Analysis shows that an average delay of over 400 sec is expected by 2010 if nothing is done. A 2x2 underpass along Bechara el-Khoury is expected to bring down the average delay of traffic in the peak hour at the at-grade signalized intersection to 23 sec. The proposed solution does not interfere with President Bechara el-Khoury monument. Plans and profiles of the proposed underpass are shown in Figure 2-23.

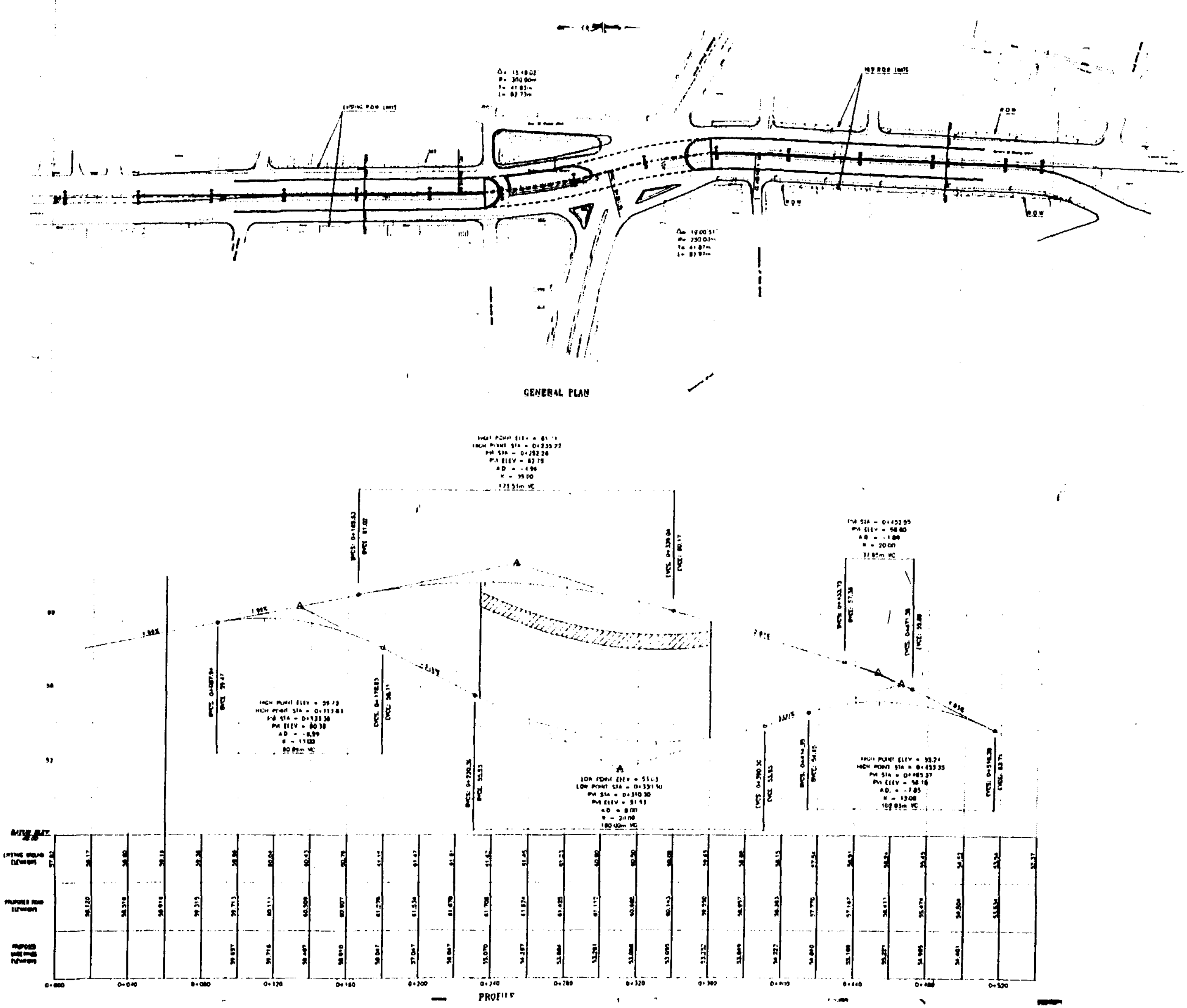
Description of Proposed Grade Separation Structure

The proposed underpass is a 2-cell cut and cover tunnel carrying Bechara El-Khoury Street traffic under Independence Avenue. The overall length of the underpass is 385 m of which 127 m is covered section under the intersection. The covered section consists of two cells separated by a 0.50 m concrete wall. The clear width of each cell is 8.35 m with a roadway width of 7.50 m measured from face-to-face of curb. The minimum clear height of the cell is 5.0 m. From each side of the tunnel portals, open sections extend approximately 130 m long forming the ramps of the tunnel. The clear width of the open sections is 17.20 m measured face-to-face of retaining walls. This width represents 2-7.50 m clear roadway widths in each direction separated by a 1.0m median barrier and a 0.60 m curb on the right side of the roadway. The retaining walls of the open sections support the marginal roads adjacent to the tunnel ramps. Exposed faces of the retaining walls are formed with vertical striations type finish.

2.4.5 Corridor No. 19: Northern Entrance

The Northern Coastal Highway, runs into Greater Beirut from its Northern Boundary at Nahr el-Kalb through Dbayeh, Antélias, Jal el-Dib, Nahr el-Mott, and continues due West into the direction of Port of Beirut.

It is the heaviest traveled corridor in Lebanon with about 210.000 vpd. At Antélias, it intersects with the road leading to Bikfaya, and at Jal el-Dib is another T-intersection. At both locations, the Northbound traffic is grade separated over a steel bridge to allow turning under it. The road junction at Nahr el-Mott is not included in this project. Further West at Dora, an existing 2-lane steel bridge carries Northbound traffic and it is highly congested for an extended period of the day.



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BECHARA KHOURY STREET/ INDEPENDENCE AVE. JUNCTION

PROPOSED GRADE SEPARATION PLAN AND PROFILE

Scale: N T S

Figure 2-[illegible]

2.4.5.1 Antélias

Existing Operating Conditions

Currently the NB traffic at Antélias goes over a barely 9.0 m steel bridge, allowing movements under it, in and out of Antélias. Just to the West is the Joseph Khoury Land Fill. Access to it from the other side is required. The level-of-service (LOS) at Antélias is F for the NB traffic, and is also F for the turning movements under the bridge.

Future Conditions and Proposed Improvements

The proposed solution is to replace the existing steel bridge by a full size 3-lane bridge in each direction which allows crossing under it to Joseph Khoury's Land Fill and provides the required turning movements under it in and out of Antélias. This solution is not a solution for the Northern Entrance. Plans and profiles of the proposed bridge are shown in Figure 2-24.

Description of Proposed Grade Separation Structure

The proposed Antélias overpass consists of dual bridges separated by 10cm gap. The bridge will carry northbound and southbound traffic over a new Antélias entrance. The bridge has 231 m, 7-span continuous superstructure with 5-35 m middle spans and 2 – 28 m end spans. The overall deck width is 11.70 m, with a clear roadway width of 10.90 m. The bridge superstructure is composed of a 1.60 m deep 2-cell pre-stressed concrete box girder with 2.0 m cantilevering arms on each side of the box. The two exterior webs of the box girder are inclined. The bridge substructure units are cast-in-place concrete and are supported on drilled concrete piles. The piers are formed from square columns that widen into a rectangular shaped bearing block. The abutments are cantilever-type with 2.50 m exposed face under the bridge deck. Retaining walls extending approximately 95 m from each side of the abutments along the marginal roads adjacent to the bridge embankment.

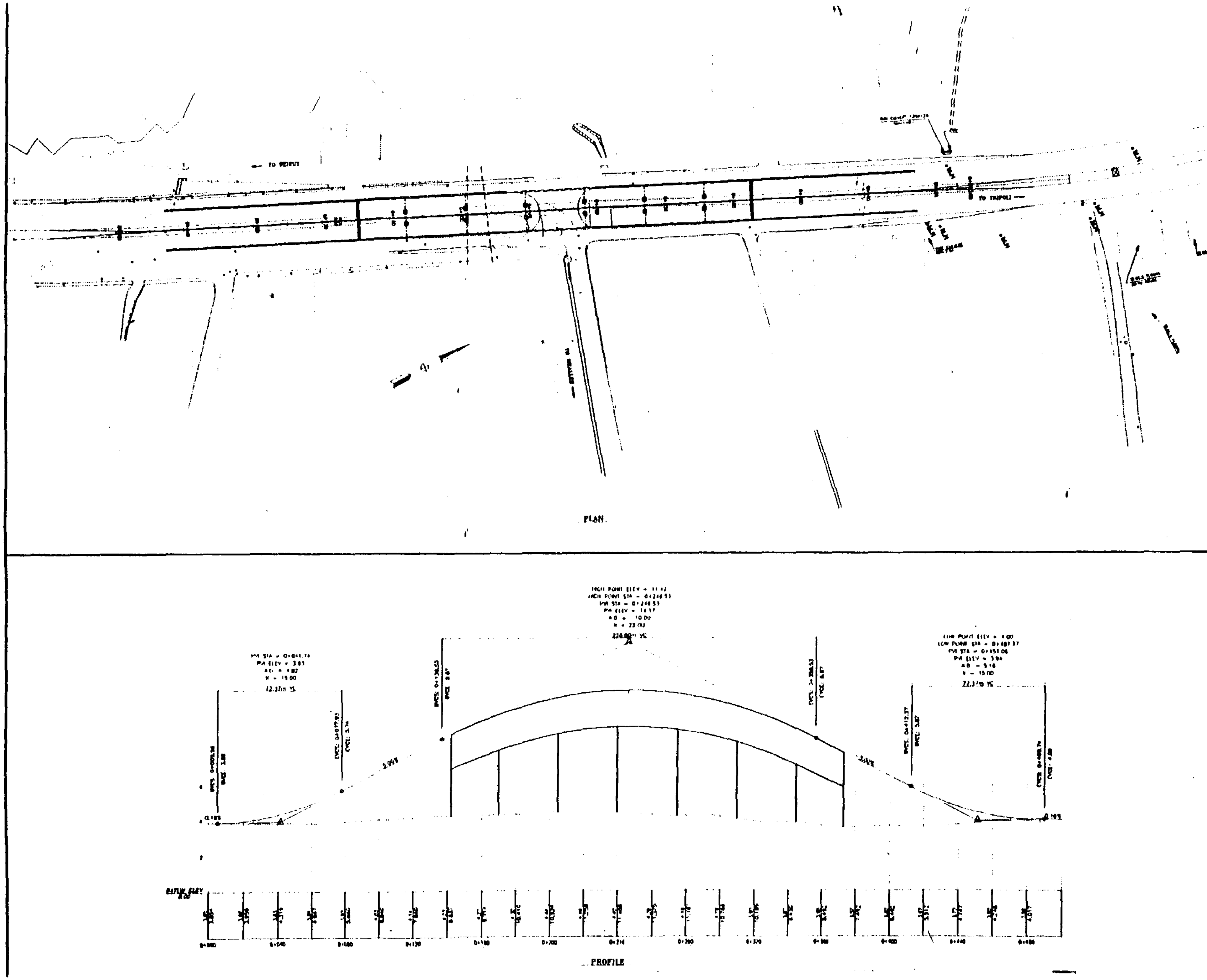
2.4.5.2 Jal el-Dib

Existing Operating Conditions

A similar situation occurs at Jal el-Dib. The existing steel overpass is a bottle-neck because it is not wide enough. The intersection under the bridge is also congested. In the future, the main access to Linord is just facing Jal el-Dib. The LOS at Jal el-Dib for the NB traffic over the bridge is F, and is also F for the turning movements at-grade.

Future Conditions and Proposed Improvements

Analysis shows delays are expected to be extremely high by 2010. The LOS of existing bridge is expected to be F. The proposed solution is to put the Northbound traffic at-grade, while constructing one-lane ramp for traffic coming from Jal el-Dib Road going South or coming from Antélias on the Autostrade and desiring to go East. It is proposed to provide these two movements separately on two adjacent roads, one is the Jal el-Dib Road itself and the other is an adjacent parallel road just to its North. This proposal would have the junction operating without conflicting movements, and the through traffic would stay at-grade and use full-size lanes. Plans and profiles of the proposed ramps are shown in Figures 2-25 and 2-26.



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BEIRUT URBAN TRANSPORT PROJECT PREPARATORY STUDY

ANTELIAS JUNCTION

Figure 2-24


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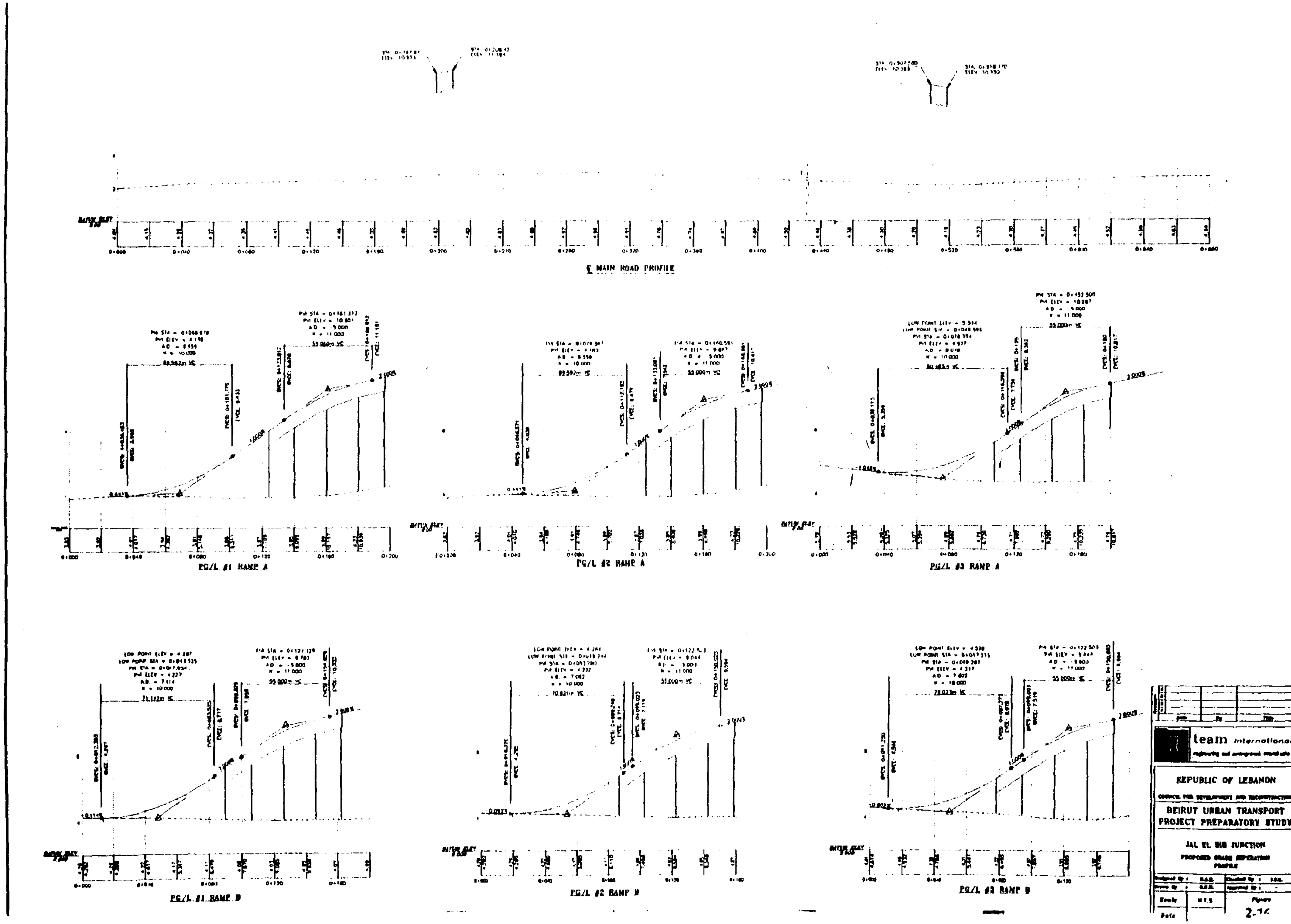
JAL EL DIB JUNCTION
Scale
Figure


MAIN ROAD PROFILE
PG/L #1 RAMP A
PG/L #2 RAMP A
PG/L #3 RAMP A
PG/L #1 RAMP B
PG/L #2 RAMP B
PG/L #3 RAMP B
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Description of Proposed Grade Separation Structure

Two identical junctions, approximately 300 m apart will constitute the accesses in and out of Jal el-Dib. Each junction consists of a U-shaped one-way ramp that will connect with another one-way ramp originating from Jal El-Dib. The two legs of the U-shaped ramp run parallel and adjacent to the Autostrade, and are 72 m long in 4-continuous spans. The overall width of these legs is 6.30 m with a clear roadway width of 5.50 m representing one traffic lane. The superstructure is composed of a 0.80 m deep trapezoidal voided concrete slab. The main section of the U-shaped ramp over the Autostrade is 36.50 m long in two spans. The overall width of this main section is 10.50 m, with a clear roadway width of 7.50 m representing 2-traffic lanes. The superstructure of this section consists of 0.90 m deep pre-cast post-tensioned AASHTO type girders spaced at 1.50 m on centers with a 0.20 m cast-in-place concrete deck. The use of the pre-cast girders was for both; ease of construction technique and to minimize disturbance to traffic during construction. The ramp bridge originating from Jal El-Dib and connecting to the main section over the Autostrade is similar to the two legs of the U-shaped ramp. The substructure units are all cast-in-place concrete and are supported on shallow foundations. The pier units for the one-lane ramps are hammerhead type piers with 1.00 m diameter round columns and a trapezoidal shape pier cap. The piers for the main bridge section over the Autostrade are rigid frame type piers with three 1.00 m diameter columns spaced at 3.50 m on center and are connected with a 1.20 m deep pier cap. The abutments are cantilever-type with approximately 2.0 m exposed face under the bridge deck. Retaining walls extending approximately 60 m from each side of the abutments to form the embankments of the ramps. Vertical striations type finish is formed on the exposed faces of retaining walls and abutments.

2.4.5.3 Dora Bridge

Existing Operating Conditions

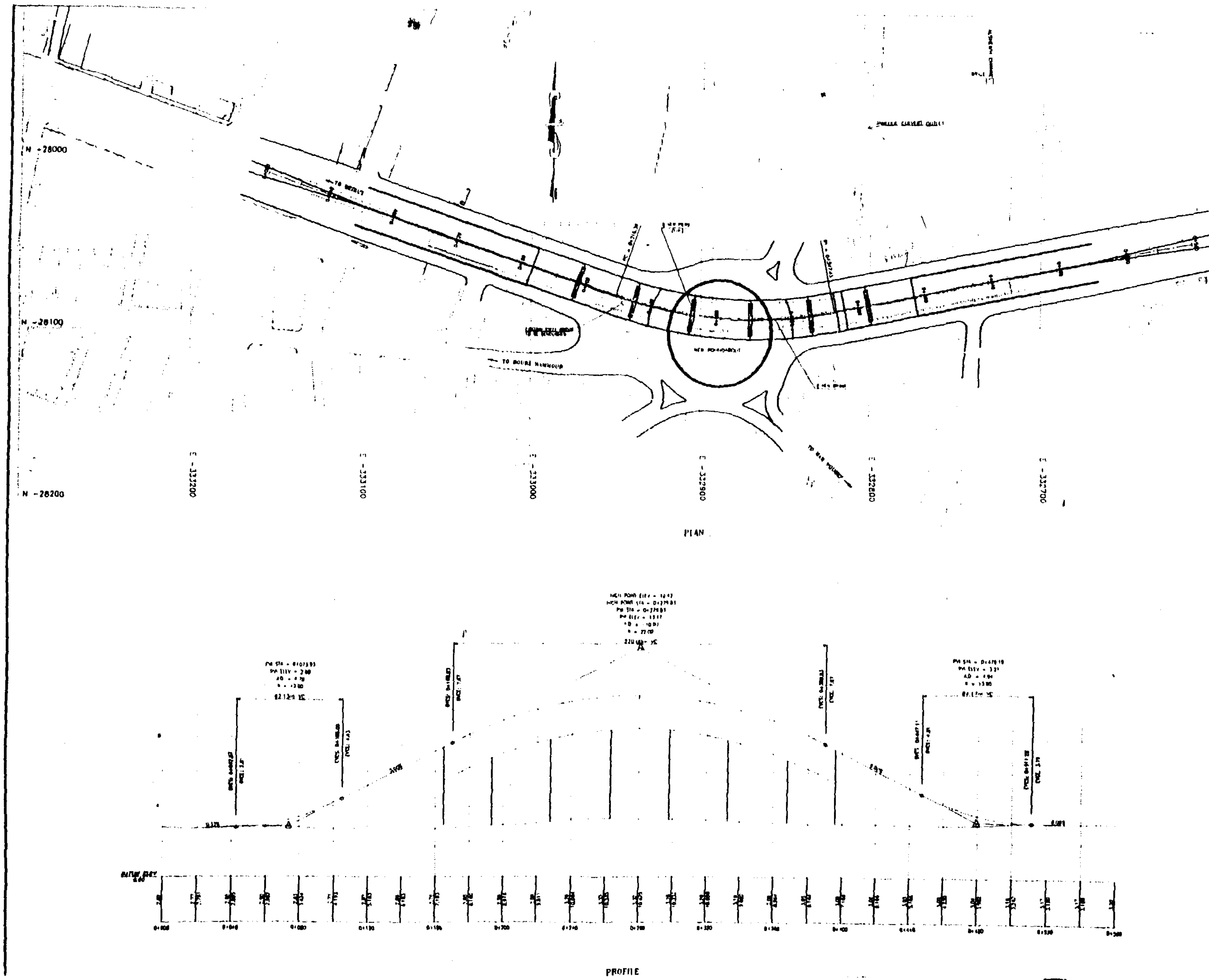
The LOS for the through traffic over the existing two-lane bridge is currently F. It is causing a bottle-neck throughout most of the hours of the day.

Future Conditions and Proposed Improvements

Analysis shows that the at-grade intersection would be operating at very low LOS, and the existing two-lane steel bridge (Eastbound) is expected to operate at LOS F. The proposed solution calls for removing the one-way two-lane steel bridge and replacing it with a 2x3 permanent overpass, and have the at-grade movements operate as a roundabout. With this solution, the level-of-service of the 2x3 overpass is expected to be E or better, by the year 2010, while the at-grade intersection would be operating satisfactorily as a roundabout. Plans and profiles of the proposed bridge are included in Figure 2-27.

Description of Proposed Grade Separation Structure

The proposed Dora overpass consists of dual bridges separated by 10cm gap. The bridges will carry eastbound and westbound traffic over a new Dora roundabout. The bridges have 231 m, 7-span continuous superstructure with 5-35 m middle spans and 2 –28 m end spans. The overall deck width of each bridge is 11.70 m, with a clear roadway width of 10.90 m. The superstructure is composed of a 1.60 m deep 2-cell pre-stressed concrete box girder with 2.0m cantilevering arms on each side of the box. The two exterior webs of the box girder are inclined. The substructure units are cast-in-place concrete and are supported on drilled concrete piles. The piers are formed from square columns that widen into a rectangular shaped bearing block. The abutments are cantilever-type with 2.50 m exposed face under the bridge deck. Retaining walls extending approximately 95 m from each side of the abutments along the marginal roads adjacent to the bridge embankment.



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DORA JUNCTION		
PROPOSED GRADE SEPARATION PLAN AND PROFILE		
Scale	N T S	Figure

2.4.6 Corridor No. 1: Corniche el-Mazraa

This is an important boulevard that circles most of Beirut City. It is a 2x3 facility at most of its alignment. Many of its intersections with radial routes are congested, but are not included in the scope of work. The two junctions under consideration are its intersection with the Damascus Road near the Museum, and the Adlieh junction.

The latter is a junction of Abdallah el-Yafi, Pierre Gemayel with Tahwita Road (New Damascus Road). The North-South traffic from Tahwita goes on President Elias el-Hrawi Bridge. The intersection at-grade is not currently operating at a good level-of-service.

2.4.6.1 Adlieh Junction

Description

Currently an overpass carries the traffic from Alfred Naccache to Tahwita, and vice versa, while other movements are served at-grade, not all movements are provided.

Existing Operating Conditions

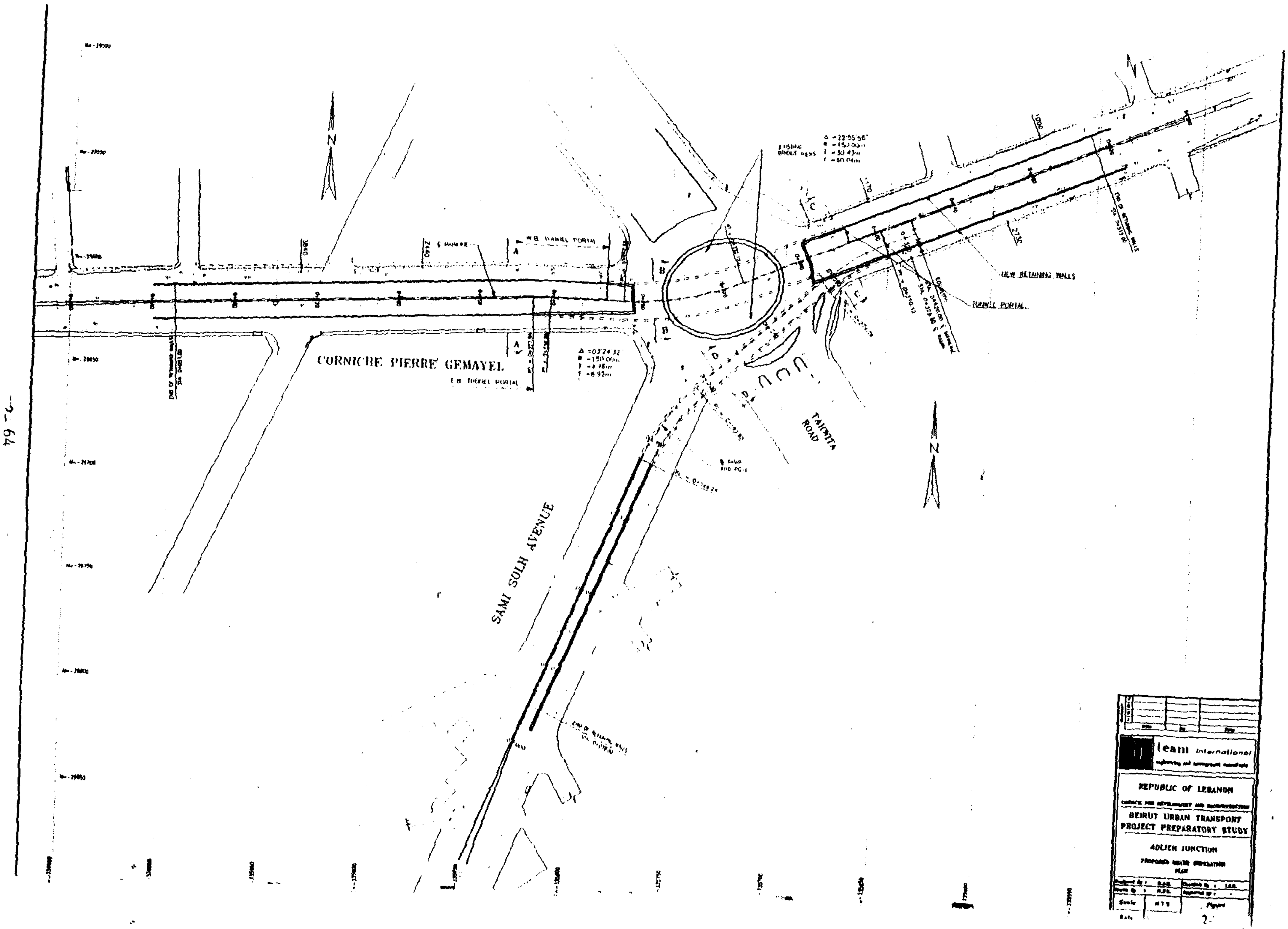
The peak hour average vehicle delay of 1998 traffic at the Adlieh junction is 385 seconds. Even with a 2x2 underpass carrying the traffic of Corniche el-Nahr, this intersection would still operate at a level-of-service E (50 sec. average delay). There is a heavy movement between Sami el-Solh and Corniche el-Nahr.

Future Conditions and Proposed Improvements

Analysis shows very high delays per vehicle are expected by 2010. The proposed solution would be to construct a 2x2 underpass along Corniche el-Mazraa and a one-way single lane underpass from Sami Solh Avenue to Corniche el-Mazraa going Eastbound and meeting with the two-lane underpass coming from Museum into a 3-lane roadway due East. This proposed solution is feasible and does not interfere with the foundations of the existing President Elias el-Hrawi Bridge. At the same time, all movements at-grade would be permitted and the junction would operate satisfactorily as a roundabout. This solution would bring peak hour average delay per vehicle down to 71 sec in year 2010. Plans and profiles of proposed underpasses are shown in Figures 2-28 and 2-29.

Description of Proposed Grade Separation Structure

A main two-cell cut and cover tunnel carrying eastbound and westbound traffic on Corniche Pierre Gemayel and joining, at its eastern end, with a directional one-way, one-cell cut and cover tunnel carrying Sami El-Solh northbound traffic under the Adlieh Roundabout. The lengths of the covered sections are 178 m and 161 m for the two-cell and one-cell tunnels respectively. The covered section of the main tunnel on Corniche Pierre Gemayel consists of two cells, one for each direction, separated by a 0.50 m concrete wall. The clear width of each cell is 8.35 m with a roadway width of 7.50 m measured from face-to-face of curb. The clear roadway width of the one-cell directional ramp tunnel is 5.50 m measured face-to-face of curb and representing one traffic lane. The southern cell of the main tunnel carrying eastbound traffic will be widened at the junction of the two tunnels to accommodate the 3 traffic lanes. From the tunnels portals, open roadway sections constituting the tunnels approach ramps and supporting the marginal roads extend 225 m from west portal, 110 m from east portal and 130m for south portal. The width of the open sections will match that of the closed section.



CORNICHE PIERRE GEMAYEL
SAMI SOLH AVENUE
W.B. TUNNEL PORTAL
E.B. TUNNEL PORTAL
NEW RETAINING WALLS
TUNNEL PORTAL
ROAD
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ADLIEH JUNCTION

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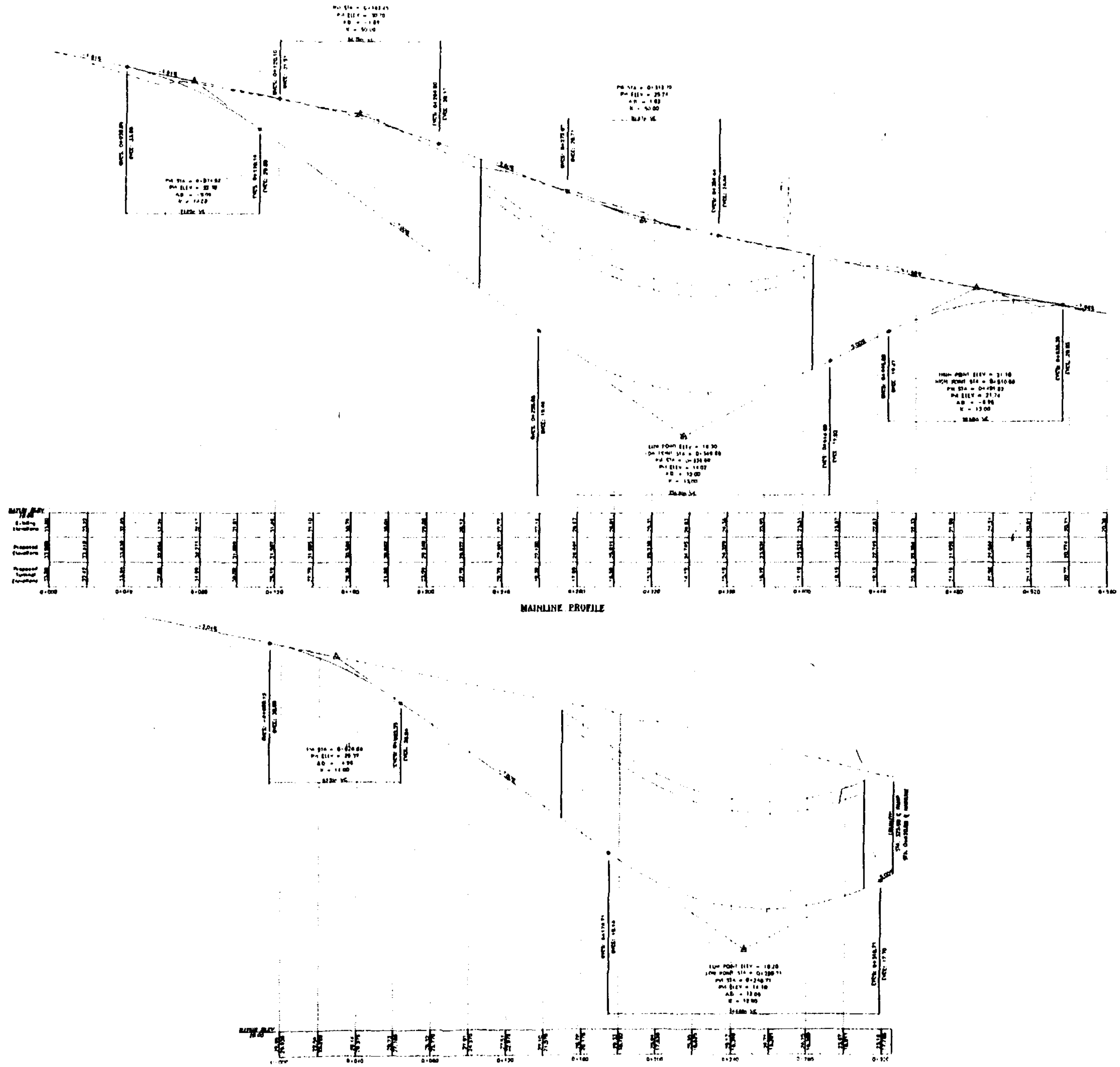

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PROJECT PREPARATORY STUDY

ADLIEH JUNCTION
PROPOSED GRADE SEPARATION
PROFILE

Designed By :	W.A.B.	Checked By :	I.B.B.
Drawn By :	H.B.B.	Approved By :	-
Scale	N T S	Figure	2.20

2.4.6.2 Museum Junction

Description

The intersection of Corniche el-Mazraa with Damascus Road is not a very congested intersection currently. The proximity to the Museum is an important constraint. An overpass is excluded due to its visual intrusion.

Existing Operating Conditions

Analyzing the traffic counted in 1998. and with an optimization of signal phasing. as proposed by the IAP. the average delay is 47 sec. provides an acceptable LOS and no grade separation is warranted at present.

Future Conditions and Proposed Improvements

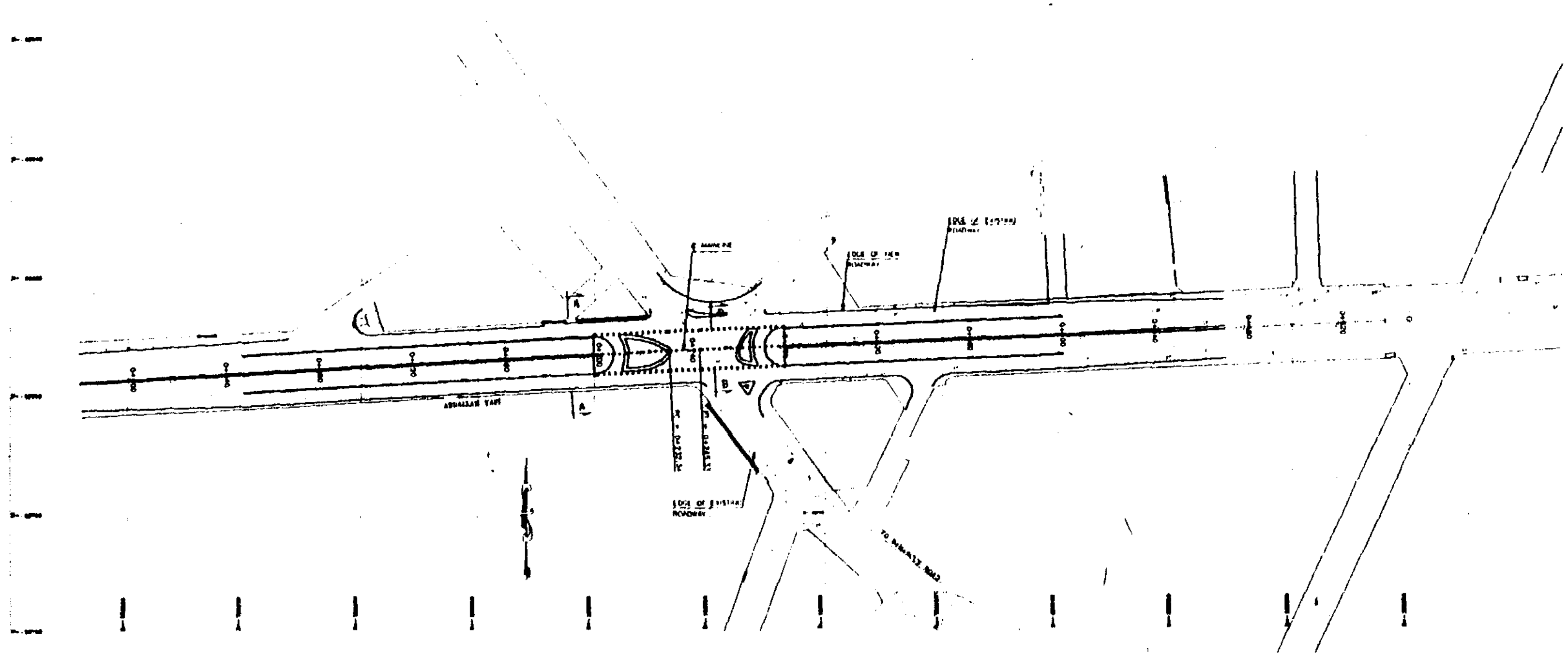
Analysis shows extremely high delays at this intersection by the year 2010 and even by 2005 (2340 and 2150 sec respectively). with the EW/WE traffic volumes are being the heaviest. a 2x2 underpass is proposed in the E-W direction and prohibiting Eastbound left turns in order to have a double right to get to Damascus Road Northbound. It should be noted that the available right-of-way on Abdallah el-Yafi is less than sufficient for a 2x2 underpass of 3.5 m lanes plus one ramp on each side. 5.5 m each. plus adequate sidewalks. The existing monument for the Unknown Soldier will not be touched. but the garden in which it is placed will be. It is proposed during final design to consider reducing slightly the main-line and ramp widths (i.e. 3.2 m lanes on main-line and 5.2 m ramps). With this proposed solution. the average delay per vehicle is expected to be 27 sec by the year 2010. It should be mentioned that traffic direction on Hotel Dieu Street has to be changed from one-way inbound to one-way outbound of the intersection. This complies with proposals made in the Immediate Action Plan. Plans and profiles of the proposed underpass are shown in Figure 2-30.

Description of Proposed Grade Separation Structure

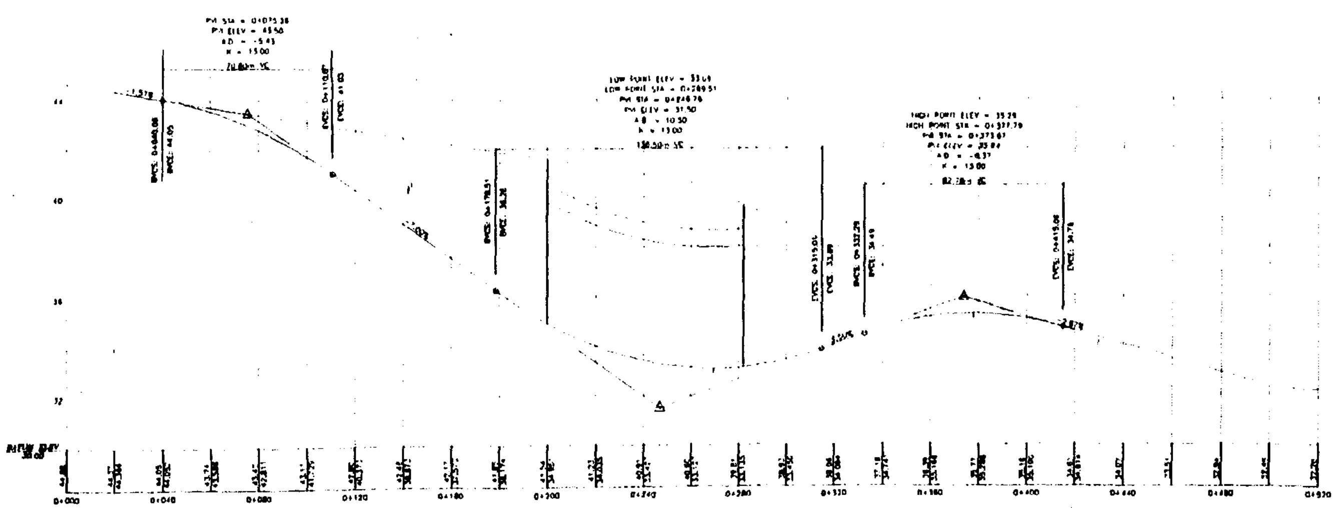
The proposed underpass is a 2-cell cut and cover tunnel carrying Abdallah Yafi Avenue traffic under Damascus Road. The overall length of the underpass is 332 m of which 82 m constitutes the covered section under the intersection. The covered section consists of two cells. one in each direction. separated by a 0.50 m concrete wall. The clear width of each cell is 8.35 m with a roadway width of 7.50 m measured from face-to-face of curb. The minimum clear height of the cell is 5.0 m. From each side of the tunnel portals. open sections extend approximately 115 m long forming the ramps of the tunnel. The clear width of the open sections is 17.20 m measured face-to-face of retaining walls representing 2-7.50 m roadway widths in each direction separated by a 1.0 m median barrier and a 0.60 m curb on the right side of the roadway. The retaining walls of the open sections support the marginal roads adjacent to the tunnel ramps. Exposed faces of the retaining walls are formed with vertical striations type finish.

2.4.7 Corridor No. 18: Old Saida Road

Old Saida Road is a long corridor starting from Khaldeh in the South and due North into the City of Beirut. It intersects with Chiyah Blvd. at Mar Mekhael. Near Khaldeh two close roads T-intersect with it: the Bchamoun and the Aramoun Roads. Traffic at those intersections experience a lot of delay. Many schools and an industrial zone are located in the hills of Bchamoun and residential areas are mushrooming on the hills. The proposed Périphérique alignment runs to the East of this corridor and close to this junction.



GENERAL PLAN



PROFILE

[illegible]	Date	By	Title

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BEIRUT URBAN TRANSPORT PROJECT PREPARATORY STUDY

ABDALLAH YAFI/DAMASCUS ROAD (MUSEUM) JUNCTION

PROPOSED GRADE SEPARATION
PLAN AND PROFILE

Designed By :	H.A.S.	Checked By :	[illegible]
Drawn By :	F.S.D.	Approved By :	-
Scale	N T S	Figure	
Date	[illegible] 1999	2-30	

2.4.7.1 Bchamoun - Aramoun Intersection

Description

The two T-intersections of Bchamoun and Aramoun Roads with Old Saida Road are very congested. No physical constraints exist except the presence of a natural water course, which precludes an underpass at this location. The proposed Périphérique alignment provides a connection with Bchamoun Road. The construction of the Périphérique will not significantly reduce the problem at that location, because most of the traffic from and to Bchamoun and Aramoun is origined and destined in Western Beirut and the Périphérique has no value in serving it.

Existing Operating Conditions

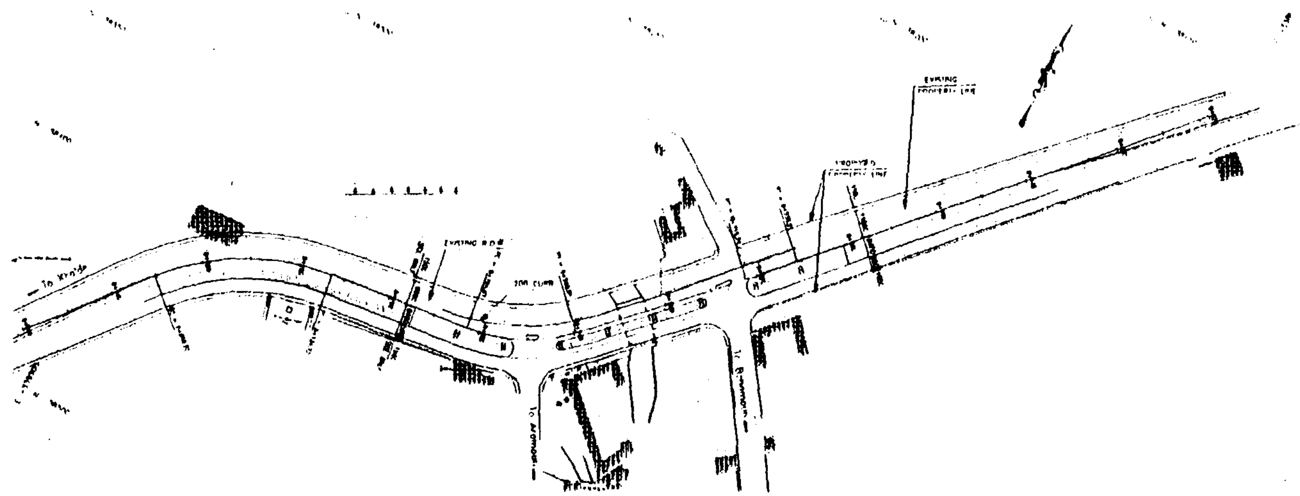
Based on 1998 traffic counts, an analysis of Bchamoun and Aramoun intersection with old Saida Road shows that the average delay at both Aramoun and Bchamoun intersections is 182 sec. This is a very low level-of-service. If additional right-of-way is expropriated to provide the required number of lanes at the approaches and the required queue storage, the intersection can operate at an acceptable LOS under coordinated signal control.

Future Conditions and Proposed Improvements

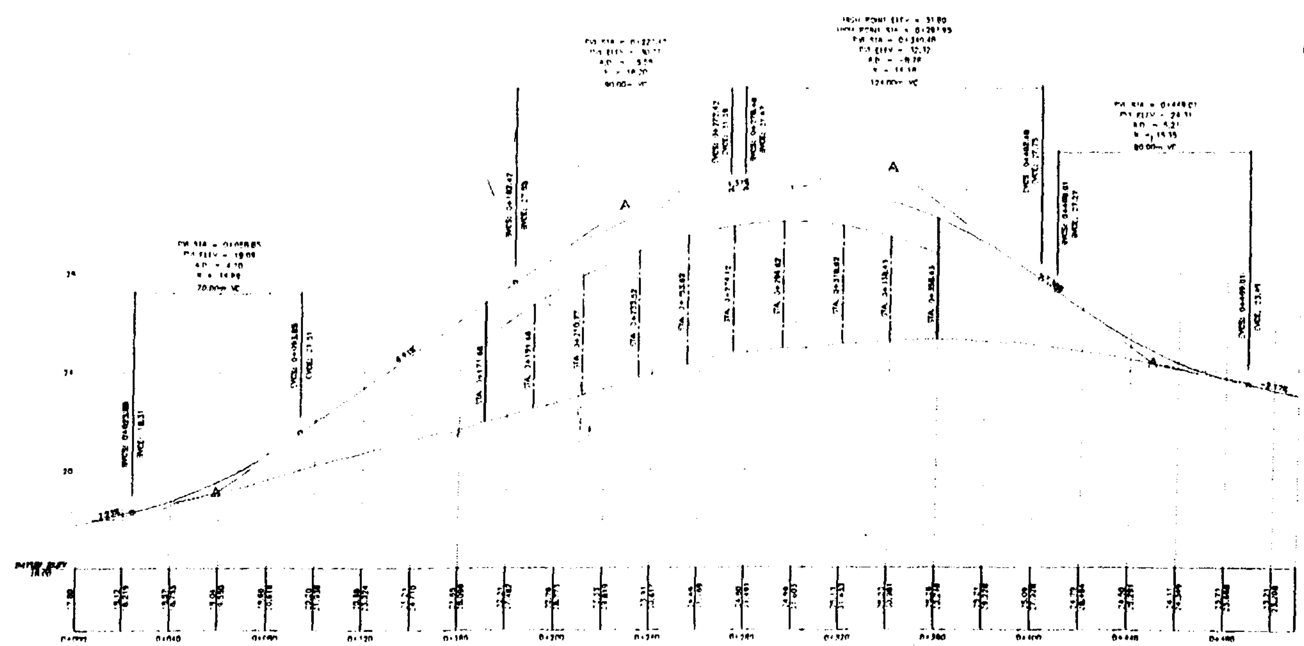
Analysis shows an expected average delay per vehicle of over 900 sec by the year 2010. A proposed solution of a 2-lane one-way overpass going Northbound on Old Saida Road would have the at-grade signalized intersection operating at an acceptable LOS with an expected delay of 27 sec by 2010. Plans and profiles of the proposed overpass are shown in Figure 2-31.

Description of Proposed Grade Separation Structure

Bchamoun-Aramoun bridge is a single direction bridge carrying northbound traffic over Bchamoun and Aramoun entrances, while southbound traffic will remain at grade. The bridge has 219 m.11-span continuous superstructure with spans lengths varying from 16 m to 24 m. The overall deck width is 8.30 m. with a clear roadway width of 7.50 m representing two traffic lanes. The bridge superstructure is composed of a 1.0 m deep solid slab with 1.50m long cantilevering arm with thickness tapering down to 0.25 m. on each side. The bridge substructure units are cast-in-place concrete and are supported on shallow foundations. The piers are formed from a rectangular single column that flares into a rectangular shaped bearing block. The abutments are cantilever-type with 2.50 m exposed face under the bridge deck. Retaining walls extending approximately 110 m from each side of the abutments along the marginal roads adjacent to the bridge embankment.



GENERAL PLAN



PROFILE

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PROJECT PREPARATORY STUDY

BCHAMOUN-ARAMOUN JUNCTION

PLAN AND PROFILE

3. ECONOMIC ANALYSIS METHODOLOGY

3.1 Introduction

Cost-effectiveness evaluation of transportation alternatives requires an estimation. understanding. and comparison of the wide range of impacts these alternatives typically generate. The economic. financial. social. and environmental impacts are traditionally assessed through appropriate evaluation methodologies; and trade off analyses are made in order to provide the decision makers with good information.

The evaluation of transportation investments has traditionally been conducted using *link level* vehicular demand and performance estimates. This approach accounts for user benefits only on the improved highway segments. suggesting that benefits or disbenefits to "undiverted trips". i.e. trips that do not shift from other facilities to the improved facility. can be ignored. On the other hand. an alternative approach using network-wide demand and performance estimates suggests that benefits accruing to users of unimproved facilities also would be accounted for in computing total user benefits. This approach accounts for benefits to these "non-user" area-wide. rather than restricting benefits analysis to those benefits that accrue only within the corridor of interest.

Since. most of the impacts of the proposed transportation improvements for the Beirut Urban Transport Project in terms of the Traffic Management Improvement Program. the Parking Improvement Program and the Grade Separation Improvement Program are realized at the highway network level. the Consultant used an analytical tool that estimates impacts of transportation alternatives in a system-wide context. The used tool is the Surface Transportation Efficiency Analysis Model (STEAM). recently developed by Federal Highway Administration to assist planners and engineers in developing economic efficiency and other evaluative information needed for comparing alternative transportation strategies in an urban area on a system-wide basis.

3.2 Overview of Steam

STEAM has been developed in 1998 by Cambridge Systematics Inc. for Federal Highway Administration (FHWA) to produce estimates of system-wide impact. i.e. impact estimation is not limited to the improvement corridor. Although. the STEAM software package is currently in its build 2.0 version. its users are increasing at a rate of 2 new customers per day.

STEAM accepts input directly from the four-step travel demand modeling software such as MINUTP. TRANPLAN. or EMME/2[1]. It post-processes traffic assignment outputs from conventional four-step travel demand models in order to more accurately estimate highway travel speeds under congested conditions[2]. STEAM is highly flexible in terms of the transportation modes. trip purposes. and time periods analyzed. It provides default analysis parameters for seven modes (auto. truck. carpool. local bus. express bus. light rail. and heavy rail) and allows the user to accommodate special circumstances or new modes by modifying these parameters.

---

[1] STEAM User Manual. FHWA. May 1998.

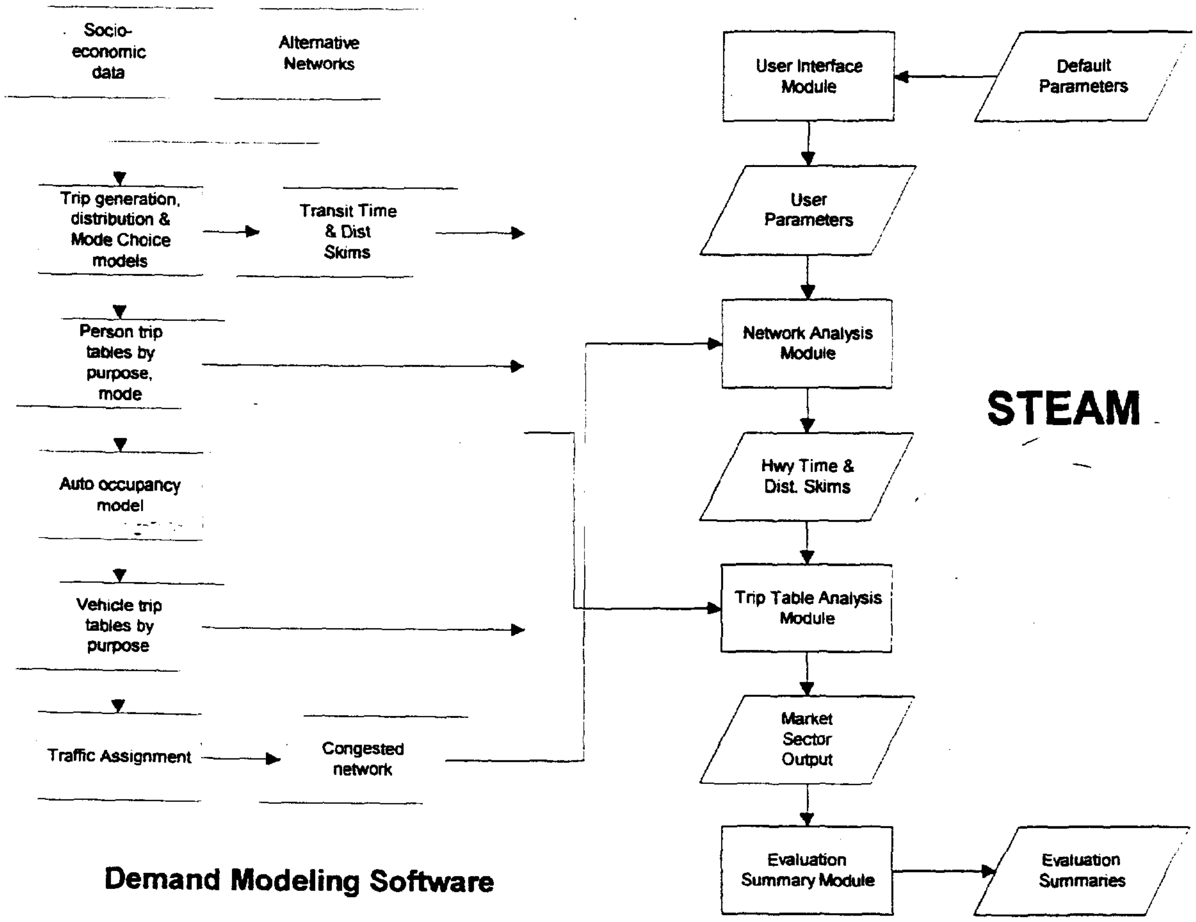
[2] Kideard Margiotta (SAIC). & Harry Cohen (Cambridge Systematics). "Improved Speed Estimation Procedures for Estimating Travel Time and Air Quality Benefits" prepared for Metropolitan Planning Division. Federal Highway Administration, 1998.

The software develops impact estimates for a wide range of transportation investments and policies, including major capital projects, pricing, and travel demand management (TDM). Impact measures are monetized to the extent feasible, and quantitative estimates of natural resource usage (e.g., energy consumption) and environmental impacts (e.g., pollutant emissions) are also provided. Decision makers can then use net monetary benefits (or costs) of alternatives as computed by STEAM to evaluate trade-offs against non-monetizable impacts.

As shown in Figure 3-1, STEAM consists of four modules:

1. A User Interface Module, which includes on-line help files.
2. A network Analysis Module, which reads a file containing highway link data and produces zone-to-zone travel times and distances based on minimum time paths.
3. A Trip Table Analysis Module, which produces estimates of user benefits based on a comparison of Base Case and Improvement Case travel times and out-of-pocket costs for each zone-to-zone trip interchange for a given forecast year. It also produces estimates of pollutant emissions, noise costs, accident costs, energy consumption, and other external costs associated with highway use.
4. An Evaluation Summary Module, which calculates net present worth and a benefit-cost ratio for the improvement under consideration. It also provides summary information on individual benefit and cost items, and probability distributions of several performance measures based on a risk analysis.

Figure 3-1: Overview of STEAM Analysis Procedures



3.3 BUTP Economic Evaluation Methodology

3.3.1 Methodology

The methodology. for conducting the BUTP economic analysis task. consists of 4 steps:

- The input parameters module
- The network analysis module and the economic analysis module
- The evaluation summary module: and
- The risk analysis module.

The Input Parameters Module determines the vehicle operation costs (VOC) by vehicle class. speed range and cost items and the value of time for vehicle drivers by vehicle class. This module utilizes input data mainly obtained from secondary sources. This step is conducted outside STEAM and utilizes the HDM-VOC program (Version 4.0. 1994) to estimate VOC. The values of time are determined from the home interview survey conducted by the Consultant for Greater Beirut Area residents in 1994. A statistical package (SPSS) is used to calculate the income of tripmakers by type of profession and then classify their tripmaking into productive and non-productive trips. The hourly value of time is then escalated to the year 1998 based on GDP annual growth.

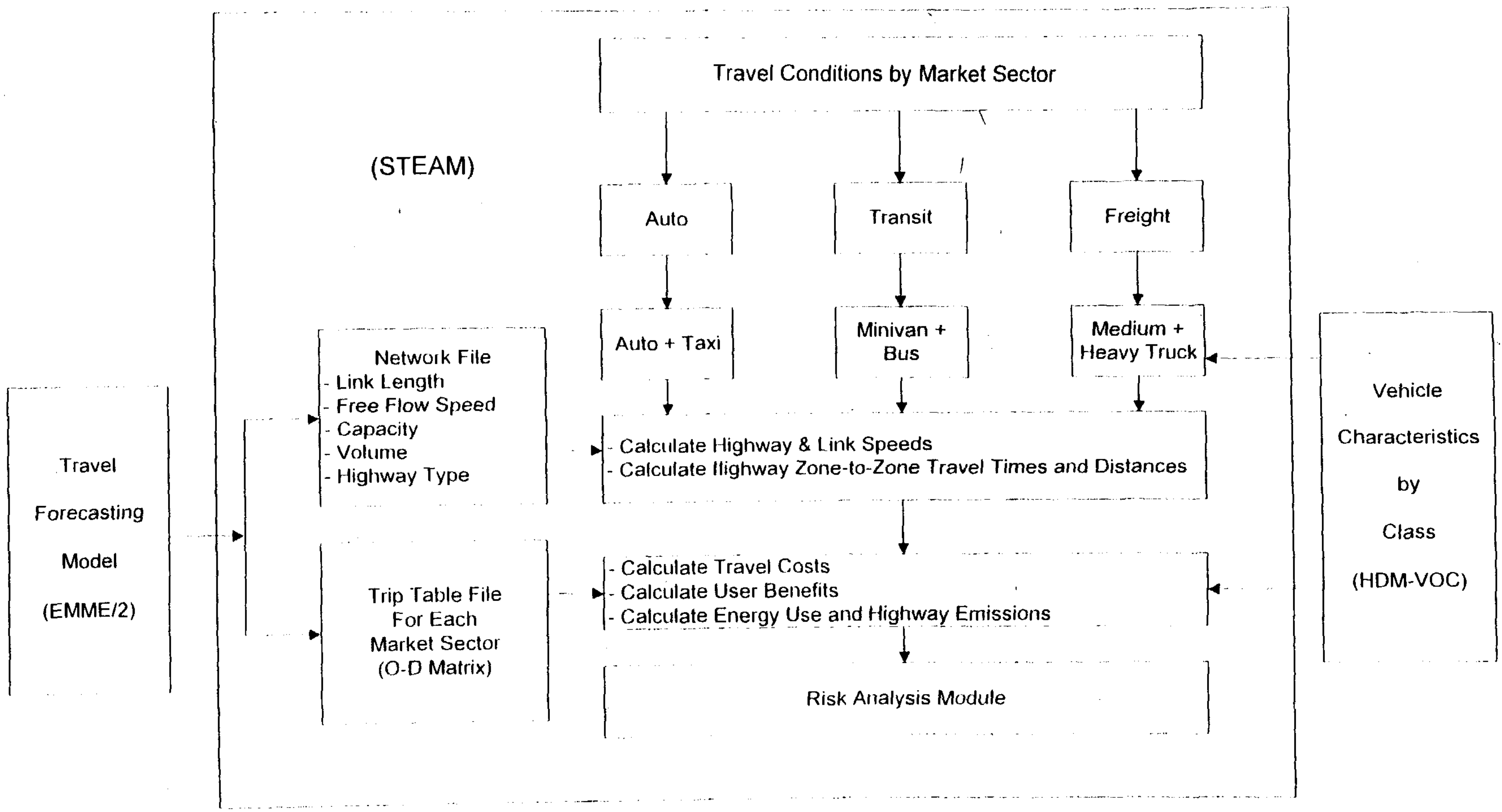
The other three steps are conducted using STEAM software. The Highway Network Analysis Module receives an input file from the travel forecasting model (EMME/2) containing link data such as length. free flow speed. capacity. volume. and highway type and computes zone to zone travel speeds. travel times. and distances based on minimum time paths through the network using the speed-volume relationships developed by STEAM for urban congestion condition The Economic Analysis Module produces estimates of user benefits. based on a comparison of Base Case and Improvement Case conditions. It also produces estimates of energy consumption and emissions. A flowchart describing the interrelationship among STEAM. EMME/2. and HOM-VOC is shown in Figure 3-2.

3.3.2 Market Sectors

The proposed improvements in Beirut Urban Transport Project affect travel conditions for a set of "market sectors". namely auto. transit. and freight. The auto-market includes all travelers by passenger cars whether small. medium. or large and by taxis. The transit sector includes travelers using public transport minivans and large buses. The truck market includes freight movements by medium and heavy trucks. In fact. the classification of vehicles adopted by the Consultant for estimating vehicle operating costs using HDM-VOC and values of travel time. were easily translated into the aforementioned three market sectors. The following grouping of vehicle classes into market sectors is shown below:

	Market Sector	Vehicle Class
1.	Auto	- Passenger car * small * medium * large - Taxi
2.	Transit	- Minibus - Large bus

FIGURE 3-2: THE RELATIONSHIPS BETWEEN STEAM, EMME/2 AND HDM-VOC



3. Freight - Medium truck
- Heavy truck

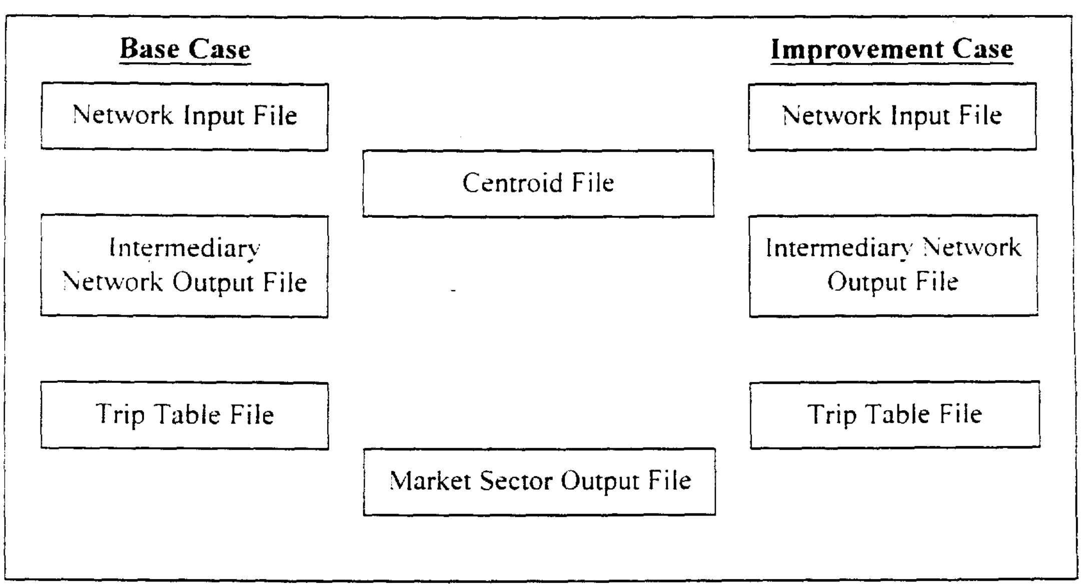
The average vehicle operating costs and values of time weighted by percent of vehicle population in each vehicle class is used in determining the corresponding unit travel cost for each market sector.

3.3.3 Estimation of Benefits and Costs

For each market sector to be analyzed. STEAM software accepts the Base Case and the Improvement Case trip tables for a particular year. specifying the number of trips from each analysis zone to other zones. STEAM uses this information to calculate the user benefits for each zone pair. and then sums them over all zone pairs. Zone-to-zone travel times. and distances for the Base Case and the Improvement Case are estimated as stated earlier. using the Network Analysis Module which uses network input file from EMME/2 and the speed-volume relationships developed by STEAM for urban congestion conditions. Figure 3-3 presents the files associated with a market sector for a particular analysis year.

Motor vehicle operating costs for each market sector are calculated as the sum of fuel and non-fuel costs by applying unit (per vehicle unit) fuel consumption rates (as a function of speed) and costs from zone-to-zone distances. The model also computes the dollar value of travel time for each zone pair by applying the corresponding unit travel time values for passengers and drivers in a market sector to zonal travel times determined by the Network Analysis Module.

FIGURE 3-3: STEAM Base and Improvement Case Files



The difference in the total cost of travel for each zone pair between Base Case and Improvement Case is calculated as the sum of changes in vehicle operating costs and the dollar value of changes in travel time. Then these values are summed over all zone pairs.

STEAM analyses are repeated for several critical years that represent significantly different travel conditions. Based on the various analysis year results. a stream of annual benefits are estimated. and these benefits are converted (exogeneously to STEAM) to a present value and compared to the present value of the cost stream to determine the Net Present Value (NPV). and other economic indicators such Internal Rate of Return (IRR) and First Year Rate of Return (FYRR).

Operation and Maintenance costs are annualized for the total life of the project. so that they can be related to the annual benefits. Total Capital Costs are converted into a stream of annual costs starting in the first year of construction and extending to the year of opening of the project.

3.4 Steam Risk Analysis Module

Uncertainty is a key attribute of both the physical and economic components of transportation user costs. Risk analysis is useful to reflect both what is known and what is uncertain in the effect of transportation conditions and performance on user costs.

Risk analysis module in STEAM allows the Consultant to evaluate the different transportation improvements programs under a variety of uncertain conditions or scenarios. The result of the risk analysis for a particular scenario is a forecast of future outcomes and the probability or odds of their occurrence.

Probability density functions for key input variables. such as vehicle operating costs and value of time per vehicle class, and capital and operating costs. are established by the user. They are accomplished by attaching probability distributions to the forecasts of each key input variable. The probability distribution for the key variable in-question is established on the basis of both statistical analysis and subjective probability. The methodology uses a Monte Carlo simulation process to generate the probability distribution of each result or output variable from repeated samplings of the "probability density functions" of key input variables. For each result. there is both a forecast and a quantification of the probability that the forecast will be achieved.

3.5 Steam Input Parameters

A list of the input model parameters for STEAM. of relevance to this project. is provided below:

- Value of time (auto, truck, local bus)
- Discount rate
- Cost per gallon of fuel (auto, truck)
- Fuel consumption rates
- Auto and truck fuel consumption rates (5 MPH categories)
- Transit fuel consumption rates (local bus)
- Non-fuel highway user costs per vehicle mile (auto, truck)
- HC emission rates per vehicle mile
- Auto and truck HC emission rates (5 MPH categories)
- CO emission rates per vehicle mile
- Auto and truck CO emission rates (5 MPH categories)
- NOx emission rates per vehicle mile

- Auto and truck NOx emission rates (5 MPH categories)
- PM 10 emission rates per vehicle mile
- Auto and truck PM 10 rates (5 MPH categories)
- Emissions per cold start (auto and truck HC. CO, NOx. PM 10)
- Cold start per vehicle trip (auto. truck).

The input data for STEAM for various analysis years for Traffic Management improvement program (Case 1) is shown in the Annex.

3.6 Steam Sample Output

A sample output of STEAM is shown in the Annex. which presents the output parameters of the model. This sample model run is conducted with Risk Analysis.

4. MEASURES OF EFFECTIVENESS AND PROJECT BENEFITS

4.1 Introduction

The primary benefits used in evaluating each proposed improvement in Greater Beirut Area are the quantifiable and monetizable benefits that accrue to road users in form of reduced travel time and reduced vehicle operating costs. There are several other important but non-moneterized benefits such as those derived from reduced pollution, reduced noise and reduced accidents. In addition, there are important non-monetizable institutional benefits derived from the institution building component of this project, which are discussed in other deliverables.

The non-monetizable benefits derived from reduced pollution, reduced accidents and increased trade are discussed first, followed by the methods and the results for estimating the value of time and the vehicle operating costs.

4.2 Measures of Effectiveness

The three physical improvement components of the BUTP have measurable criteria of effectiveness. This section highlights them.

4.2.1 Traffic Management Component

The Traffic Management Component's effectiveness can be measured in two ways. The first is the intersection's level-of-service (LOS), which is the average stopped delay per vehicle. The second is the average travel time and speed along major corridors.

Table 4-1 summarizes the LOS at the intersections to be signalized, showing the current and the expected LOS as a consequence of implementing the proposed circulation plans and the installation of the traffic signals.

Similarly Table 4-2 documents the average travel time and speed along major corridors, prior to the implementation of the proposed traffic management measures. These figures constitute a benchmark against which to measure the effectiveness of the implemented measures.

Setting up of the Traffic Management Organization (TMO) will also have important impacts which include: a reduction in the average time between failure of a signal and its repair. During the last two years, several intersections in the Study Area were equipped with traffic signals, as part of road improvement projects. Most of them are not operational now, due to the absence of the TMO that takes care of their maintenance. Another measure of effectiveness of the TMO is the increased responsiveness to the changes in traffic patterns which are entirely absent today.

It is recommended that a full "Before and After Study" be conducted as part of the BUTP. The "Before Study" should be conducted immediately prior to putting the traffic signals and TCC in operation. Such a study should measure intersection delays and speed along various corridors. An "After Study" should be conducted once conditions stabilize following the implementation of the traffic management component.

4.2.2 Parking Improvement Component

The organization of on-street parking will have significant impacts on the fluidity of traffic and the capacity of the streets and intersections. It would be difficult to measure these benefits in isolation from those attributable to the traffic management component.

TABLE 4-1 : GREATER BEIRUT AREA INTERSECTIONS' LEVEL-OF-SERVICE SUMMARY

Int. No	Location Description	1994 Existing LOS	IAP Intersection LOS
1	Fakhreddine St at Ahmad Shawki St	*	C
2	Fakhreddine St at Omar El Daouk St	F	B
3	Fakhreddine St at Climenceau St	C	B
4	Fakhreddine St at Michel Chiha St	E	B
5	Fakhreddine St at Spears	E	B
6	Climenceau St at May Zivadeh St	B	B
7	Climenceau St at Jestinian St	A	A
8	Michel Chiha St at May Zivadeh St	F	C
9	Michel Chiha St at Jestinian St	B	C
10	Climenceau St at Rbeiz	A	A
11	Spears St at Halwani	B	C
12	Bliss St at Abdel Aziz St	B	D
13	Abdel Aziz St at Makhoul St	D	D
14	Abdel Aziz at Sidani St	B	B
15	Sorati St at Cairo St	B	B
16	Makdisi St at Cairo St	B	B
17	Abdel Aziz St at Makdisi St	B	B
18	Hamra St at Amin Mnaimneh St	C	A
19	Abdel Aziz at Hamra St	B	C
20	Hamra St at Ibrahim Abdel Aal St	A	A
21	Hamra St at Jean D'arc	B	B
22	Kuwait St at Tannoukhin	D	A
23	Bliss St at Najib Ardati St	B	B
24	Sadat St at Mansour Jirdak	B	B
25	Sidani St at Ghandi St	F	B
26	Climenceau St at Roma St	*	B
27	Sorati St at Roma St	*	B
28	Hamra St at Roma St	B	A
29	Emille Edde St at Roma St	B	C
30	Roma St at Dunant St	F	A
31	Ain El Mraisseh at Abdel Nasser	*	B
32	Entrance Ain El Mraisseh Street	*	B
33	Bain Militaire	*	C
34	Raouche at Dbaibo	*	B
35	Mar Elias St at Algeria St	F	C
35A	Algeria St at Batriarcat St	NC	C
35B	Algeria St at Chouf St	NC	B
36	Mar Elias St at Independence Ave	F	C
36A	Indenendence Ave at Chouf St	NC	B
37	Independence Ave at Midhat Bacha St	C	B
38	Algeria St at Midhat Bacha St	B	C
39	Verdun St at Bachir Kassar St	*	C
39A	Verdun St at Tamer Mallat St	NC	B
40	Itani St at Abdallah El Machnouk	D	C
40A	Itani St at Badr Dimachkiveh St	*	C
41	Itani St at Madame Curie	C	C
42	Madame Curie at Alfred Nobel	F	B
43	Mar Elias St at Rachid Nakhle St	F	C
44	Mar Elias St at Bachir Junblat	B	C
45	Mar Elias St at Mazraa St	C	B
46	Hashem Khalil St at Ibn Rochoud	B	B
47	Hashem Khalil St at Daibis El Murr	B	B
48	Mar Elias St at Imam Abi Hanifa	B	B
49	Midhat Bacha St at Rachid Nakhle St	B	C
50	Berlin St at Australia St	B	A
51	Verdun St at Al Wihda Al Wataniya	F	A
52	Verdun St at Unesco	D	B
53	Rachidine St at Bashir Kassar St	F	B
53A	Rachidine St at Tamer Mallat St	NC	B
54	Hashem Khalil St at Abi Hanifa	B	B
55	Rachidine St at Algeria St	F	C
56	Rachidine St at Independence Ave	E	C
57	Tallet El Drouze - Verdun	F	D
58	Dunant-Verdun-Descent Es Safir	D	A
59	Emille Edde St at Sadat St	C	C
60	Badr Dimachkiveh at Madame Curie	B	B

Int. No.	Location Description	1994 Existing LOS	IAP Intersection LOS
61	Chatila at Khaled Shehab	E	C
62	Madame Curie at Abdel Menhem Riad	B	C
63	Madame Curie St at Saudi Arabia Embassy	C	C
64	Ain El Mraisseh St at Graham St	B	B
65	Hashem Khalil St at Bachir Kassar St	B	B
66	Badr Dimachkiyeh at BUC	B	B
67	Raouche at Salah Eddine St	C	B
68	Hamra St at Cairo St	A	A
70	Climenceau St at Street No 50	A	A
71	Sadat St at Hamra St	B	A
73	Abdel Aziz St at Emille Edde St	B	C
75	Abdel Aziz St at Baalbeck St	B	B
78	Emille Edde St at Cairo St	B	B
79	Emille Edde St at Amin Mnaimneh St	B	C
102	Al Barrakieh at Boutros Boustani St	F	B
103	Algeria-Independence-Moussaitbeh-Hamra	C	C
104	Moussaitbeh St at Wassef Baroud St	*	B
107	Ahmad Beyhum St at Abi Bakr Es Siddik	*	C
108	Independence Ave at Tabbara	B	D
109	Borj Abi Haidar St at El Maamoun	D	A
110	Borj Abi Haidar St at Sbai St	B	A
111	Borj Abi Haidar St at Abdel Ghani Arayssi	B	B
112	Borj Abi Haidar St at Mazraa St	B	B
113	Borj Abi Haidar St at Zreik	B	B
114	Bachir Jounblat St at Salim Salam Blvd	B	C
116	Independence Ave at Bechara Khoury St	F	B
117	Independence Ave at Basta St	*	B
118	Independence Ave at Ahmad Tabbara	D	C
119	Basta St at Maamoun	C	C
120	Abdel Fattah Hamad St at Boutros Boustani	*	B
121	Omar Ben El Khattab St at Saleh Ben Yahya	B	B
122	Omar Ben El Khattab St at Ras El Nabaa	*	B
123	Bechara Khoury St at Noueiri	B	C
124	Mohammad El Hout St	A	B
125	Basta St at Mazraa St	A	B
126	Basta St at Noueiri	C	B
128	Jisr Fouad Chehab at Church El Injilia	*	C
131	Salim Salam Ave at Fouad Chehab Ave	A	A
132	Fouad Chehab Ave at Bechara Khoury St	F	D
201	Adib Ishac St at Habib Bacha	F	C
202	Alfred Naccache St at Guatemala St	E	C
202A	Alfred Naccache St at Sassine St	NC	C
203	Alfred Naccache St at Voice of Lebanon	C	A
204	Independence Ave at Adib Ishac St	C	B
205	Independence Ave at Rizk Hospital	D	B
206	Independence Ave at Baydoun Mosque	D	B
208	Independence Ave at Damascus Rd	F	D
209	Independence Ave at Iskandar St	D	B
210	Independence-El Saideh- El Masarra	C	B
211	Independence Ave at Cheikh El Ghabi	B	B
212	Amin Gemayel St at Cheikh El Ghabi	A	B
213	Amin Gemayel St at Jalakh St	B	C
214	Furn El Hayek St at Adib Ishac St	C	B
215	Furn El Hayek St at Achrafieh St	B	C
216	Alfred Naccache St at Mar Mitr Cemetery	A	B
217	Alfred Naccache St at Mar Mitr St	*	B
218	Fouad Chehab Ave at Hikmeh	F	B
219	Mar Mitr St at Nassif El Rayess	B	B
220	Fouad Chehab Ave at Youssef Sursock St	D	B
221	Fouad Chehab Ave at Nassif El Rayess	B	C
222	Fouad ChehabAve at Kindou Street No 66	B	B
223	Mar Mitr St at Zahret El Ihsan	B	C
224	Fouad Chehab Ave at Talaat El Ikkawi	F	C
225	Fouad Cheheb Ave at Mar Nicola	B	B
226	Fouad Chehab Ave at Tabaris	F	D
227	Talaat El Ikkawi at Batrak El Orthodox	B	A

TABLE 4-1 (Contd) : GREATER BEIRUT AREA INTERSECTIONS' LEVEL-OF-SERVICE SUMMARY

Int No	Location Description	1994 Existing LOS	IAP Intersection LOS
228	Talaat El Ikkawi at Goreaud St	C	D
229	Saint Louis St at Lebanese Hospital St	B	B
230	Nahr St at Khodor St	A	C
231	Kubaiyyat St at Kataeb Statue	B	B
232	Charles Helou Ave at Brazil St	A	A
233	Nahr St at Skoda Cars	B	B
234	Nahr St at Transport Utilities	B	B
235	Adib Ishac St at Habib Bacha	A	A
236	Habib Bacha St at Hotel Dieu St	A	B
237	Mar Mitr St at Orthodox Hospital St	B	B
240	Independence-El Saideh extension- El Masarra	B	B
301	Spinneys-Cola-Unesco	F	B
302	Habib Abi Chahla St at Mouaouiya	E	D
304	Habib Abi Chahla St at Social Security	C	B
305	Afif Tibi St at Arab University St	*	D
307	Municipal Stadium Square	*	D
310	Soleiman Boustani St at Tarik El Jadidah	C	C
311	Sabra St at Dana	C	D
312	El Sabil Square	C	C
315	Asaad El Asaad St at Mucharrafieh Chiyah	D	D
316	Maroun Misk St at Hassan Kanj St	C	D
317	Old Saida Rd at Maroun Maroun St	F	C
318	Sannine Street	B	D
320	Old Saida Rd at Rocade Urban North	C	C
321	Chahidain St at Neamani St	B	B
322	Chahidain St	A	C
323	Chahidain St at Maroun Misk St	F	C
324	Damascus Rd at Badaro St	D	B
325	Damascus Rd at Sami Solh Ave	*	D
329	Damascus Rd at Furn El Chebbak Tahwita	F	D
330	Camille Chamoun Blvd at Kataeb Statue	*	D
331	Maroun Maroun St at Pierre Gemayel St	F	D
332	Maroun Maroun St at Chahidain St	F	D
336	El Nahr - Borj Hammoud St at Arminia St	B	C
337	Municipality Square - Borj Hammoud	E	B
340	Amanous Square	C	C
341	Borj Hammoud	C	C
342	Malaab El Baladi at Kilikia St	E	C
343	Nahr Rd at Roastery El Rahib	E	D
344	Nahr Rd at Snack Ghaleb	E	D
352	Cola Roundabout	*	C
354	Farid Trad St-Hariri Ave-Al Akhtal Assagir St	C	C
355	Al Akhtal Assagir St at Adnan Hakim St	F	D
360	Ouzai Coastal Hwy at Henri Chehab Military Base	C	C
361	November Ave at Jalloul St	A	C
362	Adnan Hakim St at Sports City Blvd	*	C
363	Tayouneh Roundabout	F	C
364	Chatila Roundabout	F	D
365	Sports City Blvd at College of Science	*	D
406	Old Tripoli Rd at Deek El Mehdi	E	E
408	Old Tripoli Rd at El Naccache	F	C
409	Antelias Square	*	C
410	Coastal Highway at Antelias	E	C
411	Jal El Dib Square	*	E
412	Coastal Highway at Jal El Dib	E	D
419	Old Bouchrieh Rd at Mar Takla	D	C
421	Jdaideh Ave at Sabtiyeh	C	C
425	Damascus Rd at Jisr El Bacha Rd	F	C
426	Damascus Rd at Jisr El Bacha Bypass Rd	B	A
427	Dar Assayad	F	D
428	Chiyah Blvd at Hadath Baabda Rd	*	D
430	Damascus Rd at Military School U-Turn	F	C
431	Dekwaneh Square	*	E
432	Mar Takla Square-Baouchrieh	E	D
433	Damascus Rd at TV Station Entrance	A	C
434	Damascus Rd at Said Fraiyha St	A	C
435	Mkalles Roundabout	*	D
501	Charles De Gaule Ave at Berlin St	D	C
502	Charles De Gaule Ave at Hariri Ave	D	D
503	Saeb salam Blvd at Verdun	B	B
504	Saeb Salam Blvd at Unesco	*	C
505	Saeb Salam Blvd at Rachidine St	*	B
506	Saeb Salam Blvd at Mar Elias St	D	D
507	Saeb Salam Blvd at Borj Abi Haidar	E	B
507A	Saeb Salam Blvd at Afif Tibi St	NC	B
508	Saeb Salam Blvd at Abou Chaker St	B	B
509	Saeb Salam Blvd at Ouzai St	B	C
510	Damascus Rd at Abdallah Yafi Ave	*	D
511	Corniche Pierre Gemayel at Badaro St	*	D
513	Corniche Pierre Gemayel at Safa Bros St	B	B
514	Corniche pierre Gemayel at Abd Square	B	A
515	Corniche Pierre Gemayel at Jisr El Fiat	A	B
516	Corniche Pierre Gemayel at Nahr St	F	D
517	Jisr El Wati	C	C
518	Chiyah Blvd at Ouzai Coastal Highway	*	D
519	Chiyah Blvd at Ghoberry	*	D
520	Chiyah Blvd at Mucharrafieh	*	C
521	Chiyah Blvd at Old Saida Rd-Mar Mekhael	*	D
522	Chiyah Blvd at Camille Chamoun Blvd-Galerie semaan	*	C
528	Sin El Fil Blvd at Malaab El Baladi	A	A
529	Qalaa Roundabout	F	C
531	Sin El Fil Blvd at Galerie El Ittihad	E	C
532	Sin El Fil Blvd at Almaza Factory	E	C
533	Nahr El Mott Junction	E	D
534	Tahwita Rd at Sin El Fil Blvd-Futuroscope Rd	B	D
535	Hayek Roundabout	*	C
536	Saloume Roundabout	*	C
550	Chiyah Blvd at Airport Rd	NC	C
603	Airport Rd at Shiite Council	A	A
605	Airport Rd at El Rimal Station	*	D
606	Airport Rd at El Aytam Station	F	C
609	Airport Station-to Ain El Dilbeh	A	A
610	Cocody	B	B
613	Ashbal El Sahel School	B	B
616	Abdel Nour St	F	B
617	Airport Rd at the Camps	F	C
618	Anan St	F	A
619	Ain Es Sikki Rd	B	A
626	Ain Es Sikki-Mraijeh near Supermarket Safa	F	NC
627	Borj El Brajneh Rd	F	B
631	Cocody Rd at Tahwita	B	B
638	Abdel Nour Rouis St at Sandy Bell Bakery	F	D
639	El Khatib Station Halbaoui Bros Factory El Rouiss	E	E
645	Kafaat Rd at Hashem Station	*	C
646	Mraijeh Station at Mraijeh Bakery	*	C
647	El Jammal Bank	*	C
656	Old Saida Rd at Camille Chamoun Blvd-St Therese	F	C
658	El Ouzai - El Borj	E	B
660	Hadath-Baabda Rd at Snoubra	F	B
661	Hadath at Bassil Phamracy	*	C
663	Old Saida Rd at Rigie-Wadi Chahrour	E	B
664	Old Saida Rd at Choueifat-Haret El Umara	F	B
665	Old Saida Rd at Tiro Rd-Tinol	F	B
666	Old Saida Rd at Deirkoubel	E	B
667	Old Saida Rd at Bchamoun	F	B
668	Old saida Rd at Aramoun	F	B

A B C D E & F denotes level-of-service at intersection
* denotes that delay is too high and level-of-service can not be determind
NC denotes No Conflict

TABLE 4-2
AVERAGE TRAVEL SPEEDS ALONG CERTAIN CORRIDORS IN GREATER BEIRUT AREA

Corridor No.	Corridor	Average Speed (KMPH)
5	Damascus Road between Chevrolet and Jamhour	29
5	Damascus Road between Jamhour and Chevrolet	22
14	Ouzaii Coastal Highway between Khaldeh and Ramlet El Baida	18
14	Ouzaii Coastal Highway between Ramlet El Baida and Khaldeh	23
18	Old Saida Road between Khaldeh and Galerie Semaan	23
18	Old Saida Road between Galerie Semaan and Khaldeh	24
19	Northern Coastal Highway between Nahr El Mott and Nahr El Kalb	31
19	Northern Coastal Highway between Nahr El Kalb and Nahr El Mott	28
20	Chiyah Blvd. between Sultan Ibrahim and Dar Assayad	11
20	Chiyah Blvd. between Dar Assayad and Sultan Ibrahim	12
20	Camille Chamoun Blvd. / Sin El Fil Blvd. between Galerie Semaan and Nahr El Mott	17
20	Camille Chamoun Blvd. / Sin El Fil Blvd. between Nahr El Mott and Galerie Semaan	19

The effectiveness of the proposed on-street parking organization can be measured by the reduction in illegal parking and an increase in parking turnover (the number of vehicles that occupy the same parking space).

The current levels of illegal parking are very high, they were reported earlier in this Report. In the zones covered by the Parking Improvement Program, the percentage of vehicles parked on the streets illegally vary between 33% and 63% with an average of 49%.

The "Before and After Study" recommended above should also include on-street parking inventories and turnover studies, immediately prior and subsequent to the implementation of the on-street parking measures.

The measure of effectiveness for the grade separation is the LOS of the intersection to be grade separated. The LOS without the grade separation is a measure of the average stopped delay of all vehicles passing through the intersection. While the LOS with the grade separation in place is a measure of the average stopped delay of vehicles passing through the at-grade intersection only, while vehicles using the overpass or underpass are not experiencing any stopped-delay. Thus, even a moderate decrease in average stopped delay per vehicle reflects indeed a substantial decrease in total delay at grade-separated intersection.

Table 4-3 provides a summary of simulated average delay at the junctions candidate for grade-separating, with and without the prepared grade separation, both in 1998 and 2010. The Grade Separation Component is part of a Corridor Improvement Program. In addition to the reduction of vehicle delays at each intersection due to implementing a grade separation on it, there will be an improvement in speed for vehicles traveling along the corridor to which the grade separation belong.

The recommended "Before and After Study" should cover the corridors benefiting from the grade separation component.

4.3 Emissions Analysis

In STEAM, emissions for autos and trucks are calculated as the sum of: 1) mileage-based emissions on the highway system calculated under the assumption that the vehicles are already warmed up; and 2) added emissions due to cold starts.

Mileage-based emissions are calculated, using emission rates as a function of speed. Specifically, emission rates for various speeds for Greater Beirut Area are estimated from primary and secondary sources, and are used as inputs into STEAM. The average speeds are trip-based and are determined in the Network Analysis Module. The added emissions due to cold starts are calculated on a per-vehicle trip-basis and are added to the mileage-based emissions.

Transit emissions are calculated by applying emission rates to changes in transit vehicle miles. Since the proposed improvements under the BUTP do not involve any changes in transit operations, the transit emissions are not addressed in this task.

4.4 Accidents Analysis

STEAM accepts per-vehicle mile rates and unit costs for fatal, injury, and property damage only accidents. It includes default rates for limited access and non-limited access highways. These default values are developed from United States accident databases and cannot be justifiably used for the highway improvement programs proposed for Greater Beirut Area.

In the absence of accident data for Beirut, and the difficulty in obtaining unit costs for fatal, injury and property damage crashes in Lebanon, the changes in accident rates for the

Table 4-3
Evaluation Summary
Junctions' Existing and Future Conditions

Location	Peak Hour Average Delay Per Vehicle (Sec)			Proposed Cycle Length (sec) For Turning Movements at Grade
	Year 1998 Existing Conditions	Year 2010 Base Case	Year 2010 with Grade Separation	
Galerie Semaan	1945	4528	130	180
Mar Mekhael	153	1181	27	90
Mucharrafieh	262	2233	67	140
Hayek – Saloume	244	639	7	160
Mkalles	204	251	10	Roundabout
Tayounneh	164	330	56	Roundabout
Damascus Road / Sami Solh Ave.	96	504	17	60
Airport Road / Chiyah Blvd.	No Conflict	1012	17	90
Bechara Khoury / Omar Beyhum	444	2035	No Conflict	NA
Bechara Khoury / Independence	797	463	23	70
Antelias	660	1428	No Conflict *	NA
Jal el Dib	436	14618	No Conflict *	NA
Dora	NA	NA	NA	NA
Adlieh	385	2720	71	Roundabout
Museum	47	2340	27	90
Bchamoun - Aramoun	182	529	27	100

NA indicates Not Applicable
* E-W overpasses and coastal highway at-grade

improvement programs are not estimated in this evaluation task. However, it is important to note that these programs, in terms of traffic signals, grade separation, and parking management will definitely have positive impacts on traffic safety in Beirut based on international publications, such as Manual on Traffic Control Services, Highway Capacity Manual, Geometric Design of highways and others. The additional benefits accrued to the road users from reduction in fatal, injury, and property damage crashes will not be accounted for in the stream of benefits for a particular improvement program, which would result in under-estimating total benefits.

4.5 Other External Costs

Indirect costs such as those resulting from reduction in business/economic activity along existing routes due to the improvement programs are not quantified in this task. Similarly, the external costs to transportation users or non-users that occur as a result of the construction process such as travel delay, noise, and fugitive dust during construction are also not quantified.

4.6 Value of Time

The 1994 home-interview survey conducted by the Consultant for the "Greater Beirut Transportation Plan" has databases that contain the trip-making characteristics of heads of households by type of profession and by income. After careful review of these databases, the Consultant selected a subset that includes the head of the household as a car driver with a single household income, in order to eliminate the non-time dependent income. For the 24 hr: daily trips, the average annual income of this data set, turned out to be 13.4 million Lebanese Pounds. Further classification of the average income of the tripmaker by peak and off-peak periods and by trip purpose did not show any significant difference from the average value.

Therefore, the 1994 average annual income of a car driver or a car passenger for all trips, adopted from the 1994 surveys, is LL 13.4 M. If we assume that there are 2000 working hours per year and 1500 LL are equivalent to 1 US Dollar, then the 1994 average hourly income of a car driver/passenger is $4.467. If average annual income is escalated at 5% per year, then the average hourly wage rate in 1998 is $5.17.

If home-based work trips and work-based work trips, which constitute 40% of all trips are considered to be productive trips, then the auto driver/passenger time value in 1998 is reduced to $2.06/hr. If these work and business trips time values are attributed to the employer, then the hourly wage rate is augmented by 33% to reflect the extra costs directly associated with employment of labor (social security taxes, costs of uniform, etc.)[3]. In addition, if the time values for non-work trips (60% of total auto trips) are considered to be 30% of the wage rate, then the final time value of a car driver/passenger is $3.68/hr.

Similar analyses were conducted to determine the values of travel time of taxi and bus passengers. The statistical analysis of the 1994 surveys indicates that the annual imcomes of taxi and bus passengers were LL 8.93 M and LL 6.525 M respectively. However, the percentages of work and business trips in these cases are 50% for taxi and 60% for bus travelers. If the same escalation and adjustment factors for auto trips are used for these trips, then the 1998 hourly time value for taxi and bus passengers are $2.80/hr. and $2.31/hr. respectively. The results are shown in Table 4-4. The crew travel time costs of medium and

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[3] Kenneth M. Gwilliam "The Value of Time in Economic evaluation of Transport Projects: Lessons from Recent Research". Infrastructure Notes – Transport Note No. OT, World Bank, January 1977.

heavy trucks are adopted from the Dar al-Handasah" Road User Charging Study"[4]. The values were obtained from local surveys and the results are also shown in Table 4-1. The value of out-of-vehicle travel times are not determined in this study, because the proposed improvements under BUTP have little or no impact on these" excess travel" times.

Table 4-4: Travel Time Costs (1998)

Vehicle Class	Time Value US$ / hr.
Passenger car	3.68
Taxi	2.80
Minibus / van	2.31
Bus	2.31
Medium truck *	3.24
Heavy truck *	3.24

* Source: Dar al-Handasah "Road User Charging Study".

The resultant value of time for the auto sector is based on the proportion of taxis and private vehicles in the passenger car fleet weighted by the vehicle occupancy for private passenger cars and taxis.

4.7 Vehicle Operating Costs

4.7.1 Methodology

The HDM – VOC Program[5] (version 4.0. 1994) is used by the Consultant to provide estimates of the various components of Vehicle Operating Costs for various speeds based on road and vehicle characteristics. However, the fuel consumption levels per vehicle class in the HDM – VOC Program are determined using average free-flow speed, which takes into account grades, curves, surface roughness, and desired speed (but not the delays caused by other traffic on the road). However, the HDM – VOC version 4.0 gives an additional option, where the user can directly specify vehicle speed based on other sources of information. This feature is used to take into account the variation of fuel consumption by various speed levels.

4.7.2 Data Collection

The Consultant has used primarily secondary data sources, where available, to determine the input parameters for estimating Vehicle Operating Costs. Several transportation studies, conducted in Lebanon by this Consultant and others, were used as a basis for determining estimates of Vehicle Operating Costs. Among them are:

i) "Maintenance and Rehabilitation of Lebanon Road Network". Dar Al-Handasah. July 1995.

ii) "Road User Charging Study", as part of the Lebanon National Roads Project. Dar Al-Handasah. Upcoming 1998.

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4 "Road User Charging Study" as part of the Lebanon National Roads Project. Draft Report. Dar al-Handasah. Beirut. Lebanon, 1998.

5 Archondo – Calloo, R.S. and Faiz, A. "Estimating Vehicle Operating Costs" World Band Technical Paper, 234, Washington, D.C., 1994.

iii) "Greater Beirut Transportation Plan", TEAM International/IAURIF/SOFRETU. June 1994.

iv) "Economic Feasibility of the Coastal Motorway: Tripoli – Syrian Border". TEAM International. June 1996.

v) "Economic Feasibility Study of the Qalamoun – Abdeh Section: Tripoli – Syrian Border Motorway". TEAM International. April 1998.

vi) "Traffic Surveys and Trip Matrix Update: for the Design of the Northern Highway Périphérique and the Pan-Arab Highway", TEAM International. 1998.

vii) "Report of Survey and Analysis on the Value of Travel Time". TEAM International. February 1998.

From these sources and others. the following data were collected.

4.7.2.1 Vehicle Classes

For economic analysis purposes. assumptions need to be made about the vehicle classes that are predominantly in use. or will come to use on the road network in Greater Beirut Area. The following eight vehicle classes were identified to be relevant to the scope of the study and appropriate for determining VOC for the proposed improvement programs.

- Passenger Car
  * small car
  * medium car
  * large car
- Taxis
- Pick-up or Van or Light Truck
- Bus (>30 seats)
- Medium Truck (2 axle)
- Heavy / Articulated Truck (>3 axle).

The division of the passenger car category into three classes (small. medium. and large) is based on the assumption that there is a wide variation in new vehicle prices. and in fuel consumption rates particularly. under urban congested networks. Besides. the passenger car category constitutes close to 75% of the vehicle fleet in Beirut. Thus. any methodology that would provide a better and more refined estimate of VOC in this category is worth investigating.

The taxis constitute a separate passenger vehicle class in Beirut. since they are predominantly represented by an old Mercedes 200. In addition. they make up a sizeable portion of the circulating vehicles in GBA. The articulated trucks represent a very small percentage of the vehicle fleet in Beirut. and therefore they are lumpsummed with heavy goods vehicles of 3 axles and more.

Representative vehicle characteristics for each vehicle class were obtained from the Dar Al-Handasah studies and from automobile dealers distributed around the Greater Beirut Area.

4.7.2.2 Vehicle Characteristics. Utilization. and Prices

Once the vehicle classes and their representative vehicle are determined for the study; the following vehicle characteristics. utilization. and price data were collected for each vehicle class. as shown in Table 4-5.

Table 4-5: VOC Model Parameters
Vehicle Characteristics

Vehicle Characteristics	Vehicle Class							
	Small Car	Medium Car	Large Car	Taxi	Van/Minibus	Large Bus	Medium Truck	Heavy/Art Truck
							(2 Axl)	(≥ 3 Axl)
% of Vehicle Population	25.92	31.68	14.4	16	9.5	.50	1.2	.8
Vehicle Occupancy	1.7	1.7	1.7	2.75	6.5	17	1.0	1.0
Representative Vehicle	Sunny	Honda	Mercd.	Mercd.	Toyota	Berliet	Mercd.	Mercd.
Model	Nissan	Accord	300E	200	Dyna 250	RVI	2024	2631
Fuel Type	Gas.	Gas.	Gas.	Gas.	Gas.	Des.	Des.	Des.
Tare Weight (Kg.)	1000	1350	1650	1350	3000	8900	11000	16000
Payload (Kg.)	200	200	200	400	1200	4500	7000	15300
No. of Tires	4	4	4	4	4	6	6	10
HPDRIVE, mt./HP	53	70	90	70	63	90	120	120
HPBRAKE, mt./HP	19	23	29	23	28	130	230	240
DRAG Coef. CD	.35	.35	.45	.45	.48	.65	.9	.9
Front Area AR	1.80	2.08	2.20	2.08	2.72	6.3	5.2	5.2
CRPM	3500	3000	3300	3000	3300	2300	1800	1800
Energy Efficiency Factor	.85	.85	.9	.9	.95	.95	.95	.95
Fuel Adjustment Factor	1.3	1.10	1.25	1.1	1.16	1.16	1.15	1.15

Table 4-5: VOC Model Parameters (Cont'd)
Vehicle Utilization and Cost Data

Vehicle Utilization Data	Unit	Small Car	Medium Car	Large Car	Taxi	Van/Minibus	Large Bus	Medium Truck	Large Truck
Km. Driven in Lifetime	Km	210000	210000	210000	720000	280000	720000	640000	640000
Service Life	Years	14	14	14	16	14	18	16	16
Annual Utilization	Hrs/Year	1250	1250	1250	3000	1600	1750	1900	1900
Km. Driven per year	Km-Year	15000	15000	15000	45000	20000	40000	40000	40000
Utilization Fraction	-	.65	.65	.65	.85	.8	.85	.75	.75
Depreciation Code	-	1	1	1	1	1	1	1	1
Annual Interest Rate	%	12	12	12	12	12	12	12	12
Economic Unit Costs									
New Vehicle Price	$	10.000	15419	38536	6774	15830	66152	81592	99165
New Tire Price	$	35	35	35	35	35	63.5	233	233
Maintenance Labor Cost	$/hr	2.0	2.5	3.0	2.0	2.0	2.21	4.86	5.53
Fuel Cost	$/Lt.	0.147	0.147	0.147	0.147	.147	.16	.16	.16
Lubricant Cost	$/Lt.	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15
Financial Unit Cost									
New Vehicle Price	$	12500	32900	79000	10500	19500	85600	89500	109500
New Tire Price	$	45	45	45	45	45	83.5	275	275
Maintenance Labor Cost	$/hr	2.0	2.5	3.0	2.0	2.0	2.21	4.86	5.53
Fuel Cost	$/Lt.	.353	.353	.353	.353	.353	.18	.18	.18
Lubricant Cost	$/Lt.	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27

The distribution of vehicle population is assumed to be the same throughout the analysis period. There is no compelling reason to assume a different distribution. since vehicle cohorts take a long time to change. But the fuel consumption rates have been assumed to change. as influenced by technology changes.

The new prices for vehicles and tires were determined from market prices which included items such as taxes. custom duties. import duties. etc. Rates of taxes and customs were obtained from the Ministry of Finance and deducted from the market prices to arrive at the economic prices of the vehicles and tires. Similarly. the financial costs of fuel and lubricants were determined from surveys at several patrol stations in the GBA. and then translated into economic costs by excluding taxes. custom duties. etc. Maintenance labor costs. and crew costs were obtained from data published in previous studies. from the Ministry of Transport. and from surveys conducted at vehicle maintenance service stations in GBA.

4.7.2.3 Roadway Characteristics

The roadway characteristics of interest to Vehicle Operating Costs are:

* Average roughness (IRI)
* Average gradient
* Proportion of uphill travel
* Average horizontal curve
* Altitude of terrain
* Effective number of lanes.

These characteristics as shown in Table 4-3. were determined for the highway network within the study area involving the proposed improvement programs. They were obtained from previous studies conducted by the Consultant and from the Dar Al-Handasah 1995 RRP study and the 1998 Road User Charging Study.

Table 4-6: Roadway Characteristics

Surface type	Code: 1 – Paved 0 – Unpaved	1
Average roughness (IRI)	m / km	3.00
Average positive gradient	%	3.00
Average negative gradient	%	3.00
Proportion of uphill travel	%	50.00
Average horizontal curvature	deg / km	55.00
Average superelevation	fraction	0.01
Altitude of terrain	m	50.00
Effective number of lanes	Code: 1 – One 0 – more than one	0

4.7.3 Outputs of VOC Model

The results of the HDM-VOC model runs are shown in Tables 4-7 to 4-16. The displayed results show the fuel consumption rates and the fuel and non-fuel highway user costs per vehicle class for various ranges of vehicular speed. The vehicle speeds. for the range of speeds that are applicable to each vehicle class, were varied in steps of 10 km/hr for the eight vehicle classes.

TABLE 4-7
OUTPUTS OF VOC MODEL
FOR VEHICULAR SPEED OF 10 KM/HR

	Small Car	Medium Car	Large Car	Taxi	Minibus / Van	Bus	Medium Truck	Heavy Truck
Resources per 1000 Veh - Km								
Fuel (Liters)	153.05	341.96	488.46	393.76	649.49	730.89	791.42	990.83
Lubricants (Liters)	2.00	2.00	2.00	2.00	2.00	3.52	3.52	3.52
Tire Wear (No. of equivalent new tires)	0.07	0.07	0.07	0.07	0.07	0.22	0.22	0.39
Maintenance Labor (Lab-hr)	2.54	2.54	2.54	3.13	2.67	7.36	9.05	12.75
Spare Pars (% of new Vehicle Price)	0.20	0.20	0.20	0.29	0.21	0.05	0.18	0.23
Depreciation (% of new Vehicle Price)	0.54	0.54	0.54	0.18	0.43	0.14	0.29	0.29
Interest (% of new Vehicle Price)	0.45	0.45	0.45	0.17	0.36	0.13	0.27	0.27
Economic VOC US $ per 1000 Veh - Km								
Fuel	22.50	50.27	73.27	59.06	97.42	116.94	126.63	158.53
Lubricants	4.31	4.31	4.31	4.35	4.31	7.57	7.57	7.57
Tires	2.34	2.34	2.34	2.34	2.34	13.88	51.62	91.80
Maintenance Labor	5.08	6.35	7.62	6.26	5.34	14.71	43.97	70.53
Spare Pars	19.51	30.09	75.19	43.97	33.75	40.86	145.03	223.78
Depreciation	53.81	82.97	207.36	27.84	67.84	109.27	233.17	283.39
Interest	45.20	69.69	174.18	26.73	56.99	98.35	223.84	272.05
Total Running Cost	**152.75**	**246.02**	**544.27**	**170.55**	**267.99**	**401.58**	**831.83**	**1107.65**

TABLE 4-8
OUTPUTS OF VOC MODEL
FOR VEHICULAR SPEED OF 20 KM/HR

	Small Car	Medium Car	Large Car	Taxi	Minibus / Van	Bus	Medium Truck	Heavy Truck
Resources per 1000 Veh - Km								
Fuel (Liters)	89.39	190.19	258.99	220.02	393.09	473.31	539.36	801.14
Lubricants (Liters)	2.00	2.00	2.00	2.00	2.00	3.52	3.52	3.52
Tire Wear (No. of equivalent new tires)	0.07	0.07	0.07	0.07	0.07	0.22	0.22	0.39
Maintenance Labor (Lab-hr)	2.54	2.54	2.54	3.13	2.67	7.36	9.05	12.75
Spare Pars (% of new Vehicle Price)	0.20	0.20	0.20	0.29	0.21	0.05	0.18	0.23
Depreciation (% of new Vehicle Price)	0.35	0.35	0.35	0.12	0.25	0.14	0.16	0.16
Interest (% of new Vehicle Price)	0.30	0.30	0.30	0.11	0.21	0.13	0.16	0.16
Economic VOC US $ per 1000 Veh - Km								
Fuel	13.14	27.96	38.85	33.00	58.96	75.73	86.30	128.18
Lubricants	4.31	4.31	4.31	4.35	4.31	7.57	7.57	7.57
Tires	2.34	2.34	2.34	2.34	2.34	13.88	51.93	92.03
Maintenance Labor	5.08	6.35	7.62	6.26	5.34	14.71	43.97	70.53
Spare Pars	19.51	30.09	75.19	43.97	33.75	40.86	145.03	223.78
Depreciation	35.24	54.33	135.79	18.20	39.57	109.27	132.52	161.06
Interest	29.60	45.64	114.07	17.47	33.24	98.35	127.22	154.62
Total Running Cost	**109.22**	**171.02**	**378.17**	**125.59**	**177.51**	**360.37**	**594.54**	**837.77**

TABLE 4-9
OUTPUTS OF VOC MODEL
FOR VEHICULAR SPEED OF 30 KM/HR

	Small Car	Medium Car	Large Car	Taxi	Minibus / Van	Bus	Medium Truck	Heavy Truck
Resources per 1000 Veh - Km								
Fuel (Liters)	69.07	140.84	184.05	163.80	309.82	398.90	481.55	790.61
Lubricants (Liters)	2.00	2.00	2.00	2.00	2.00	3.52	3.52	3.52
Tire Wear (No. of equivalent new tires)	0.07	0.07	0.07	0.07	0.07	0.22	0.22	0.40
Maintenance Labor (Lab-hr)	2.54	2.54	2.54	3.13	2.67	7.36	9.05	12.75
Spare Pars (% of new Vehicle Price)	0.20	0.20	0.20	0.29	0.21	0.05	0.18	0.23
Depreciation (% of new Vehicle Price)	0.29	0.29	0.29	0.10	0.19	0.06	0.12	0.12
Interest (% of new Vehicle Price)	0.24	0.24	0.24	0.09	0.16	0.05	0.12	0.12
Economic VOC US $ per 1000 Veh - Km								
Fuel	10.15	20.70	27.61	24.57	46.47	63.82	77.05	126.50
Lubricants	4.31	4.31	4.31	4.35	4.31	7.57	7.57	7.57
Tires	2.34	2.34	2.34	2.34	2.34	14.08	52.34	92.05
Maintenance Labor	5.08	6.35	7.62	6.26	5.34	14.71	43.97	70.53
Spare Pars	19.51	30.09	75.19	43.97	33.75	40.86	145.03	223.78
Depreciation	29.05	44.79	111.94	14.99	30.15	47.16	98.97	120.29
Interest	24.40	37.62	94.03	14.39	25.33	42.44	95.01	115.48
Total Running Cost	**94.84**	**146.20**	**323.04**	**110.87**	**147.69**	**230.64**	**519.94**	**756.20**

TABLE 4-10
OUTPUTS OF VOC MODEL
FOR VEHICULAR SPEED OF 40 KM/HR

	Small Car	Medium Car	Large Car	Taxi	Minibus / Van	Bus	Medium Truck	Heavy Truck
Resources per 1000 Veh - Km								
Fuel (Liters)	59.92	117.57	148.26	137.60	270.57	370.39	470.99	820.90
Lubricants (Liters)	2.00	2.00	2.00	2.00	2,00	3.52	3.52	3.52
Tire Wear (No. of equivalent new tires)	0.07	0.07	0.07	0.07	0.07	0.22	0.23	0.39
Maintenance Labor (Lab-hr)	2.54	2.54	2.54	3.13	2.67	7.36	9.05	12.75
Spare Pars (% of new Vehicle Price)	0.20	0.20	0.20	0.29	0.21	0.05	0.18	0.23
Depreciation (% of new Vehicle Price)	0.26	0.26	0.26	0.09	0.16	0.05	0.10	0.10
Interest (% of new Vehicle Price)	0.22	0.22	0.22	0.08	0.13	0.05	0.10	0.10
Economic VOC US $ per 1000 Veh - Km								
Fuel	8.81	17.28	22.24	20.64	40.59	59.26	75.36	131.34
Lubricants	4.31	4.31	4.31	4.35	4.31	7.57	7.57	7.57
Tires	2.34	2.34	2.34	2.34	2.34	14.17	52.67	91.65
Maintenance Labor	5.08	6.35	7.62	6.26	5.34	14.71	43.97	70.53
Spare Pars	19.51	30.09	75.19	43.97	33.75	40.86	145.03	223.78
Depreciation	25.95	40.02	100.01	13.38	25.44	39.39	82.20	99.90
Interest	21.80	33.61	84.01	12.85	21.37	35.45	78.91	95.90
Total Running Cost	**87.80**	**134.00**	**295.72**	**103.79**	**133.14**	**211.41**	**485.71**	**720.67**

TABLE 4-11
OUTPUTS OF VOC MODEL
FOR VEHICULAR SPEED OF 50 KM/HR

	Small Car	Medium Car	Large Car	Taxi	Minibus / Van	Bus	Medium Truck	Heavy Truck
Resources per 1000 Veh - Km								
Fuel (Liters)	59.09	105.10	128.56	123.93	249.50	360.64	478.97	865.76
Lubricants (Liters)	2.00	2.00	2.00	2.00	2.00	3.52	3.52	3.52
Tire Wear (No. of equivalent new tires)	0.07	0.04	0.07	0.07	0.07	0.22	0.23	0.39
Maintenance Labor (Lab-hr)	2.54	2.54	2.54	3.13	2.67	7.36	9.05	12.75
Spare Pars (% of new Vehicle Price)	0.20	0.20	0.20	0.29	0.21	0.05	0.18	0.23
Depreciation (% of new Vehicle Price)	0.24	0.24	0.24	0.08	0.14	0.04	0.09	0.09
Interest (% of new Vehicle Price)	0.20	0.20	0.20	0.08	0.12	0.04	0.08	0.08
Economic VOC US $ per 1000 Veh - Km								
Fuel	8.69	15.45	19.28	18.59	37.43	57.70	76.64	138.52
Lubricants	4.31	4.31	4.31	4.35	4.31	5.57	7.57	7.57
Tires	2.34	2.34	2.34	2.34	2.34	14.21	52.86	90.84
Maintenance Labor	5.08	6.35	7.62	6.26	5.34	14.71	43.97	70.53
Spare Pars	19.51	30.09	75.19	43.97	33.75	40.86	145.03	223.78
Depreciation	24.10	37.15	92.85	12.42	22.61	34.73	72.13	87.67
Interest	20.24	31.21	78.00	11.92	19.00	31.26	69.25	84.16
Total Running Cost	**84.27**	**126.90**	**279.59**	**99.85**	**124.78**	**199.04**	**467.45**	**703.07**

TABLE 4-12
OUTPUTS OF VOC MODEL
FOR VEHICULAR SPEED OF 60 KM/HR

	Small Car	Medium Car	Large Car	Taxi	Minibus / Van	Bus	Medium Truck	Heavy Truck
Resources per 1000 Veh - Km								
Fuel (Liters)	62.93	102.99	126.62	122.61	237.97	361.56	497.46	918.02
Lubricants (Liters)	2.00	2.00	2.00	2.00	2.00	3.52	3.52	3.52
Tire Wear (No. of equivalent new tires)	0.07	0.07	0.07	0.07	0.07	0.22	0.23	0.39
Maintenance Labor (Lab-hr)	2.54	2.54	2.54	3.13	2.67	7.36	9.05	12.75
Spare Pars (% of new Vehicle Price)	0.20	0.20	0.20	0.29	0.21	0.05	0.18	0.23
Depreciation (% of new Vehicle Price)	0.23	0.23	0.23	0.08	0.13	0.04	0.08	0.08
Interest (% of new Vehicle Price)	0.19	0.19	0.19	0.07	0.11	0.04	0.08	0.08
Economic VOC US $ per 1000 Veh - Km								
Fuel	9.25	15.14	18.99	18.39	35.70	57.85	79.59	146.88
Lubricants	4.31	4.31	4.31	4.31	4.31	7.57	7.57	7.57
Tires	2.34	2.34	2.34	2.34	2.34	14.24	53.00	89.85
Maintenance Labor	5.08	6.35	7.62	6.26	5.34	14.71	43.97	70.53
Spare Pars	19.51	30.09	75.19	43.97	33.75	40.86	145.03	223.78
Depreciation	22.86	35.24	88.08	11.78	20.73	31.63	65.42	79.51
Interest	19.20	29.60	73.99	11.31	17.41	28.47	62.80	76.33
Total Running Cost	**82.55**	**123.07**	**270.52**	**98.36**	**119.58**	**195.33**	**457.38**	**694.45**

TABLE 4-13
OUTPUTS OF VOC MODEL
FOR VEHICULAR SPEED OF 70 KM/HR

	Small Car	Medium Car	Large Car	Taxi	Minibus / Van	Bus	Medium Truck	Heavy Truck
Resources per 1000 Veh - Km								
Fuel (Liters)	66.96	107.50	136.03	129.10	236.24	371.40	525.38	981.63
Lubricants (Liters)	2.00	2.00	2.00	2.00	2.00	3.52	3.52	3.52
Tire Wear (No. of equivalent new tires)	0.07	0.07	0.07	0.07	0.07	0.23	0.23	0.38
Maintenance Labor (Lab-hr)	2.54	2.54	2.54	3.13	2.67	7.36	9.05	12.75
Spare Pars (% of new Vehicle Price)	0.20	0.20	0.20	0.29	0.21	0.05	0.18	0.23
Depreciation (% of new Vehicle Price)	0.22	0.22	0.22	0.07	0.12	0.04	0.07	0.07
Interest (% of new Vehicle Price)	0.18	0.18	0.18	0.07	0.10	0.03	0.07	0.07
Economic VOC US $ per 1000 Veh - Km								
Fuel	9.84	15.80	20.40	19.37	35.44	59.42	84.06	157.06
Lubricants	4.31	4.31	4.31	4.31	4.31	7.57	7.57	7.57
Tires	2.34	2.34	2.34	2.34	2.34	14.34	53.39	89.40
Maintenance Labor	5.08	6.35	7.62	6.26	5.34	14.71	43.97	70.53
Spare Pars	19.51	30.09	75.19	43.97	33.75	40.86	145.03	223.78
Depreciation	21.97	33.88	84.67	11.32	19.38	29.41	60.63	73.69
Interest	18.46	28.46	71.13	10.87	16.28	26.47	58.20	70.74
Total Running Cost	**81.51**	**121.23**	**265.66**	**98.44**	**116.84**	**192.78**	**452.85**	**692.77**

TABLE 4-14
OUTPUTS OF VOC MODEL
FOR VEHICULAR SPEED OF 80 KM/HR

	Small Car	Medium Car	Large Car	Taxi	Minibus / Van
Resources per 1000 Veh - Km					
Fuel (Liters)	71.31	113.17	146.20	137.03	240.04
Lubricants (Liters)	2.00	2.00	2.00	2.00	2.00
Tire Wear (No. of equivalent new tires)	0.07	0.07	0.07	0.07	0.07
Maintenance Labor (Lab-hr)	2.54	2.54	2.54	3.13	2.67
Spare Pars (% of new Vehicle Price)	0.20	0.20	0.20	0.29	0.21
Depreciation (% of new Vehicle Price)	0.21	0.21	0.21	0.07	0.12
Interest (% of new Vehicle Price)	0.18	0.18	0.18	0.07	0.10
Economic VOC US $ per 1000 Veh - Km					
Fuel	10.48	16.64	21.93	23.50	36.01
Lubricants	4.31	4.31	4.31	4.31	4.31
Tires	2.34	2.34	2.34	2.34	2.34
Maintenance Labor	5.08	6.35	7.62	6.26	5.34
Spare Pars	19.51	30.09	75.19	43.97	33.75
Depreciation	21.31	32.86	82.12	10.49	18.37
Interest	17.90	27.60	68.98	10.07	15.43
Total Running Cost	**80.93**	**120.19**	**262.49**	**100.94**	**115.55**

TABLE 4-15
OUTPUTS OF VOC MODEL
FOR VEHICULAR SPEED OF 90 KM/HR

	Small Car	Medium Car	Large Car	Taxi	Minibus / Van
Resources per 1000 Veh - Km					
Fuel (Liters)	76.03	119.83	157.49	146.23	248.26
Lubricants (Liters)	2.00	2.00	2.00	2.00	2.00
Tire Wear (No. of equivalent new tires)	0.07	0.07	0.07	0.07	0.07
Maintenance Labor (Lab-hr)	2.54	2.54	2.54	3.13	2.67
Spare Pars (% of new Vehicle Price)	0.20	0.20	0.20	0.29	0.21
Depreciation (% of new Vehicle Price)	0.21	0.21	0.21	0.07	0.11
Interest (% of new Vehicle Price)	0.17	0.17	0.17	0.07	0.09
Economic VOC US $ per 1000 Veh - Km					
Fuel	11.18	17.62	23.62	21.94	37.24
Lubricants	4.31	4.31	4.31	4.31	4.31
Tires	2.34	2.34	2.34	2.34	2.34
Maintenance Labor	5.08	6.35	7.62	6.26	5.34
Spare Pars	19.51	30.09	75.19	43.97	33.75
Depreciation	20.79	32.06	80.13	10.71	17.59
Interest	17.47	26.93	67.31	10.28	14.77
Total Running Cost	**80.68**	**119.70**	**260.52**	**99.81**	**115.34**

TABLE 4-16
OUTPUTS OF VOC MODEL
FOR VEHICULAR SPEED OF 100 KM/HR

	Small Car	**Medium Car**	**Large Car**	**Taxi**
Resources per 1000 Veh - Km				
Fuel (Liters)	81.19	127.41	170.20	156.63
Lubricants (Liters)	2.00	2.00	2.00	2.00
Tire Wear (No. of equivalent new tires)	0.07	0.07	0.07	0.07
Maintenance Labor (Lab-hr)	2.54	2.54	2.54	3.13
Spare Pars (% of new Vehicle Price)	0.20	0.20	0.20	0.29
Depreciation (% of new Vehicle Price)	0.20	0.20	0.20	0.07
Interest (% of new Vehicle Price)	0.17	0.17	0.17	0.07
Economic VOC US $ per 1000 Veh - Km				
Fuel	11.93	18.73	25.53	23.50
Lubricants	4.31	4.31	4.31	4.31
Tires	2.34	2.34	2.34	2.34
Maintenance Labor	5.08	6.35	7.62	6.26
Spare Pars	19.51	30.09	75.19	43.97
Depreciation	20.38	31.43	78.54	10.49
Interest	17.12	24.60	65.97	10.07
Total Running Cost	**80.67**	**117.85**	**259.50**	**100.94**

STEAM accepts the fuel consumption rates as well as the non-fuel highway user cost per vehicle class. The percent of vehicle population in each class was used to calculate the weighted average of the VOC values for the combined vehicle classes that represent each "Market Sector" for final use in the STEAM model.

The fuel and non-fuel costs are the same throughout the analysis period starting from year 1998. The non-fuel costs include all cost items other than that of fuel such as lubricants, tires, maintenance, spare parts, depreciation, and interest. The non-fuel costs are added, for a particular class, and converted from $/veh-km to $/gallon based on a fuel consumption rate of an average vehicle speed of 50 km/hr. Then they are summed up for all vehicle classes within a market sector (see Figure 3-2) weighted by the percentage of each vehicle class within that market sector vehicle population.

The non-fuel costs will still vary with speed according to the variation in fuel consumption (gallons of fuel) as a function of speed.

In the current version of STEAM, its input requirement is not compatible with HDM-VOC output. It was recommended to FHWA by the Consultant to adjust this in the future versions of STEAM, i.e. to make non-fuel costs sensitive to Veh-Km or Veh-Mile by range of speed.

4.8 Project Key Assumptions

Table 4-17 summaries the key assumptions and parameters used in the economic analysis. A key assumption has been made with respect to the project benefits in the out years where additional capacity will again be necessary to accommodate the future traffic demand. It is unrealistic to assume that the growth in traffic projected for evaluation purposes throughout the horizon of the evaluation will be solely accommodated by the BUTP proposed improvement programs, without any additional significant improvements in road network and/or in the public transport system. Therefore, it is assumed that not all the benefits in the out years will be attributed to the proposed improvements. The benefits, in this study, are held constant after the year 2015, where the volume-to-capacity ratio on almost all link exceeds 1.0. This result is observed from running the EMME/2 model for the year 2015. This assumption will render the estimates of benefits a bit conservative.

Other key assumptions relate the growth in value of travel time to the real term growth in Gross Domestic Product (GDP). The reduction in fuel consumption rates were related to the improvements in vehicular design and use of alternative fuel, and the increase in the percentage of new cars in the vehicular fleet mix in Lebanon. Similarly, the emission rates were reduced over time to reflect the reduction in fuel consumption rates, and the possible installation of catalytic converter's on cars in Lebanon. The emission rates in Lebanon now are equivalent to the early seventies in the US, and the assumption is that by year 2015 the emission rates in Lebanon will be similar to the current emission rates in the US.

Car vehicle occupancy is assumed to remain constant at 1.65, while the transit vehicle occupancy is assumed to increase by time due to increased usage of mass transit. The yearly expansion factor is assumed to be 332 days, because of the 6-day work week in Lebanon, and because most people travel on holidays to the beach or to the mountains causing traffic congestion comparable to that on a normal weekday.

Table 4-17: Key Assumptions

Project Assumption Description	Assumption
Project Benefit Period	20 years
Project Benefits held constant beyond	2015
Discount Rate	12%
Currency	1998 USD
Salvage Value	Varies with improvement case
Standard Cost Conversion Factor	0.94
GDP Real Term Growth/capita	Years (1998 to 2004) @2.2% Thereafter @ 1.5%
Value of Time Growth	Same as GDP Real Term Growth
Reduction in Emission Rates	Years (1998 to 2004) - constant Year 2005 - by 10% Year 2010 - by 25% Year 2015 - by 50%
Reduction in Fuel Consumption Rates	Years (1998 to 2004) - constant Year 2005 - by 10% Year 2010 - by 20% Year 2015 - by 30%
Transit Vehicle Occupancy	Years 1998 (20). 2001 (24). 2002 (26). 2003 (28). 2005 (30). 2010 (40). 2015 (50)
Car Vehicle Occupancy	1.65 - constant
Truck Vehicle Occupancy	1.0 - constant
Yearly Expansion Factor	332 days

5. ECONOMIC COSTS OF PROJECT COMPONENTS

5.1 Cost Estimates

Engineering cost estimates are prepared for the three components of the project to be incorporated in the economic analysis of the proposed investments.

5.1.1 Determination of Unit Prices

Unit prices were developed by analyzing unit prices of highway and structures projects implemented in the last few years or currently under construction in Lebanon.

A tabulation of the unit prices adopted for developing cost estimates used in this report is shown in Table 5–1.

5.1.2 Quantities Estimate

Quantity estimates for the signal works and grade separation projects are based on detailed study to reach an accurate estimate of the quantities of the main items of work such as:

- Site and earth works
- Concrete
- Steel and Railing
- Pavement
- Street lighting and Electrical Installation
- Mechanical
- Drainage
- Signing and Marking
- Signal works
- Traffic control center
- CCTV system
- Communication system
- Landscaping
- Incidental
- Mobilization.

It is worth mentioning that quantities used in estimating construction cost of the signal components (including signing, marking and civil works) as well as the bridges in Hayek and Galerie Semaan are based on Bills of Quantities as prepared and calculated in the tender document of these projects. The quantities for other grade separation projects are based on the preliminary design of these facilities.

5.1.3 Salvage Value

The economic salvage values of projects alternatives after some years of services are considered to be the sum of the economic value of the residual of each component of the individual projects.

A service life was assumed for each component and a residual value of 100% of its economic cost is considered at the year it is put in service and 0% of its cost at the end of its serviceable life with a linear interpolation corresponding to the intermediate year 2020.

TABLE 5 - 1
UNIT PRICE USED IN CONSTRUCTION COST ESTIMATION

Item No.	Item Description	Unit	Unit Cost (U.S.D.)
100	**DIVISION I - GENERAL REQUIREMENTS**		
101	Relocation including removal of existing services and utilities.	L.S.	-
102	Provision. Erection. Installation of Building and Its Services.	L.S.	-
103	Provision and Maintenance of Equipment and Supply of Materials.	L.S.	-
104	Maintenance and protection of Traffic during Construction.	L.S.	-
200	**DIVISION II - SITE WORKS**		
201	Removal of sidewalks. curbs and islands.	m^2	5
202	Removal of existing light pole (any type).	Ea.	70
203	Removal of existing manhole. inlet or catch basin (any type).	Ea.	50
204	Structure excavation.	m^3	6
205	Fill.	m^3	10
206	Subgrade preparation.	m^2	2.5
207	Permeable drainage layer.	m^3	12
300	**DIVISION III - CONCRETE WORKS**		
301	Lean concrete "Blinding".	m^3	65
302	Structural cement concrete (f'c = 250 kg/cm²) with finishing as shown on drawings:		
	- Abutments.	m^3	125
	- Approach slab.	m^3	90
	- Pier foundation.	m^3	90
	-Retaining walls.	m^3	110
303	Structural cement concrete (f'c = 300 kg/cm²) with finishing as shown on drawings:		
	- Piers (columns and caps).	m^3	140
304	Structural cement concrete (f'c = 400 kg/cm²) with finishing as shown on drawings:		
	- Tunnel .	m^3	140
	- Bridge deck.	m^3	110
305	High tensile steel reinforcing bars:		
	- Abutments.	Ton	600
	- Approach slab.	Ton	600
	- Piers and pier foundations.	Ton	600
	- Retaining walls.	Ton	600
	- Tunnel.	Ton	600
	- Bridge deck.	Ton	600
306	15.7 mm diameter super low relaxation prestressing strands.	Ton	6,000

TABLE 5 - 1 (Continued)
UNIT PRICE USED IN CONSTRUCTION COST ESTIMATION

Item No.	Item Description	Unit	Unit Cost (U.S.D.)
307	Waterproofing of structures:		
	- Two coats bituminous paint for concrete surfaces below ground.	m^2	3
	- Waterproofing membrane for tunnel base slab.	m^2	10
	- Waterproofing membrane for bridge deck.	m^2	10
308	Bridge deck drainage system:		
	- Scuppers grates and frames.	Ea.	150
	- 200mm. diameter PVC pipes for bridge deck Drainage.	m	6
309	Bridge deck expansion joint.	m	1.000
310	Replaceable bridge pot bearings:	Ea.	3.500
311	1200mm diam. C.I.P. concrete piles.		
	- 1200mm diam. prebored concrete pile.	m.	300
	- Pile load test to twice the working load.	Ea.	40.000
	- Pile load test to 1.5 the working load.	Ea.	20.000
	- Non destructive integrity testing of piles.	Ea.	75
400	**DIVISION IV - STEEL AND RAILING WORKS**		
401	Bridge parapets and railing.		
	- Precast concrete facia.	m	50
	- Aluminum rails.(TYPE1).	m	60
	- Aluminum rails.(TYPE 2).	m	90
	- Aluminum rails.(TYPE 3).	m	160
	- Concrete median curb.	m	10
402	Overhead Sign Steel Structure - Cantilever Post Gantry.	Ea.	10.000
500	**DIVISION V - BITUMINOUS MATERIALS**		
501	Aggregate Base Course.	m^3	18
502	Bituminous Prime Coat.	m^2	0.5
503	Bituminous Tack Coat.	m^2	0.35
504	Bituminous Base Course.	m^3	90
505	Bituminous binder and wearing course.	m^3	95
600	**DIVISION VI - INCIDENTAL CONSTRUCTION**		
601	Supply and install thermoplastic road paint lines - All types.	m^2	16
602	Supply and install raised pavement markers.	Per 100	600
603	Concrete curbstone.	m	10
604	Concrete pavement tiles.	m^2	10

TABLE 5 - 1 (Continued)
UNIT PRICE USED IN CONSTRUCTION COST ESTIMATION

Item No.	Item Description	Unit	Unit Cost (U.S.D.)
605	Supply and install traffic signs all types & shapes. sizes < 1.00m².	Ea.	200
606	Supply and install directional signs.	m²	350
700	**DIVISION VII - STREET LIGHTING & ELECTRICAL INSTALLATION**		
701	Supply and install 14m. high street light pole carrying single 400W luminaires with control gear. cabling. and associated materials.	Ea.	2.500
702	Construct reinforced concrete base for street light poles (any size) with column anchor bolts. steel template and all other items. as specified.	Ea.	350
703	Supply and install PVC conduit (100mm) under sidewalks including bushings and caps.	m	15
704	Supply and install galvanized rigid steel conduit (100mm) under paved area including bushings and caps.	m	20
705	Trenching. bedding. laying. backfilling and compacting including base and wearing courses.	m	16
	supply and install 4-conductor power cable in conduits and poles for street lighting.	m	3
706	Supply and install 600x600mm. junction box.	Ea.	200
	Junction connection boxes for underpass luminaries.	Ea.	80
707	Supply and install under-bridge lighting luminaires. Including lamps and housing.	Ea.	650
	Supply. install & test underpass luminaries lighting system including 400 watt HPI lamps with symmetrical diffusers & control. plugs & internal cabling & mounting support system.	Ea.	400
800	**DIVISION VIII - MECHANICAL WORKS**		
801	Fire Fighting System.		
	- Supply and install fire pump set complete with all valve accessories and fittings.	Set	80.000
	- Supply and install galvanized steel pipes (different diameters) including all fittings.	m	100
	- Supply and install fire hose cabinets complete with fire hose reel 2 1/2" diameter 50m long with aluminum nozzle.	Ea.	900
	- Supply. install and test fire system accessories including valves. switches. fittings. dry chemical and CO_2 fire extinguishers.	L.S.	-
900	**DIVISION IX - DRAINAGE WORKS**		
901	Concrete or Asbestos cement pipes of various diameters:		
	- 250 mm. diameter.	m	30
	- 300 mm. diameter.	m	40
	- 400 mm. diameter.	m	60
902	Trench excavation for pipes including bedding and backfilling :	m³	7
903	Concrete for encasement of pipes.	m³	65
904	Road curb inlets.	Ea.	300
905	Cast in place R.C.. manholes	Ea.	900
906	Catch basin at bridge retainning walls including 200mm. diameter pipe connecting to collector pipe.	Ea.	800
907	Catch basin in underpass including piping and grating and all required connections to collector pipe.	Ea.	800
908	Adjust Existing Catch Basin or Manhole.	Ea.	120

TABLE 5 - 1 (Continued)
UNIT PRICE USED IN CONSTRUCTION COST ESTIMATION

Item No.	Item Description	Unit	Unit Cost (U.S.D.)
1000	**DIVISION X - LANDSCAPING**		
1001	Trees - Type as specified.	Ea.	150
1002	Shrubs - Type as specified.	Ea.	15
1003	Grass ground cover - Type as specified.	m^2	5
1100	**DIVISION XI - SIGNAL WORKS**		
1101	Supply, install & test 4 phase controller including wiring, conduit trenching back filling and junction boxes.	Ea.	15,000
1102	Supply, install & test 8 phase controller including wiring, conduit trenching back filling and junction boxes.	Ea.	15,000
1103	Supply, install & test 16 phase controller including wiring, conduit trenching back filling and junction boxes.	Ea.	1,500
1104	Supply and install type I traffic signal pole.	Ea.	500
1105	Supply and install type II traffic signal pole with 5m mast arm.	Ea.	1,500
1106	Supply and install type II traffic signal pole with 8m mast arm.	Ea.	2,000
1107	Supply and install type II traffic signal pole with 10m mast arm.	Ea.	2,500
1108	Supply, install and test "3 aspect signal head 300mm".	Ea.	250
1109	Supply, install and test "3 aspect signal head 200mm".	Ea.	200
1110	Supply, install and test "2 aspect signal head 200mm" for pedestrian.	Ea.	150
1111	Supply and install pedestrian push button assembly, associated signs, and mounting brackets as specified.	Ea.	100
1112	Supply, install and test induction loop.	Ea.	100
1113	Supply and install signal interconnect.	L.M.	4
1114	Relocation of type I signal pole.	Ea.	200
1115	Relocation of type II signal pole.	Ea.	300
1116	Removing of type I signal pole.	Ea.	100
1117	Removing of type II signal pole.	Ea.	150
1118	Supply and install dial-up 28.8k external modem in the controller cabinet as specified.	Ea.	150
1200	**DIVISION XII - TCC & CCTV WORKS**		
1201	CCTV System		
	- Camera.	Ea.	5,000
	- Camera pole.	Ea.	3,000
	- Camera control cabinet.	Ea.	10,000
	- Terminal cabinets & mounts.	Ea.	2,000
	- Cabling.	Ea.	1,000

TABLE 5 - 1 (Continued)
UNIT PRICE USED IN CONSTRUCTION COST ESTIMATION

Item No.	Item Description	Unit	Unit Cost (U.S.D.)
1202	Traffic Control Center:		
	- Signal server.	Ea.	15.000
	- Communication server.	Ea.	15.000
	- Video control workstation.	Ea.	20.000
	- Maintenance inventory server.	Ea.	10.000
	- Video wall.	Ea.	100.000
	- Printer.	Ea.	2.000
	- Video switch.	Ea.	20.000
	- Test simulator.	Ea.	20.000
	- Software licenses.	Ea.	750.000
	- Electrical & backup.	L.S.	5.000
	- Communication racks.	Ea.	5.000
1203	Communication System (60 Km)		
	- Fiber optic and twisted pair.	m	30
	- Fiber optic and twisted pair.	m	10
	- SDH Electronics (12 nodes)	L.S.	4.000.000

5.1.4 Right-Of-Way Cost

Value of Right-of-way for each project location was based on land value information obtained from various sources such as the Real Estate Department at the Ministry of Finance and private developers in building development sector.

An average economic unit cost of land acquisition was established. reflecting the current use of the property and its proximity to commercial and business areas.

Land acquisition is required mainly for the majority of the proposed overpasses and underpasses where as no expropriation is needed for signal and parking components.

Table 5–2 shows the surface areas to be expropriated for each grade separation location and the average prevailing cost per square meter.

5.1.5 Operating Cost

Both traffic management (signals + TCC + Video Surveillance) and parking structures components need to be controlled and operated in order to maintain well functioning and insure convenience and good level-of-service for users.

Operating costs covers mainly human resources (including all fringe benefits) and electricity power. whereas equipment and other physical assets are included in the maintenance costs.

5.1.6 Maintenance Costs

Maintenance is needed to keep a given asset in good physical condition for protection of the initial capital cost and assume continued operations and safety of the facility and the users as well.

Economic maintenance costs adopted in the economic analysis are differentiated according the nature of the project assets and taken as percentages of their values.

For instance they were assumed 2% for the structures. 5% for communication networks. 10% for electrical and mechanical equipment. 14% for signing works and 25% for marking works.

5.2 COST ESTIMATES

Both financial and economic costs were estimated for each scenario alternative. The difference between financial cost and economic cost is that financial cost include customs fees and taxes in construction cost estimate.

A ratio of 0.94% economic cost to financial cost was used based on an analysis of tax incidence on contractor's pricing done for the feasibility of Beirut Entrances. Tables 5–3 through 5–10. present the financial economic estimates for each project components.

Table 5–11 presents a resume of economic investment. salvage. operation and maintenance costs for the different analysis scenarios adopted and illustrated earlier (Chapter III Economic Analysis Methodology).

TABLE 5 - 2
EXPROPRIATION ESTIMATES FOR GRADE SEPARATION PROJECTS

No.	Intersection	Expropriation Area m²
1	Chiyah Blvd. and Airport Road	1.162
2	Mucharrafieh	540
3	Mar Mekhael	2.502
4	Galerie Semaan	3.500
5	Tayounneh	723
6	Omar Beyhum at Beit El Atfal	1.926
7	Bechara El Khoury	600
8	Adlieh	994
9	Abdallah Yafi and Damascus Road (Museum)	No Expropriation
10	Sami Solh and Damascus Road	No Expropriation
11	Hayek and Saloume	3.773
12	Mkalles	2.471
13	Dora	No Expropriation
14	Jal El Dib	2.490
15	Antelias	No Expropriation
16	Bchamoun - Aramoun	3.010

TABLE 5 - 3
CAPITAL & MAINTENANCE COSTS ESTIMATES FOR TRAFFIC MANAGEMENT PROJECTS - in USD

5-3-1 - Signal Installation (work to be completed by the end of year 2000)

Component	Lifetime Duration	Capital Cost	Salvage by 2020		Annual Maintenance Cost		Annual Electricity Cost
			%	USD	%	USD	
Signal Works	20 y	7.635.975	0	0	10	763.598	110.000
Civil Works	30 y	4.914.954	33	1.621.935	0	0	
Signing	7 y	688.956	0	0	14	96.454	
Marking	4 y	1.988.506	0	0	25	497.127	
Mobilization & Traffic Mgt. During Construction 5%		761.419					
Total Financial Cost		15.989.810		1.621.935		1.357.178	110.000
Total Economic Cost		15.030.421		1.524.619		1.275.747	110.000

Note: * Signal capital cost is reduced by USD 1.2 million to take into consideration the existing signal installed by CEGPVB.
* Maintenance cost for signals will cover the whole system including BCD Area.

5-3-2 - TCC (work to be completed by the end of year 2000)

Component	Lifetime Duration	Capital Cost	Salvage by 2020		Annual Maintenance Cost		Annual Electricity Cost
			%	USD	%	USD	
Building 1000 m^2	50 y	1.000.000	60	600.000	2	20.000	20.000
Furniture 75 m^2	10 y	75.000	0	0	10	7.500	
CCTV	20 y	1.050.000	0	0	10	105.000	
TCC Equipment	20 y	1.052.000	0	0	10	105.200	
Communication	20 y	5.200.000	0	0	5	260.000	
Total Financial Cost		8.377.000		600.000		497.700	20.000
Total Economic Cost		7.874.380		564.000		467.838	20.000

TABLE 5 - 4
STAFFING PLAN FOR GREATER BEIRUT TRAFFIC CONTROL CENTER

Function	No. Total	Hours	Grade	Qualification / Education	Annual Cost (USD)
TCC System Manager	1	8AM to 5PM	Senior Engineer	10 years min. experience in Traffic Engineering BSCE	48.000
Area Traffic Engineer	2	7AM to 11PM (2 shifts)	Traffic Engineer	5 years min. experience in Traffic Engineering BSCE	60.000
TCC Operators	4	7AM to 11PM (2 shifts)	Engineering Technician	1 year min. experience in Technical Certification	96.000
Clerical	1	8AM to 5PM	Receptionist	1 year min. experience in Training	12.000
Electronic Maintenance	2	7AM to 11PM (2 shifts)	Electrical Lead	5 years min. experience in Technical Certification	60.000
Lead Maintenance Technician	2	7AM to 11PM (2 shifts)	Main Supervisor	6 years min. experience in Technical Certification	60.000
Maintenance Technician	6	3 Shifts. 7days a week	Maintenance Technician	3 years min. experience in Technical Certification	108.000
Total					444.000

TABLE 5 - 5
SUMMARY OF TRAFFIC MANAGEMENT COMPONENT COSTS

	Capital Cost (USD)	Salvage Value (USD	Annual Operation & Maintenance (USD)
Financial	24.366.810	2.221.935	2.428.878
Economic	22.904.801	2.088.619	2.317.585

TABLE 5 - 6
SUMMARY OF CONSTRUCTION COST ESTIMATES FOR THE PROPOSED GRADE SEPARATIONS
(in 1000 USD)

No.	Grade Separation Location	General Requirements	Site Works	Concrete Works	Steel & Railing Works	Bituminous Materials	Incidental Construction	Street Lighting & Electrical Installation	Mechanical Works	Drainage Works	Landscaping Works	Grand Total
1	Chiyah Blvd. and Airport Road	720.0	672.4	3,617.5	149.3	427.0	157.4	220.6	131.4	243.7	40.1	6,379.4
2	Mucharrafieh	595.0	113.7	1,588.0	111.5	358.8	83.0	251.5	0.0	131.8	21.3	3,254.5
3	Mar Mekhael	260.0	333.9	1,596.6	135.0	417.9	69.5	282.8	119.6	130.3	14.0	3,359.6
4	Galerie Semaan	645.0	121.0	2,035.5	135.0	347.4	124.1	184.9	0.0	133.4	33.3	3,759.4
5	Tayouneh	250.0	636.5	1,948.3	133.0	467.9	105.6	295.9	123.2	266.9	12.8	4,240.0
6	Omar Beyhum at Beit El Atfal	250.0	885.1	3,090.5	129.0	625.7	210.0	366.9	159.2	234.5	20.3	5,971.1
7	Bechara El Khoury	250.0	429.0	1,885.3	147.6	509.7	146.4	312.1	123.2	139.3	13.0	3,955.6
8	Adlieh	250.0	766.4	2,884.0	292.0	641.9	160.6	314.0	123.2	181.3	22.8	5,636.1
9	Abdallah Yafi and Damascus Ro	250.0	394.1	1,041.3	97.0	306.2	64.8	294.1	123.2	169.0	12.8	2,752.3
10	Sami Solh and Damascus Road	250.0	284.7	609.6	86.0	244.9	74.0	110.5	0.0	152.3	12.8	1,824.7
11	Hayek and Saloume	720.0	159.8	1,963.7	185.4	897.4	355.8	697.7	0.0	273.7	47.5	5,301.0
12	Mkalles	540.0	99.2	1,411.3	92.7	146.4	125.4	269.0	0.0	97.4	26.4	2,807.8
13	Dora	620.0	249.9	3,279.7	210.6	351.8	61.0	218.0	0.0	141.6	19.5	5,152.0
14	Jal El Dib	620.0	211.3	2,292.9	153.0	137.8	164.0	409.1	0.0	326.2	0.0	4,314.3
15	Antelias	620.0	249.7	3,279.7	210.6	336.9	62.5	218.0	0.0	141.6	19.5	5,138.4
16	Bchamoun - Aramoun	250.0	119.5	658.7	235.8	155.9	77.8	196.5	0.0	167.5	19.5	1,881.1
	Grand Total											65,727.1

TABLE 5 - 7
SUMMARY OF INVESTEMENT COSTS
FOR THE PROPOSED GRADE SEPARATIONS
(in USD)

No.	Location	Group	Year Completed	Land Acquisition		Economic ROW	Financial Construction Cost	Economic Construction Cost	Total Economic Investment	Residual %	Salvage Value Year 2020	Annual Maintenance Cost
				Area sqm	Rate $/sqm							
1	Chiyah Blvd. and Airport Road	2	2,002	1,162	750	871,500	6,379,366	5,996,604	6,868,104	64	3,837,827	119,932
2	Mucharrafieh	2	2,002	540	750	405,000	3,254,511	3,059,240	3,464,240	64	1,957,914	61,185
3	Mar Mekhael	2	2,002	2,502	750	1,876,500	3,359,580	3,158,005	5,034,505	64	2,021,123	63,160
4	Galerie Semaan	1	2,001	3,500	1,000	3,500,000	3,759,410	3,533,845	7,033,845	62	2,190,984	70,677
5	Tayouneh	1	2,001	723	1,000	723,000	4,239,975	3,985,577	4,708,577	62	2,471,057	79,712
6	Omar Beyhum at Beit El Atfal	2	2,002	1,926	2,000	3,852,000	5,971,055	5,612,792	9,464,792	64	3,592,187	112,256
7	Bechara El Khoury	3	2,004	600	2,000	1,200,000	3,955,550	3,718,217	4,918,217	68	2,528,388	74,364
8	Adlieh	3	2,004	994	2,000	1,988,000	5,636,125	5,297,958	7,285,958	68	3,602,611	105,959
9	Abdallah Yafi and Damascus Ro	3	2,004	0	2,000	0	2,752,274	2,587,138	2,587,138	68	1,759,254	51,743
10	Sami Solh and Damascus Road	3	2,004	0	1,500	0	1,824,670	1,715,190	1,715,190	68	1,166,329	34,304
11	Hayek and Saloume	1	2,001	3,773	1,250	4,716,250	5,300,965	4,982,907	9,699,157	62	3,089,402	99,658
12	Mkalles	1	2,001	2,471	750	1,853,250	2,807,790	2,639,323	4,492,573	62	1,636,380	52,786
13	Dora	1	2,001	0	1,250	0	5,151,955	4,842,838	4,842,838	62	3,002,559	96,857
14	Jal El Dib	3	2,004	2,490	750	1,867,500	4,314,304	4,055,446	5,922,946	68	2,757,703	81,109
15	Antelias	3	2,004	0	400	0	5,138,420	4,830,115	4,830,115	68	3,284,478	96,602
16	Bchamoun - Aramoun	3	2,004	3,010	400	1,204,000	1,881,100	1,768,234	2,972,234	68	1,202,399	35,365
Grand Total						24,057,000	65,727,050	61,783,427	85,840,427		40,100,595	1,235,669

TABLE 5 - 8
COST ESTIMATES OF PARKING STRUCTURE (in USD)
(capacity = 500 cars)

Component	Capital Cost	Salvage by 2020		Annual Maintenance Cost		Annual Operations Costs**(USD)
		%	USD	%	USD	
Construction Cost*	3.000.000	62	1.860.000	2	60.000	120.000
Landscaping	1.000.000	0	0	0	0	
2 Lifts	50.000	0	0	10	5.000	
Ventilation System	150.000	0	0	10	15.000	
Fire Fighting System	150.000	0	0	10	15.000	
Generator & UPS System	50.000	0	0	10	5.000	
Serveillance & Control Home	100.000	0	0	10	10.000	
Marking & Signing	20.000	0	0	10	2.000	
Pay-on-Foot System	30.000	0	0	10	3.000	
Engineering Fees	270.000					
Total Financial	4.820.000		1.860.000		115.000	120.000
Financial Cost Per Space	**9640**		**3720**		**230**	**240**
Total Economic	4.530.800		1.748.400		108.100	112.800
Economic Cost Per Space	**9062**		**3497**		**216**	**226**

*30m² X 500 cars X 200$/m²

**includes staffing and electricity cost

TABLE 5 - 9
PARKING STRUCTURES COSTS
(in Million USD)

Parking Structure Location	Sanayeh	Mazraa	Tallet Kayyat	Mar Nicolas	Total
Capacity (car spaces)	1000	300	100	100	1500
Financial Construction Cost	9.640	2.892	0.964	0.964	14.460
Economic Cost	9.062	2.718	0.906	0.906	13.592
Operation and Maintenance	0.442	0.133	0.044	0.044	0.663
Economic Salvage Year 2020	3.497	1.049	0.350	0.350	5.246

TABLE 5 - 10
SUMMARY OF
PARKING CONTROL EQUIPMENT COSTS
(in USD)

	Quantities	Unit Financial Cost	Capital Cost	Year of Investment	Salvage Value Year 2020	Operation & Maintenance
Parkmeter (pay & display)	175	8.000	1.400.000	2.000	0	140.000
Towing Trucks	13	40.000	520.000	2.000	0	52.000
Tirelock	130	300	39.000	2.000	0	4.000
Total Financial Cost			1.959.000	2.000	0	196.000
Total Economic Cost			1.841.000			184.000

TABLE 5 - 11
INVESTMENT, SALVAGE AND O/M COSTS FOR PROJECT COMPONENTS (IN THOUSAND USD)

Project Component	Investment Cost (Economic)	Mid Point Year	Salvage value Year 2020	Annual Operation & Maintenance Costs
Traffic Management	22.905	2000	2.089	2.545
Grade Separation				
Group I	31.776	2000	11.331	420
Group I + II	56.628	2001	21.813	794
Group I + II + III	88.058	2002	36.916	1.297
Parking Management Scheme				
Parking Structures Only	13.592	2000	5.245	663
Total Parking Plan	15.433	2000	5.245	847
Total BUTP Project	126.396	2001	44.250	4.689

6. DEVELOPMENT AND CALIBRATION OF A TRAFFIC FORECASTING MODEL

For the BUTP Preparatory Study, a traffic forecasting model was developed and calibrated using EMME/2 transportation planning software, in order to assist in forecasting future traffic demand and in determining the performance of the transportation network for the various scenarios under consideration. In order to develop this model, the following sequence was done (Figure 6-1).

6.1 Development of a Year 1998 (Base Year) Highway Network

The 1994 highway network, originally used by TEAM International in the development of the Greater Beirut Area Transportation Plan (GBATP), was used and its attributes were converted to the EMME/2 format. This was followed by updating the network to reflect 1998 roadway conditions. This was done by coding all roadway projects completed between the years 1994 and 1998.

The roadway classification system used in the development of the highway network divided the roadways into fourteen (14) link types and are presented in Table 6-1. Each link type has its own attributes: number of lanes per direction, free flow speed, hourly capacity per lane, and volume - delay function.

However, lane capacity for each link type differs from one area to another depending on the type of operation at the adjacent intersection. Table 6-1 presents the lane capacity (in pcu/hr) for each type and for each operational mode of the intersection (unsignalized, police-operated/isolated signalized, and signalized progressive).

Table 6-2 shows the reduction in link capacity if parking is allowed on one or two sides of the road. The reduction in capacity was estimated by considering the effect of a parked vehicle in a traveled lane on its capacity to be directly related to the reduction in traveled lane width. The effects of localized double parking and cruising in search of a parking space were taken as 0.1 and 0.05 of the capacity of a single lane.

6.2 Volume - Delay Functions

The travel time between two locations depends on facility types available between two locations and projected traffic levels. Appropriate functions which relate roadway capacity to travel time are usually used. These functions are referred to as volume-delay functions (VDFs) for each link type (listed in Table 6-1) and expressed as the product of free flow speed times and normalized congestion functions f(x) such as:

$$Time_V = Time_O * f(v/c)$$

Where, congestion time ($Time_V$) is usually modeled via a non-linear function which uses volume to capacity ratio (v/c) times free flow time ($Time_O$).

A function developed many years ago by Bureau of Public Road (BPR) has been widely used in various travel forecasting analysis. The BPR function is:

$$Time_V = Time_O * [1 + (v/c)^a]$$

With higher values of a, the effect of congestion becomes more pronounced and increases $Time_V$ at a high rate. Heinz Spiess of EMME/2 Support Center has demonstrated the shortcomings of the BPR type functions and alternatively developed Conical VDFs such as:

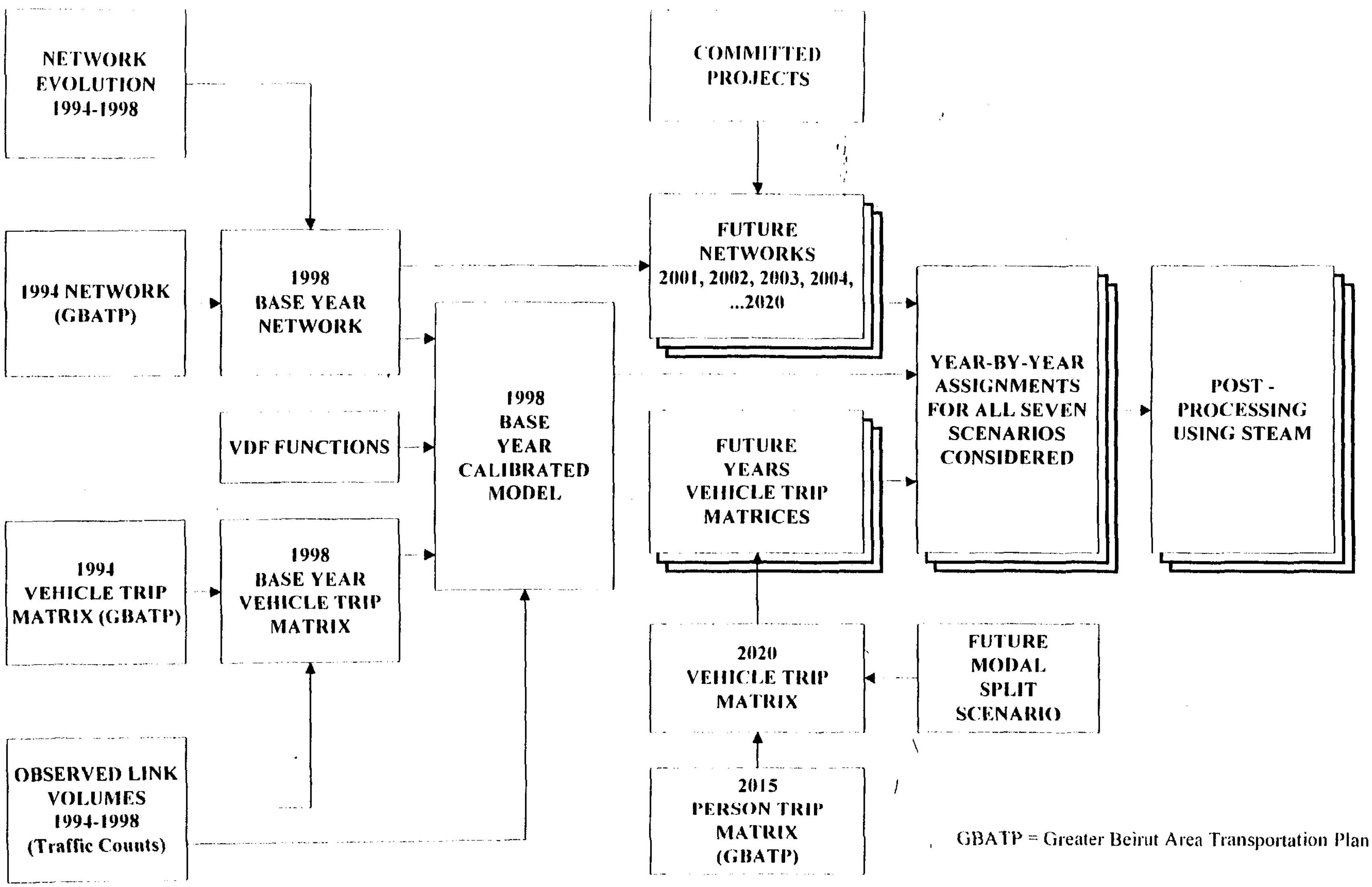

FIGURE 6 - 1 TRAFFIC MODELLING AND TESTING OF ALTERNATIVES

TABLE 6 - 1
BEIRUT URBAN TRANSPORT PROJECT
EMME/2 ROAD LINKS ATTRIBUTES

Link Type	Description	No. of Lanes Per Direction	Free Flow Speed (kmph)	Lane Capacity (pcu/hr) Node Operation Mode			Link Capacity Reduction Due To Parking (pcu/hr)(no cruise)	
				Unsignalized	Police-Operated or Isolated Signalized	Signalized Progressive	One Side	Two Sides
1	Centroid Connector	-	-	-	-	-	-	-
2	One-Way	1	40	600	700	NA	180	360
3	One-Way	2 & 3	50	600	700	800	400	800
4	Two-Way Undivided	1	45	600	700	NA	230	460
5	Two-Way Undivided	2	60	600	700	850	400	800
6	Two-Way Divided	2	65	900	1000	1200	600	1200
7	Two-Way Divided	3	70	1000 *	1100 *	1300 *	670 *	1340 *
8	Two-Way Mountainous	2	60	1200	NA	NA	NA	NA
9	Two-Way Mountainous	1	50	800	NA	NA	NA	NA
10	Expressway	2 & 3	80	1400	NA	NA	940 *	1880 *
11	Expressway	4	80	1600	NA	NA	1070 *	2140 *
12	Grade Separation	2	70	1600	NA	NA	NA	NA
13	Freeway	2 & 3	90	1800	NA	NA	NA	NA
14	Ramp	1 & 2	40	1000	NA	NA	NA	NA

NA indicates not applicable

* The capacity is reported per lane while the reduction in capacity is reported for the multi-lane link(roadway)

TABLE 6 - 2
LINK CAPACITY REDUCTION DUE TO PARKING

Link Type	Lane Width (m)	Pavement Width Reduction (m)	Pavement Reduction Ratio	HCM Friction Ratio	Total Ratio	Additional Reduction'		Original Lane Capacity (pcu/hr)	Reduced Link Capacity (No Cruise) (pcu/hr)	Additional Reduced Link Capacity With Double Parking & Cruise (pcu/hr)
						Double Parking	Cruise			
2	5.0 *	1	0.20	0.1	0.30	0.10	0.05	600	180	90
3	3.5	2	0.57	0.1	0.67	0.10	0.05	600	400	90
4	3.5	1	0.28	0.1	0.38	0.10	0.05	600	230	90
5	3.5	2	0.57	0.1	0.67	0.10	0.05	600	400	90
6	3.5	2	0.57	0.1	0.67	0.10	0.05	900	600	135
7	3.5	2	0.57	0.1	0.67	0.10	0.05	1000	670	150
10	3.5	2	0.57	0.1	0.67	NA	NA	1400	940	NA
11	3.5	2	0.57	0.1	0.67	NA	NA	1600	1070	NA

NA indicates Not Applicable

* Roadway width

$$\text{Time}_V = \text{Time}_O * \left\{2 + \sqrt{a^2(1 - v/c)^2 + b^2} - a(1 - v/c) - b\right\}$$

where b is given as:

$$b = (2a - 1) / (2a - 2)$$

TEAM International has adopted Spiess's Conical type function[1] and assembled the following VDFs:

* VDF1 = 1

VDF2 = (length/(40/60))*(0.9-6*(1-(volau/lanes*600-180*ul1+100*ul2)))+sqrt(36*(1-(volau/(lanes*600-180*ul1+100*ul2)))^2+1.21))

VDF3 = (length/(50/60))*(0.9-6*(1-volau/(lanes*600-400*ul1+100*ul2+200*ul3)))+sqrt(36*(1-(volau/(lanes*600-400*ul1+100*ul2+200*ul3)))^2+1.21))

VDF4 = (length/(45/60))*(0.9-6*(1-(volau/(lanes*600-230*ul1+100*ul2)))+sqrt(36*(1-(volau/(lanes*600-230*ul1+100*ul2)))^2+1.21))

VDF5 = (length/(60/60))*(0.9-6*(1-(volau/(lanes*600-400*ul1+100*ul2+250*ul3)))+sqrt(36*(1-(volau/(lanes*600-400*ul1+100*ul2+250*ul3)))^2+1.21))

VDF6 = (length/(65/60))*(0.9-6*(1-(volau/(lanes*900-600*ul1+100*ul2+300*ul3)))+sqrt(36*(1-(volau/(lanes*900-600*ul1+100*ul2+300*ul3)))^2+1.21))

VDF7 = (length/(70/60))*(0.9-6*(1-(volau/(lanes*1000-670*ul1+100*ul2+300*ul3)))+sqrt(36*(1-(volau/(lanes*1000-670*ul1+100*ul2+300*ul3)))^2+1.21))

VDF8 = (length/(60/60))*(0.875-5*(1-(volau/(lanes*1200)))+ sqrt(25*(1-(volau/(lanes*1200)))^2+1.265625))

VDF9 = (length/(50/60))*(0.875-5*(1-(volau/(lanes*800)))+ sqrt(25*(1-(volau/(lanes*800)))^2+1.265625))

VDF10 = (length/(80/60))*(0.875-5*(1-(volau/(lanes*1400-940*ul1)))+ sqrt(25*(1-(volau/(lanes*1400-940*ul1)))^2+1.265625))

VDF11 = (length/(80/60))*(0.875-5*(1-(volau/(lanes*1600-1070*ul1)))+ sqrt(25*(1-(volau/(lanes*1600-1070*ul1)))^2+1.265625))

VDF12 = (length/(70/60))*(0.875-5*(1-(volau/(lanes*1600)))+ sqrt(25*(1-(volau/(lanes*1600)))^2+1.265625))

VDF13 = (length/(90/60))*(0.857-4.5*(1-(volau/(lanes*1800)))+ sqrt(20.25*(1-(volau/(lanes*1800)))^2+1.30622))+ul1*length

VDF14 = (length/(40/60))*(0.875-5*(1-(volau/(lanes*1000)))+sqrt(25*(1-(volau/(lanes*1000)))^2+1.265625))+ul1*length

Figure 6-2 illustrates the graphs of these volume-delay functions.

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[1] Spiess, Heinz "Conical Volume-Delay Functions", EMME/2 Support Center, Aegerten, Switzerland, October 1989.

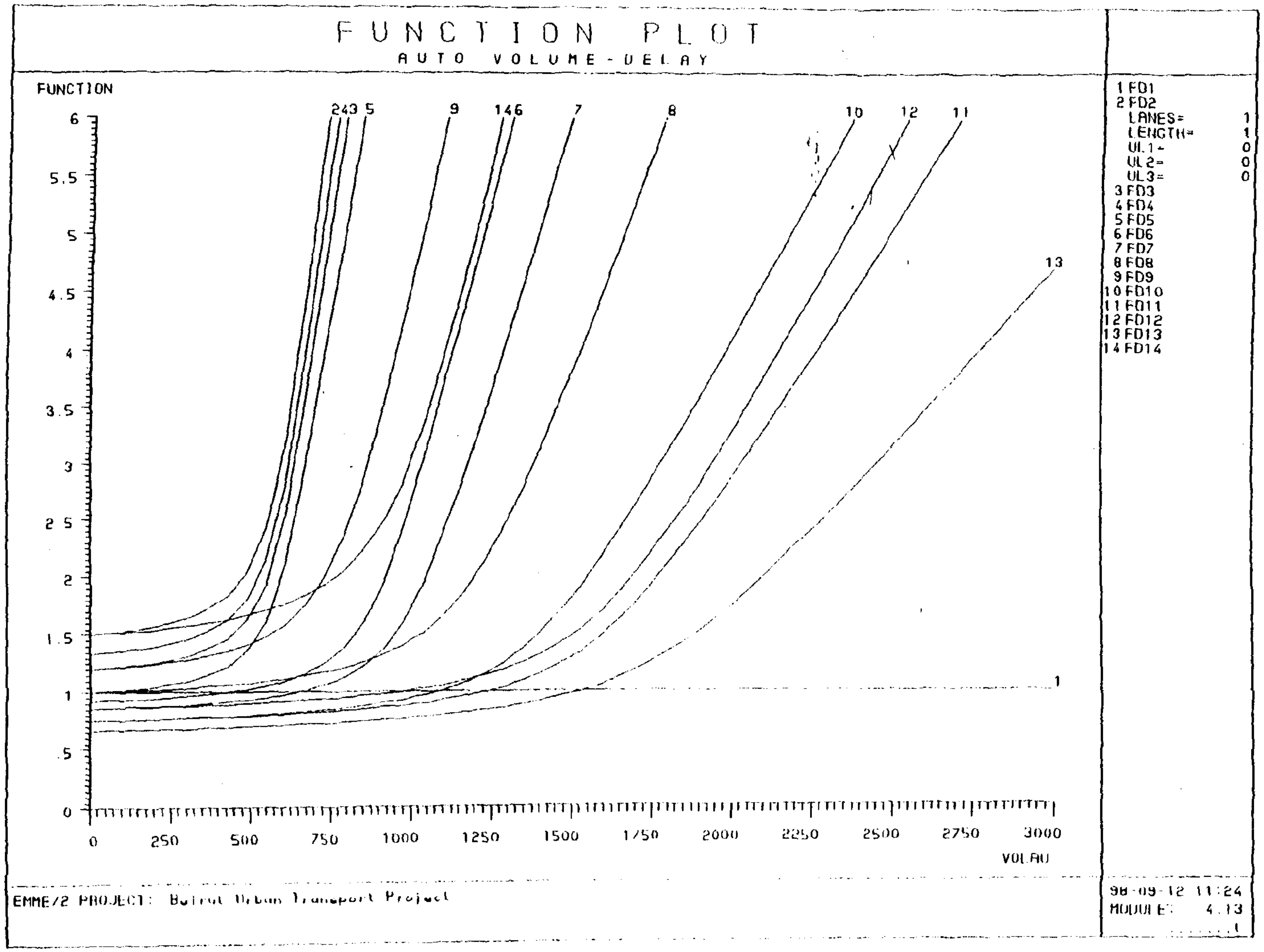

FUNCTION PLOT
AUTO VOLUME-DELAY
FUNCTION
VOLAU
1 FD1
2 FD2
LANES= 1
LENGTH= 1
UL1= 0
UL2= 0
UL3= 0
3 FD3
4 FD4
5 FD5
6 FD6
7 FD7
8 FD8
9 FD9
10 FD10
11 FD11
12 FD12
13 FD13
14 FD14
EMME/2 PROJECT: Beirut Urban Transport Project
98-09-12 11:24
MODULE: 4.13

FIGURE 6-2

*VDF1 represents the travel times on the dummy links connecting zone centroids to the highway network. It is a contrast value of one minute.

Note: ul1 is used to represent capacity reduction due to parked vehicles for vdf2, vdf3, vdf4, vdf5, vdf6 and vdf7; in this case, ul1 can take the following values:

ul1 value	Description
0	No parking on link
1	Parking on one side of the link
2	Parking on both sides
1.15	Double parking on one side
2.15	Parking on one side and double parking on the other side
1.03	Parking meter on one side
2.06	Parking meter on both sides

For vdf13 and vdf14, ul1 can be used to represent the tolls at the Périphérique and Northern Highway. The values of 1 min/km and 2 min/km respectively are used and explained in Section 6.7. The ul2 factor is the increased capacity in case of police operation of an isolated signal [ul2 takes the value of 0 (if no police or signal) and 1 otherwise]. The ul3 factor is the increased capacity due to progression [ul3 takes the value of 0 (if no progression) and 1 otherwise].

The above VDFs are used to estimate travel times at various levels of congestion rather than the more simple BPR functions.

6.3 Development of a Year 1998 (Base Year) Trip Matrix

The traffic analysis zone system was based on the Greater Beirut Area Transportation Plan. There were sixty-three (63) internal zones and five (5) external zones, providing a 68x68 trip matrix. Figure 6-3 shows the boundaries of the zones in the GBA. The sixty-three zones were grouped into twelve (12) districts. The boundaries of the districts are also shown in Figure 6-3. Table 6-3 shows a partial listing of cities, villages, or neighborhoods in each zone and district.

The 1994 vehicle trip matrix was taken as the basis for the development of the 1998 vehicle trip matrix. Based on traffic surveys and counts conducted in Greater Beirut during Fall of 1997 and Spring of 1998, growth rates were developed between 1994 and 1998. These annual growth in trips among pairs of zones in the GBA, are shown in the table below.

Destination / Origin	Zones 1 thru 29	Zones 30 thru 45	Zones 46 thru 63	Zones 64 thru 68
Zones 1 thru 29	1%	3%	1%	0%
Zones 30 thru 45	3%	2%	1%	0%
Zones 46 thru 63	1%	1%	1%	0%
Zones 64 thru 68	0%	0%	0%	0%

Table 6-4 shows the district - level year 1998 daily vehicular trip table (17 x 17 matrix).

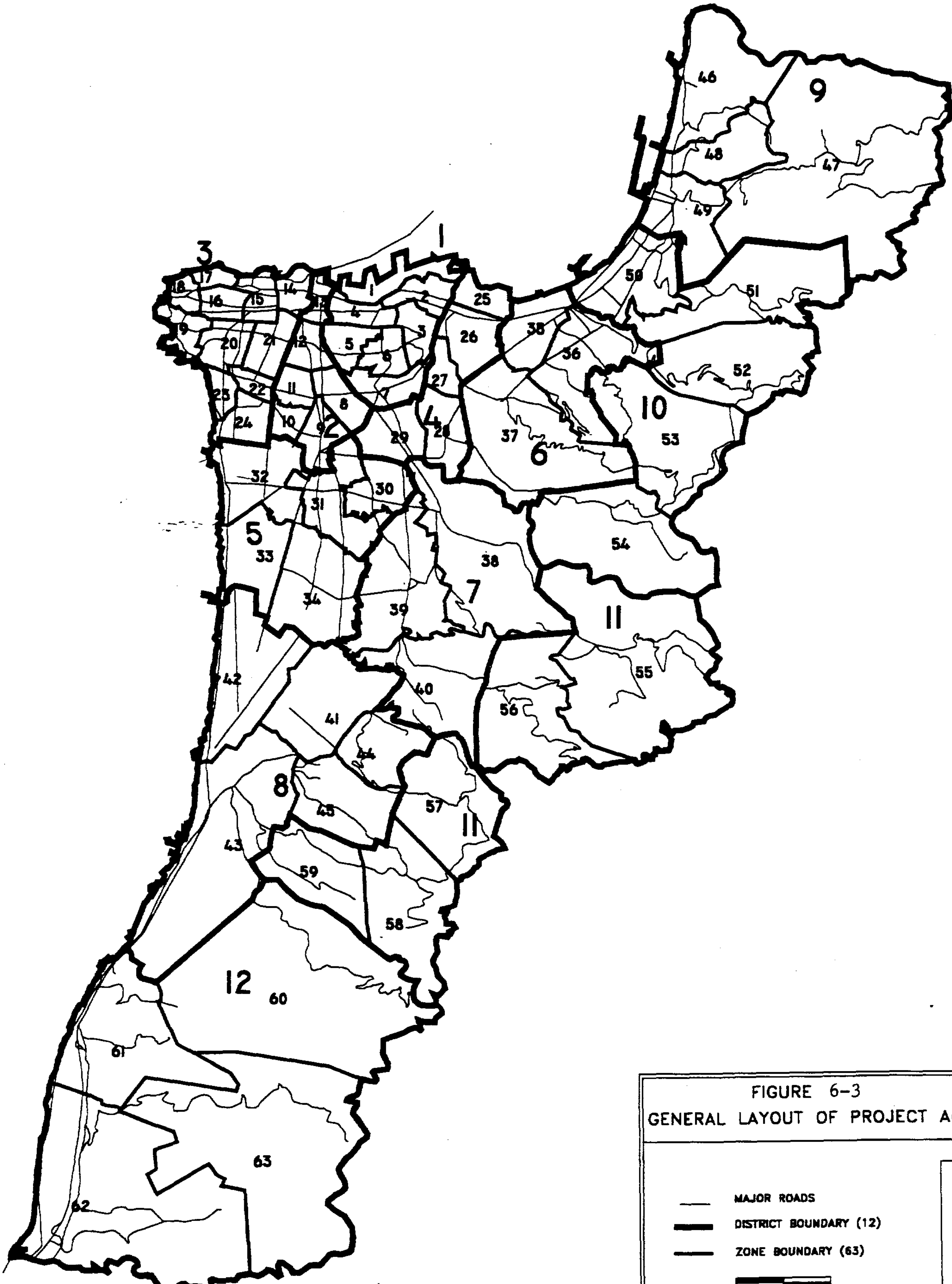


FIGURE 6-3
GENERAL LAYOUT OF PROJECT ARE[A]

TEAM / IAURIF / SOFRETU
NOVEMBER 1994

TABLE 6 - 3
TRAFFIC ANALYSIS ZONES

District No. / Name	Zone No.	Cities, Villages or Neighborhoods
1-East Beirut	1	Port of Beirut
	2	El Jisr, El Khodr. Mar Mekhael, El Kubayyat
	3	Al Jiitawi. Orthodox Hospital, Al Ghabi (Corniche El Nahr). Karm El Zeitoun
	4	El Hikmeh. St. Nicholas, El Rmeil, El Jemaize. Saifi
	5	St. Joseph, Furn El Hayek. El Nasra
	6	Mar Mitr, Achrafieh
	7	Hotel Dieu. Sioufi, Adliyeh. Kasr El Adl
2-Central Beirut	8	El Sabac (Parc). Ras El Nabeh. Amlieh. El Mathaf
	9	El Horch. Kaskas. Beit El Atfal, El Chuhadah. R.P. Chatila. Dar El Ajazeh
	10	El Malaab El Baladi. Tarik El Jadidah. Fakhani
	11	Makassed Hospital. Abou Chaker. El Bir Wal Ihsan. Al Mazraa. Barbour. Borj Abi Haidar
	12	Al Basta Al Fawka. Noueiri. Al Basta El Tahta. Al Bachoura. Al Khandak El Ghamik. Hawde El Wilaya (park). Karm El Ariss
	13	Riad El Solh. Ghalgoul, Azariyeh, Sahat El Nijme (Parliament), El Majidiyeh, El Baladieh. El Jamii El Kabir. Maarad. Mar Maroun
3-West Beirut	14	Minet El Hosn, Zeitouni, Starco, Bab Idriss. Sarai. Kabouchieh. Wadi Abou Jmil. Al Ahlieh. Borj El Murr
	15	Ain El Mraisseh. St Georges. Phoenicia. Holiday Inn. Kantari. Junblat. Al Sanayeh. Kuliyet El Houkouk. Presidence du Conseil. Central Bank. El Izaa. Zariff
	16	Hamra
	17	AUB. I.C.
	18	Ras Beirut. Jal El Bahr. Bain Militaire. Manarah
	19	Koraitem. Raouche. Chouran. Sakiet El Janzir
	20	Ain El Tineh, Snoubra, Tallet El Drouze. Dar El Fatwa. Munla
	21	Zaidanieh. El Batrakieh. Moussaitbeh
	22	T.V.. Tallet El Khayat. Soviet Embassy,Sakanet El Helou. Wata El Moussaitbeh
	23	Unesco, Ramlet El Baida
	24	Mar Elias. Dar El Muallimin. Nikabit El Mouhandisin

TABLE 6 - 3 (Continued)
TRAFFIC ANALYSIS ZONES

District No. / Name	Zone No.	Cities, Villages or Neighborhoods
4-Borj Hammoud /	25	Borj Hammoud 1
	26	Borj Hammoud 2
	27	Sin El Fil 1
	28	Sin El Fil 2. Jisr El Bacha
	29	Furn El Chebbak. Ain El Roumaneh
5-Borj El Brajneh /	30	Chiyah
	31	Ghobeiry 1, Haret Hreik
	32	Ghobeiry 2
	33	Ouzaii
	34	Borj El Brajneh
6-Jdaideh / Baouchrieh	35	El Baouchrieh
	36	Jdaideh. Sad El Baouchrieh
	37	Dekwaneh
7-Hazmieh / Baabda	38	Hazmieh, Fayadieh. Baabda
	39	Hadath. Hay El Laylake
	40	Boutchay, Kfarshima
8-Khaldeh / Choueifat	41	Hay Es Sollom
	42	Beirut International Airport
	43	Khaldeh
	44	Choueifat
	45	Deirkoubel

TABLE 6 - 3 (Continued)
TRAFFIC ANALYSIS ZONES

District No. / Name	Zone No.	Cities, Villages or Neighborhoods
9-Dbayeh / Antelias	46	Dbayeh. Haret El Belane. Deir Aauker. Zouk El Kharab
	47	Dik El Mehdi. Beit Ech Chaar. Mtaileb. Rabieh. Raboue. Zakrit. Mazraat Yachoue. Beit Kekko. Ain Aar. Qornet Chahwan
	48	Tal El Srour. Naccache
	49	Antelias, Haret Ghaouarni
10-Jal El Dib	50	Jal El Dib. Bainnaya. Deir El Salib. Amaret Chalhoub. El Zalka
	51	Biakout. Bsalim. Nabay
	52	Roumie
	53	El Fanar. Ain Saade
	54	Mansourieh. Mountazah. Dachounie
11-Jamhour / Bchamoun	55	Louaize. Jamhour. Haret El Sit. Rjoum. Bsous
	56	Wadi Chahrour. Bdadoun. Houmal. Blaybel
	57	Bsaba. Ain Aanoube
	58	Bchamoun, Srahmoul
	59	Yanar
12-Damour	60	Aramoun
	61	Daouha. Naame. Haret Naame
	62	Damour. El Hamra. Mechref Kadim
	63	Baaourta. Daqqoune
13-Southern Lebanon	64	South Lebanon. Saida. Sour. Chouf
14-Eastern Lebanon	65	Aley. Beqaa. Damascus. Syria. Other Mount Lebanon
15-Metn	66	Beit Meri. Broummana. Other Metn Areas
16-High Metn	67	Bikfaya. Other High Metn
17-Northern Lebanon	68	Jounieh. Kesrouan, Tripoli, North Lebanon. Syria. Turkey. Europe

TABLE 6 - 4
DISTRICT-LEVEL YEAR 1998 DAILY VEHICULAR TRIP MATRIX

From District	To District 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Row Total
1 East Beirut	38,151	8,295	5,730	31,985	6,026	27,259	11.073	2,034	6,997	9,128	1,428	556	1,443	1,656	1,973	926	11,750	166,410
2 Central Beirut	8,505	32,098	33,591	20,024	33,065	6,589	5.108	12,282	1,861	1,848	1,247	2,225	5,032	3.963	515	302	5,632	173,887
3 West Beirut	5,790	31,191	26,937	25,402	28,219	5,989	3.601	6,547	1.702	2,190	1,175	1,801	4,149	3,444	715	445	4,056	153,353
4 Borj Hammoud / Sin El Fil	31.985	20,024	25,402	39.806	17,029	17,961	15.362	4,817	6.127	7,748	2,019	1,283	2,667	2,714	2,266	853	7,796	205,859
5 Borj El Brajneh / Ghobeiry	6.086	33.065	28.501	17,029	54,409	3.194	4.545	10.141	792	849	898	1,862	4,104	3,561	316	245	2.632	172,229
6 Jdaideh / Baouchrieh	27.259	6,589	5,989	17.961	3,194	20.983	7.407	1,512	7.088	7,745	1.406	397	1,468	2.151	1,751	1,387	14,693	128,980
7 Hazmieh / Baabda	11,073	5.108	3,601	15,362	4,545	7.407	19.687	1.429	2.044	2.313	3,311	504	1,151	1.846	587	340	4.810	85,118
8 Khaldeh / Choueifat	2,128	12,282	6,769	4.817	10,141	1.512	1.429	13.035	581	649	890	1,755	1.938	1,621	175	92	1,491	61,305
9 Dbayeh / Antelias	6,997	1,861	1.702	6,127	792	7,088	2.044	581	12.122	3,616	324	159	374	434	422	375	8.515	53,533
10 Jal El Dib	9,128	1,848	2.190	7,748	849	7.745	2.313	649	3.616	6,183	666	126	409	562	704	446	5,162	50,344
11 Jamhour / Bchamoun	1,533	1,247	1,198	2,019	898	1,406	3.311	890	324	666	1,996	173	268	198	175	22	704	17,028
12 Damour	556	2,225	1.801	1.283	1.862	397	504	1,755	159	126	173	725	552	268	45	35	385	12,851
13 Southern Lebanon	1,443	5.032	4.149	2,667	4,104	1.468	1.151	1,938	374	409	268	552	235	717	164	129	2.517	27,317
14 Eastern Lebanon	1.656	3,963	3.444	2.714	3.561	2.151	1.846	1.621	434	562	198	268	717	247	141	94	2.270	25.887
15 Metn	1.973	515	715	2.266	316	1.751	587	175	422	704	175	45	164	141	23	11	929	10.912
16 High Metn	926	302	445	853	245	1.387	340	92	375	446	22	35	129	94	11	11	623	6,336
17 Northern Lebanon	11.750	5,632	4.056	7.796	2,632	14.693	4.810	1.491	8.515	5.162	704	385	2.517	2,270	929	623	3,058	77,023
Column Total	166.939	171.277	156.220	205,859	171.887	128.980	85.118	60.989	53.533	50.344	16.900	12,851	27,317	25.887	10.912	6.336	77.023	1.428.372

6.4 Model Calibration

Model calibration is an iterative procedure in which the assignment of a base year scenario will reproduce the existing traffic conditions on the roadway network. Proper calibration of the base year scenario is necessary to get reliable results in order to simulate future network configuration using forecasted travel demand matrices. The steps involved in model calibration are the following:

a) perform initial equilibrium assignments using 1998 vehicle trip matrix on the 1998 roadway network;

b) analyze travel time and travel distance among the zones in the study area;

c) compare volumes produced by the model to the ones counted at specific screenline;

d) analyze speeds and volumes according to link classification;

e) modify network attributes and/or volume-delay functions, if necessary;

f) perform other assignments and re-analyze the results;

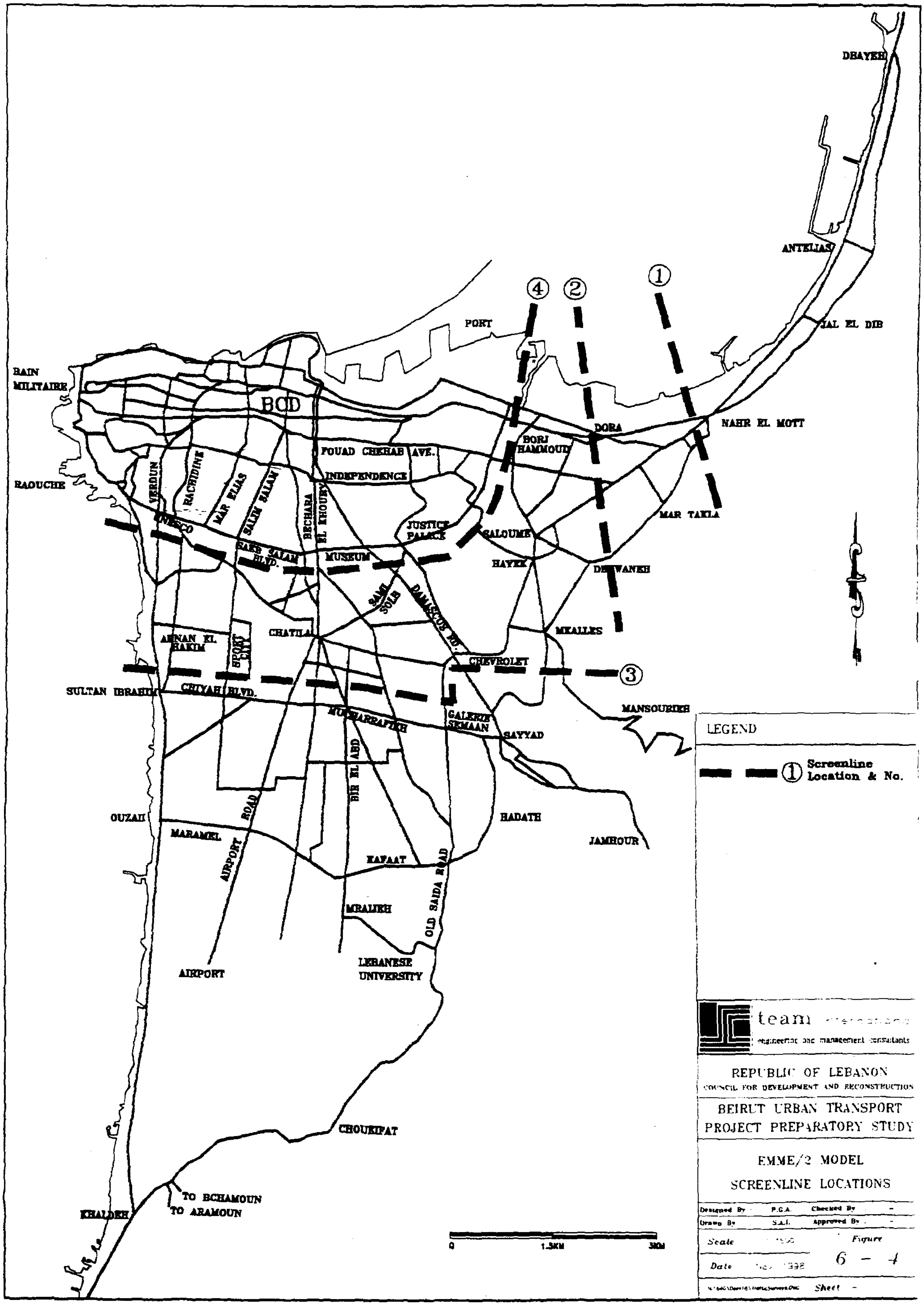
g) once the assignment results reflect existing traffic conditions on the roadway network (i.e. assigned traffic volumes are within ten percentage points of counted traffic volumes on screenline basis), the model is considered properly calibrated.

Figure 6-4 depicts the screenline locations used in the EMME/2 model validation. Table 6-5 shows a comparison of modeled volumes versus counted volumes by screenline.

6.5 Future Years Highway Networks

Future years highway networks were developed for the years 2001, 2002, 2003, 2005, 2010, 2015 and 2020. The year 1998 highway network (developed earlier) was augmented by the programmed and planned roadway projects. The following roadway projects were added to the respective networks based on their programmed completion date. Figure 6-5 shows the roadway construction projects programmed in Greater Beirut Area. For example, if a project is programmed to be completed by the year 2004; then it is coded in the year 2005 network, when it will be open for traffic.

- Coastal Highway Tollway between BCD and Dbayeh expected to be completed by the year 2002
- Borj Hammoud - Nabaa expected to be completed by the year 1999
- Borj Hammoud - Baouchrieh expected to be completed by the year 2009
- Port Penetrator expected to be completed by the year 1999
- Tahwita Road between Adlieh and Hazmieh expected to be completed by the year 1999
- Rocade Urban North expected to be completed by the year 1998
- Hazmieh - Airport Road expected to be completed by the year 2000
- Cocody - Cola 1 between Cocody and Solh Palace expected to be completed by the year 1998
- Cocody - Cola 2 between Solh Palace and Salam Viaduct expected to be completed by the year 1998
- Chatila - Choueifat 1 between Chatila and Kafaat Road expected to be completed by the year 1998



DBAYEH
ANTELIAS
JAL EL DIB
NAHR EL MOTT
PORT
BAIN MILITAIRE
BCD
DORA
BORJ HAMMOUD
FOUAD CHEHAB AVE.
INDEPENDENCE
RAOUCHE
VERDUN
RACHIDINE
MAR ELIAS
SALIM SALAM
BECHARA EL KHOURY
MAR TAKLA
JUSTICE PALACE
SALOUME
UNESCO
SAEB SALAM BLVD.
MUSEUM
HAYEK
DEKWANEH
SAMI SOLH
DAMASCUS RD.
MKALLES
CHATILA
ADNAN EL HAKIM
SPORT CITY
CHEVROLET
SULTAN IBRAHIM
GHIYAH BLVD.
MANSOURIEH
MUSHARRAFIEH
GALERIE SEMAAN
SAYYAD
BIR EL ABD
OUZAII
MARAMEL
AIRPORT ROAD
HADATH
JAMHOUR
KAFAAT
OLD SAIDA ROAD
MRAIJEH
AIRPORT
LEBANESE UNIVERSITY
CHOUEIFAT
KHALDEH
TO BCHAMOUN
TO ARAMOUN
0
1.5KM
3KM
LEGEND
Screenline Location & No.
team
engineering and management consultants
REPUBLIC OF LEBANON
COUNCIL FOR DEVELOPMENT AND RECONSTRUCTION
BEIRUT URBAN TRANSPORT
PROJECT PREPARATORY STUDY
EMME/2 MODEL
SCREENLINE LOCATIONS
Designed By P.G.A.
Checked By -
Drawn By S.A.I.
Approved By -
Scale
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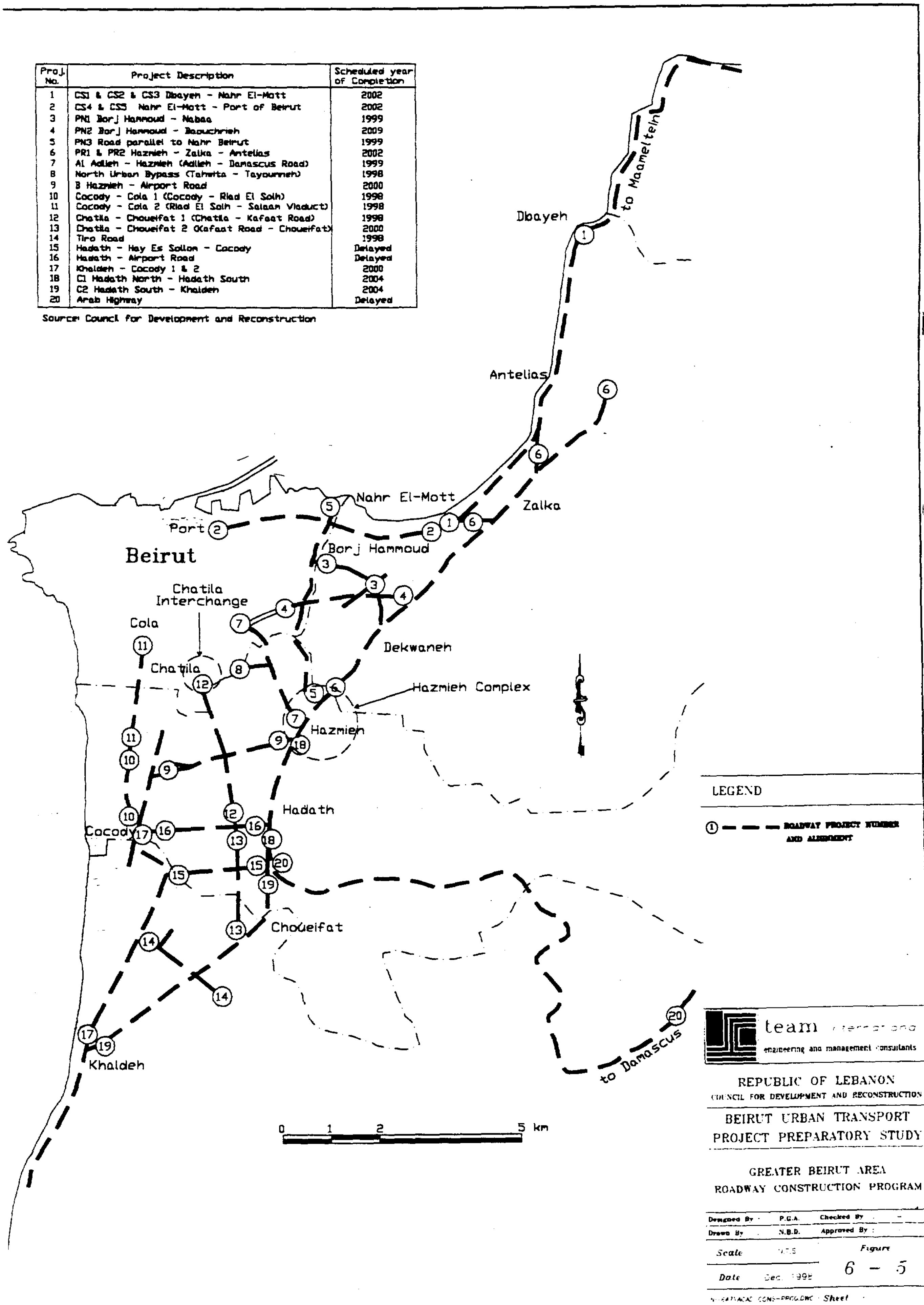
TABLE 6 - 5
1998 DAILY TRAFFIC VOLUMES
MODELED VS. COUNTED

Screenline No. / Name	Modeled Volumes	Counted Volumes	Modeled / Counted
Screenline No. 1 - Nahr El Mott			
Dora Blvd. at Mercedes	116.981	112.373	1.04
Jdaideh Road at Hikmeh	20.574	34.318	0.60
Sin El Fil Blvd. North of Almaza	86.201	74.718	1.15
Total Screenline No. 1	**223,756**	**221.409**	**1.01**
Screenline No. 2 - Dora - Dekwaneh			
Dekwaneh - Mar Takla Road	23.917	51.139	0.47
Dora Autostrade	127.644	104.790	1.22
Sin El Fil Blvd. North of Galerie Khabbaz	67.069	65.885	1.02
Total Screenline No. 2	**218.630**	**221.814**	**0.99**
Screenline No. 3 - Chiyah Boulevard			
Airport Road North of Chiyah Blvd.	46,203	86.222	0.54
Camille Chamoun Blvd. North of Chiyah Blvd.	32.434	31.536	1.03
Coastal Highway North of Sultan Ibrahim	6.028	17.358	0.35
Damascus Road South of Chevrolet	22.899	36.610	0.63
Ghobeiry Road North of Chiyah Blvd.	9.419	8.462	1.11
Jisr El Bacha Road North of Nahr Beirut	34.769	58.877	0.59
Mkalles - Mansourieh	34.967	40.557	0.86
Mucharafieh - Chatila Blvd.	34.224	21.621	1.58
Old Saida Road North of Mar Mekhael	33.607	48.673	0.69
S. Penetrator North of Chiyah Blvd.	55.144	55.342	1.00
Sport City Blvd. North of Chiyah Blvd.	77.383	51.740	1.50
Total Screenline No. 3	**387,077**	**456.998**	**0.85**
Screenline No. 4 - Corniche El Mazraa			
Adlieh Bridge – Ramps	60.091	49.963	1.20
Bechara Khoury (Tunnel – Ramps)	86.703	90.386	0.96
Borj Abi Haidar South of Corniche El Mazraa	13.932	20.337	0.69
Charles Helou Ave. East of Nahr Beirut	163.595	120.731	1.36
Cola Bridge	46.262	28.934	1.60
Damascus Road South of Museum	12.164	10.562	1.15
Farid Trad Street South of Corniche	7.571	22.916	0.33
Hariri Avenue	53.001	35.012	1.51
Jisr El Wati	43.917	74.125	0.59
Nahr Street at Borj Hammoud	51.600	26.063	1.98
Omar Ben Khattab South of Corniche El Mazraa	9.253	8.102	1.14
Rachidine Street South Corniche El Mazraa	27.225	25.653	1.06
Salim Salam Blvd. (Under Bridge)	11.954	21.575	0.55
Sami Solh Ave. South of Corniche	44.311	42.539	1.04
Unesco (Ministry of Education)	29.494	19.418	1.52
Total Screenline No. 4	**661,073**	**596,316**	**1.11**
Total Screenlines 1 through 4	**1,490,536**	**1,496,537**	**1.00**

Proj. No.	Project Description	Scheduled year of Completion
1	CS1 & CS2 & CS3 Dbayeh - Nahr El-Mott	2002
2	CS4 & CS5 Nahr El-Mott - Port of Beirut	2002
3	PN1 Borj Hammoud - Nabaa	1999
4	PN2 Borj Hammoud - Baouchrieh	2009
5	PN3 Road parallel to Nahr Beirut	1999
6	PR1 & PR2 Hazmieh - Zalka - Antelias	2002
7	Al Adlieh - Hazmieh (Adlieh - Damascus Road)	1999
8	North Urban Bypass (Tahwita - Tayouneh)	1998
9	B Hazmieh - Airport Road	2000
10	Cocody - Cola 1 (Cocody - Riad El Solh)	1998
11	Cocody - Cola 2 (Riad El Solh - Salaam Viaduct)	1998
12	Chatila - Choueifat 1 (Chatila - Kafaat Road)	1998
13	Chatila - Choueifat 2 (Kafaat Road - Choueifat)	2000
14	Tiro Road	1998
15	Hadath - Hay Es Sollom - Cocody	Delayed
16	Hadath - Airport Road	Delayed
17	Khaldeh - Cocody 1 & 2	2000
18	C1 Hadath North - Hadath South	2004
19	C2 Hadath South - Khalden	2004
20	Arab Highway	Delayed

Source: Council for Development and Reconstruction



- Chatila - Choueifat 2 between Kafaat Road and Choueifat expected to be completed by the year 2000
- Khaldeh - Cocody expected to be completed by the year 2000
- Périphérique Section between Hazmieh and Zalka expected to be completed by the year 2002
- Périphérique Section between Khaldeh and Hazmieh expected to be completed by the year 2004
- Périphérique Section between Zalka and Antelias expected to be completed by the year 2004.

6.6 Future Years Trip Matrices

The modeling effort requires inputting zone to zone trip matrices into the assignment model.

The starting trip matrix is the 1994 vehicular trip matrix developed by the GBATP. It was based on extensive field surveys which included household DU surveys and road-side O-D surveys.

TEAM International is continuously involved in collecting traffic related data in the Greater Beirut Area as required by the various studies they are in charge of. During late 1997. additional roadside O-D surveys were conducted at the Northern Entrance near Dbayeh and at several locations along the Beirut - Chtaura - Masnaa Highway. Concurrently a traffic counting campaign was also conducted all over Greater Beirut. The results of these surveys were utilized to update the 1994 vehicular trip-matrix. In summary the updated 1997 vehicular trip matrix reflected no growth in traffic arriving and leaving the study area at its external cordon. a fair amount of growth in trips originating and destined to southern and northern suburbs. and a low growth in trips within Municipal Beirut.

More counts were made during 1998. which reflected some growth in traffic at Khaldeh. coming or leaving the Beirut urban agglomeration. Additional counts enabled further tuning of the vehicular trip matrix. to reflect the observed relative growth in various zones.

The GBATP has produced in 1995 forecasts of trip interchange through the year 2015. The forecasting process at that time took into consideration the growth in population and employment on a zone-by-zone basis. Starting with a high and low scenarios of population growth. a moderate scenario was adopted by GBATP which resulted in an average growth of total travel of 4.3% per annum by the year 2015.

The observed growth in population. employment. and general economic growth realized after 1996 is much slower than the prevailing outlook of 1994 - 1995. Accordingly. it was decided to adopt the 2015 person trip matrix developed by GBATP to reflect 2020 conditions. That is the slow economic growth would result in delaying the growth in trips over the study horizon such that the level of trip-making expected to be achieved in 2015 would now be delayed till 2020. The resulting area-wide annual average trip growth over the period 1998 - 2020 is 3.3%.

Forecasting vehicular trips requires adopting a specific modal split scenario. The modal split scenario adopted in 1995 for 2015 trips consisted of a marked shift towards public transport. The public transport is an essential component of the GBATP. It included plans for re-operating the coastal rail line as a commuter service between Jubail and Damour. introducing two metro-lines. in addition to expanding bus services. both on dedicated ROW and on city streets. The adopted government policies as reflected in the project priorities clearly show that the shift towards public transportation recommended by GBATP will not be realized by 2015.

Consequently. a more realistic scenario was adopted regarding modal split. Trips between various sub-areas within GBA would have different proportions of the trips served by public transport (entirely bus). with an overall average of 16 percent.

In transforming person trips to vehicular trips in the year 2020. the proportion of trips done by bus were as depicted in the following table. for pairs of sub-areas of the study area.

Destination / Origin	BUA	CS	MS	EA	Total
BUA	25%	10%	4%	6%	**20%**
CS	10%	8%	4%	3%	**8%**
MS	4%	4%	4%	2%	**4%**
EA	6%	3%	2%	3%	**6%**
Total	20%	8%	4%	6%	16%

BUA: Beirut Urban Agglomeration CS: Coastal Suburbs MS: Mountain Suburbs
EA: External Areas

The forecasting of vehicular trips for various time horizons followed the following steps:

1. Person trip matrices were developed for years 2001 through 2015. based on interpolation between 1998 and 2020.

2. Once the transit trips were extracted from the trip matrix. it was converted to transit vehicle trips based on the following bus-passenger occupancy. A bus occupancy of 20 passengers was taken for 1998. 30 passengers for 2005. 40 passengers for 2010. 50 passengers for 2015. and 60 passengers for 2020. The transit vehicle trip matrix was converted into passenger car trip matrix by multiplying it by 2 representing the transit bus to passenger car equivalency ratio.

3. The remaining person trip matrices (auto mode) were converted to passenger car unit matrices using an average auto occupancy of 1.65 persons per vehicle (as observed from traffic surveys).

6.7 Treatment of Toll in the Assignments

The Northern Entrance and the Périphérique are two very important projects in the Greater Beirut Area that are expected to be in service during the coming few years. Both are being considered to be executed as BOT projects. International developers have expressed their interest and are currently studying the details of the revenue forecasts. On the other hand. it does not seem that the Government of Lebanon is inclined to finance these two projects from its own resources in the near future. in case an agreement with a BOT developer is not concluded soon.

The execution of these two facilities by a certain date will have its influence on the traffic in general. and more importantly on the street network adjacent to them. Some of the grade-separation projects are very close to these proposed expressways (Mkalles Roundabout and the Périphérique, for example). The traffic diverted to the proposed expressways would greatly influence the level of improvement warranted on the street network in their vicinity.

The question to be answered is whether the proposed expressways must be considered as toll facilities or not in the assignment of future traffic. Even in the absence of conclusive knowledge of the final configuration of the Toll System (if any) and the amount of tolls to be collected. we argue that the base-case against which to compare the measure of effectiveness and the economic feasibility of the proposed projects should be a network which includes toll on the two proposed expressways. for the following reason. If the assignment is done without consideration of toll on the proposed expressways. then more traffic will be attracted to them. The proposed improvements (grade separations) on the street network in the vicinity would appear to be less warranted. One might think that this would be a conservative approach which precludes accepting a project if it is not really warranted. On the contrary. we argue that this approach is not conservative but rather optimistic vis-a-vis the traffic forecast on the street network. This is so because without tolls to support financing of the proposed expressways. these will at best be delayed, probably till after 2010. The consequence would be that more traffic would have to use the adjacent street network. and the proposed improvements on it would prove then to be more warranted.

Having reached a decision to include the proposed expressways (Northern Entrance and Périphérique) as toll facilities. it remains how to treat the toll in the assignment.

The toll systems for the proposed expressways are still under study. We have benefited from these studies. but did not adopt blindly their results. We are assuming a uniform kilometric closed toll of US$0.17 / vehicle-km on the Northern entrance and a uniform kilometric closed toll of US$0.08 / vehicle-km on the Périphérique.

The value of time is taken as US$5.00 / hr / vehicle(*). The paid toll would translate to 2 min/km of time penalty on the Northern entrances

$\left(\frac{\$0.17 / veh-hr}{\$5/hr} x \frac{60\min}{1hr} \right)$. and 1 min/km of time penalty on the Périphérique.

The adopted assumption regarding toll would provide a uniform assessment of the impact of toll on traffic diversion. Even in the case where a different toll strategy is eventually adopted and since the objective here is primarily to estimate the traffic on the street network and not to estimate toll revenue. the adopted time penalty per kilometer is more appropriate.

This approach would avoid the need to worry about changes in the level of toll in future years because the change in the level of toll would most probably be driven by the change in the perceived value of time. In this case. the time penalty would not change.

6.8 Future Years Traffic Projections

Once future roadway networks were coded into the EMME/2 model and future vehicle trip matrices (for both auto and transit modes were developed): traffic assignments were performed in order to get peak hour traffic projections for all scenarios considered in this study. A base case scenario was considered. in addition to traffic signals scenario. parking control scenario. parking structure scenario. and three grade separations scenarios. Also. a combination of all considered scenarios was studied.

(*) For a tolled facility. the decision to use it or not is based on a comparison of the driver's value of time and the toll to be paid. The heaviest use of a toll facility is during peak hours. i.e. for work trips. The average wage hourly rate ($5.17) was rounded to $5.00 in order to correspond to an easy to interpret time penalty (1 or 2 min/km).

These traffic forecasts will be an input for the economic analysis and evaluation.

Table 6-6 shows the volume - capacity ratios for scenarios tested including existing year 1998 conditions.

TABLE 6 - 6
PROJECTED VOLUME - CAPACITY RATIOS BY SCREENLINE FOR SCENARIOS TESTED

Scenarios	Year 1998					Year 2005					Year 2010					Year 2015				
	Screenline No.1	Screenline No.2	Screenline No.3	Screenline No.4	Total Screenline No.1-4	Screenline No.1	Screenline No.2	Screenline No.3	Screenline No.4	Total Screenline No.1-4	Screenline No.1	Screenline No.2	Screenline No.3	Screenline No.4	Total Screenline No.1-4	Screenline No.1	Screenline No.2	Screenline No.3	Screenline No.4	Total Screenline No.1-4
Existing Conditions - Year 1998	1.04	1.29	0.85	0.86	0.93	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Base Case Scenario	-	-	-	-	-	0.73	0.80	0.75	0.77	0.76	0.89	0.85	0.85	0.78	0.83	1.09	1.04	1.00	0.87	0.98
Improvement Case - Traffic Signals	-	-	-	-	-	0.72	0.80	0.71	0.80	0.76	0.88	0.85	0.83	0.80	0.83	1.08	1.04	0.98	0.88	0.98
Improvement Case - Parking Control	-	-	-	-	-	0.72	0.78	0.69	0.77	0.74	0.89	0.83	0.79	0.78	0.81	1.09	1.02	0.94	0.86	0.96
Improvement Case - Grade Separation (Groups I+II+III)	-	-	-	-	-	0.69	0.75	0.72	0.77	0.74	0.85	0.80	0.83	0.76	0.81	1.04	0.98	1.00	0.86	0.95
Combination of All Improvements	-	-	-	-	-	0.68	0.73	0.70	0.74	0.72	0.84	0.79	0.79	0.74	0.78	1.03	0.96	0.94	0.82	0.92
Combination of All Improvements Without Peripherique and Northern Toll Highway	-	-	-	-	-	1.22	1.33	0.92	0.89	0.99	1.43	1.48	1.07	0.98	1.12	1.74	1.76	1.28	1.14	1.33

7. ECONOMIC ANALYSIS RESULTS

7.1 Analysis Years for Improvement Programs

To perform the economic analysis. the improvement projects are divided into cases in order to compare each improvement case with the "Do-Nothing" option or Base Case Scenario. The proposed Traffic Management and Parking improvement programs. are each treated as a single improvement case. The traffic light system in association with the traffic management center. which constitute the major elements of the Traffic Management Program. is expected to be executed in a two-year period (1999 & 2000) and its deployment will impact the total highway network within the Greater Beirut Area (GBA). Similarly. the same rational applies to the improvement projects within the parking program. They are expected to be constructed within a short period of time (2000 & 2001). and will produce traffic impacts beyond their localized surrounding. This program is divided into two cases: parking controls case and parking structures case. Each of these two cases are analyzed separately. The Grade Separation improvement program for Beirut Entrances. which is composed of geometric improvements to 16 intersections. is treated as multiple improvement cases. The grouping of the intersections within one improvement case depend on their expected starting and completion dates. These dates. were determined by the design engineer based on the following criteria:

1. Readiness of engineering design and land expropriation
2. Intersection level-of service to road users
3. Network consideration. including conflicts with other proposed construction and
4. Possibility of traffic detours during construction.

Based on these developed target dates. The 16 intersections were grouped into three improvement cases as shown in Table 7-1. They are all expected to be constructed between year 1999 and year 2004. Group I is expected to start construction in 1999 and be completed in 2001.Group II will start construction in year 2001 and finish in 2002. and Group III will start construction in 2002 and complete construction in 2004. For economic analysis. Group I is treated as a separate case. then Group I & Group II are treated together as the second improvement case. and Group I plus Group II plus Group III are treated as the third improvement case in this category.

The Base Case Scenario. or the "Do-Nothing" Option. takes into consideration the existing highways under construction or planned to be constructed in the near future that may influence the three proposed programs under BUTP. such as the construction of the Périphérique of Beirut. The Périphérique is expected to be built as a toll facility. Hence. the Base Case Scenario includes the Périphérique as a toll-facility: Should the Périphérique be built not as toll facility. it would be expected to draw more traffic to it. the result is to realize less benefits from the assumption of a tolled Périphérique results in an estimate of benefits on the conservative side. The alternative improvement cases are individually or in combination tested against this Base Case Scenario.

The future analysis year for the different improvement programs vary with the construction completion date of each improvement case. and are shown in Table 7-1. In the early years of analysis when the highway network is still mainly under construction. STEAM was run for almost every year (2001. 2002 & 2003) for the various improvement programs. When most of the construction programs are completed by the year 2004. STEAM was run at 5-year equal intervals (2005. 2010. and 2015). The user benefits were then interpolated between the key analysis year.

TABLE 7-1: ANALYSIS SCENARIOS AND ANALYSIS YEARS

Analysis Scenarios	Project Description	Expected Construction Starting Date	Expected Construction Completion Date	Analysis Periods
Base Case- A	Existing and under construction highway network & Périphérique with toll	Périphérique (2002)	Périphérique (2004)	2001, 2002, 2003, 2005, 2010, 2015
Improvement Case- 1	Traffic lights & traffic control center & elimination of parking at intersections	1999	2000	2001, 2002, 2003, 2005, 2010, 2015
Improvement Case- 2a	Parking Controls	2000	2001	2002, 2003, 2005, 2010, 2015
Improvement Case- 2b	Parking Structures	2000	2001	2002, 2003, 2005, 2010, 2015
Improvement Case- 3 Group I	Grade Separations at: (Group I) -Galerie Semaan -Hayek -Dora -Mkalles -Tayouneh	1999	2001	2002, 2003, 2005, 2010, 2015
Group I & II	Grade Separations at: (Group II) -Beit al-Atfal -Mar Mkhael -Msharrafieh -Airport	2001	2002	2003, 2005, 2010, 2015
Groups I, II, & III	Grade Separations at: (Group III) -Jal el-Dib -Adlieh -Antelias -Museum -Bechara el-khoury -Samy el-Solh -Old Saida Rd. close to Khaldeh	2002	2004	2005, 2010, 2015
All Improvement Programs	A combined case of all Improvement Programs (except Parking Structures - Improvement Case - 2b)	1999	2004	2005, 2010, 2015

As started earlier, the year 2015 is considered as the final year of analysis and the benefits accrued to the specific Improvement Case were held constant to the end of the useful life of the project. It is realistic to assume that additional capacity beyond year 2015 will be provided to meet the additional demand, and not all the benefits will be attributed to the Improvement Case under consideration.

7.2 Economic Analysis Results of Each Improvement Case

7.2.1 Traffic Management – Case 1

The Traffic Management Improvement program is tested against the Base Case Scenario, and the economic analysis results are shown in Table 7-2 The results show that all the economic indicators for this improvement case are attractive and the economic return on investments are substantial. The Net Present Value (NPV), which measures the difference between the discounted present value of benefits and the discounted present value of costs, is $59.225 millions. The Internal Rate of Return (IRR), which measures the discount rate that sets the net present value of the stream of net benefits equal to zero; is 34.1% which is much higher than the adopted discount rate of 12%. The First Year Rate of Return (FYRR), which measures the rate of first-year total benefits to the project total cost is 41.3%. Overall, these economic indicators state that this improvement program is much preferred than the "Do-Nothing" option.

As expected, the dominant benefits accrued to the users come from the reduction in travel times (VOT benefits). The improvement in traffic controls, and in traffic management definitely have positive impacts on the user's travel time in the Beirut area. These benefits do increase over the years, particularly after the year 2005, when the increase in demand starts again to outpace the highway supply. In fact, the proposed improvements in the highway network under the BUTP project and other planned projects by the Lebanese government, almost all take place by the year 2004. No improvement in the highway network in the Base Case scenario or in the improvement Case scenario is taking place in year 2005 and beyond, except for one improvement in the base case scheduled for completion by 2009. That is why the benefits of the Traffic Management improvement program shows steady increase beyond 2005, since the demand for travel keeps increasing, and there are no competing highway projects in these years introduced in the Base Case Scenario. This phenomenon is not the same for the early years between 2001 and 2004. As Table 7-2 indicates the VOT benefits decrease from year 2002 to the year 2005. This phenomenon is attributed to the completion of several highway projects in the Base Case Scenario in those years. For example, the Périphérique will be completed by the year 2004 and several other major highway projects will be completed in the years 2002, and 2003. The importance of the Traffic Management improvement program is overshadowed as these new projects start serving the users in 2002 in the Base Case Scenario, and provide them with shorter travel times. However, the attributed VOT benefits to the Traffic Management improvement program are still sizeable in those years, although it went down from $13.77 millions in 2001 to $6.13 millions in 2005.

The benefits accrued to the users from vehicle operating costs (VOC) are minor compared to the VOT benefits. These benefits are negative in most of the years. Because, due to improvements in travel times on some parts of the network, drivers are willing to travel longer to gain speed and travel times. In doing so, they incur costs associated with increased vehicle miles of travel, such as in insurance, depreciation, and maintenance, which are referred to as non-fuel user costs. The higher speeds and shorter travel times will save the users fuel consumption and consequently fuel cost. Since most of the vehicle operating costs are in non-fuel user costs, the balance in the costs is in some cases negative as shown in column "total VOC benefits" of Table 7-2.

7.2.2 Parking Controls – Case 2

As stated earlier, the Parking Improvement Program is divided into two cases, Parking Controls, and Parking Structures. The economic analysis of the Parking Controls case, in comparison to the Base Case, is shown in Table 7-3. The table shows the total benefits for this case are very high and its total costs are very low. This combination produced very high Net Present Value (NPV) of $257.74 millions, Internal Rate of Return (IRR) of 557.6%, and First Year Rate of Return (FYRR) of 1810.0%. These values indicate that excellent economic return on transportation investments could be achieved through proper law enforcement procedures and control measures of on-street parking, in addition to the traditional highway construction measures. Since this case has a very low investment cost, it is worth giving it the highest priority in implementation.

7.2.3 Parking Structures – Case 2

The results of the economic analysis of this case are shown in Table 7-4. The results indicate that the total net benefits are negative for most of the years, resulting in unacceptable economic indicators. These results are expected for such type of investment, where the initial capital costs are high, and the economic benefits accrued to the users are low. This component was eventually dropped from among the components of the BUTP. Its economic indicator results will not appear in the summary of all cases combined.

7.2.4 Grade Separation Group I – Case 3

The first group of grade separations, that will be constructed between the years 1999 and 2001, are analyzed and compared to the Base Case Scenario. The economic analysis results are shown in Table 7-5. The table indicates that the Net Present Value is $ -5.01 millions, the Internal Rate of Return (IRR) is 10.8%, and the First Year Rate of Return (FYRR) is 26.4%. These economic indicators are marginal except for the First year Rate of Return.

The high cost of construction coupled with the low benefits in the early years, except for the first year, produced low net benefits and consequently low economic indicators. As stated earlier in the Traffic Management Case, the completion of major highway project in the Base Case Scenario in the years 2003 and 2004, have overshadowed and diminished the benefits accrued to the users of this Grade Separation Case in those important years. The benefits accrued in the early years are much more important than those obtained in later years, because of their sizeable impact on the economic indicators through the discount ratio.

7.2.5 Grade Separation Group II + Group I – Case 3

The economic situation changes when grade separations in Group II, to be constructed in years 2001 and 2002, are added to Group I as shown in Table 7-6. All the economic indicators for this combined case are attractive and the returns on economic investments are substantial. The NPV, FRR, and FYRR are $28.95 millions, 18.2%, and 3.3% respectively. The total benefits are steadily increasing after 2005 and the early years benefits are still good, which show the system wide impacts of this case is competitive with the new opening of highways in those years in the Base Case Scenario. The benefits of Group I alone are also introduced in the economic analysis for the year 2002 to account for user benefits prior to Group II becoming operational in year 2003.

Table 7-2: Summary of Economic Analysis

Case 1: Traffic Management

YEAR	PROJECT COSTS (million USD)			PROJECT BENEFITS (million USD)			NET BENEFITS	
	Investment Cost	Operation and Maintenance	Total Cost	Total VOC Benefits	Total VOT Benefits	Total Benefits	total Net	Discounted Net at 12%
1999	11.452		**11.452**			**0**	-11.452	-11.452
2000	11.452		**11.452**			**0**	-11.452	-10.225
2001		2.318	**2.318**	-0.227	13.776	**13.549**	11.231	8.953
2002		2.318	**2.318**	1.479	10.054	**11.533**	9.215	6.559
2003		2.318	**2.318**	-3.028	9.345	**6.317**	3.999	2.541
2004		2.318	**2.318**	-0.279	7.740	**7.4605**	5.1425	2.918
2005		2.318	**2.318**	2.47	6.134	**8.604**	6.286	3.185
2006		2.318	**2.318**	1.174	9.165	**10.339**	8.021	3.628
2007		2.318	**2.318**	-0.122	12.196	**12.074**	9.756	3.940
2008		2.318	**2.318**	-1.417	15.226	**13.809**	11.491	4.144
2009		2.318	**2.318**	-2.713	18.257	**15.544**	13.226	4.258
2010		2.318	**2.318**	-4.009	21.288	**17.279**	14.961	4.301
2011		2.318	**2.318**	-3.377	22.716	**19.339**	17.021	4.369
2012		2.318	**2.318**	-2.744	24.143	**21.399**	19.081	4.373
2013		2.318	**2.318**	-2.112	25.571	**23.459**	21.141	4.326
2014		2.318	**2.318**	-1.479	26.998	**25.519**	23.201	4.239
2015		2.318	**2.318**	-0.847	28.426	**27.579**	25.261	4.121
2016		2.318	**2.318**	-0.847	28.426	**27.579**	25.261	3.679
2017		2.318	**2.318**	-0.847	28.426	**27.579**	25.261	3.285
2018		2.318	**2.318**	-0.847	28.426	**27.579**	25.261	2.933
2019		2.318	**2.318**	-0.847	28.426	**27.579**	25.261	2.619
2020	-2.089	2.318	**0.229**	-0.847	28.426	**27.579**	27.35	2.532
							NPV =	**59.225**
							IRR =	**34.1%**
							FYRR=	**41.3%**

Table 7-3: Summary of Economic Analysis

Case 2: Parking Controls

YEAR	PROJECT COSTS (million USD)			PROJECT BENEFITS (million USD)			NET BENEFITS	
	Investment Cost	Operation and Maintenance	Total Cost	Total VOC Benefits	Total VOT Benefits	Total Benefits	Total Net	Discounted Net at 12%
2000	0.9205		**0.9205**			**0**	-0.9205	-0.921
2001	0.9205		**0.9205**			**0**	-0.9205	-0.822
2002		0.184	**0.184**	1.6	38.144	**39.744**	39.56	31.537
2003		0.184	**0.184**	0.699	35.783	**36.482**	36.298	25.836
2004		0.184	**0.184**	1.4325	28.146	**29.579**	29.395	18.681
2005		0.184	**0.184**	2.166	20.509	**22.675**	22.491	12.762
2006		0.184	**0.184**	0.981	23.125	**24.105**	23.921	12.119
2007		0.184	**0.184**	-0.204	25.740	**25.536**	25.352	11.468
2008		0.184	**0.184**	-1.390	28.356	**26.966**	26.782	10.817
2009		0.184	**0.184**	-2.575	30.971	**28.397**	28.213	10.174
2010		0.184	**0.184**	-3.760	33.587	**29.827**	29.643	9.544
2011		0.184	**0.184**	-2.892	41.302	**38.410**	38.226	10.989
2012		0.184	**0.184**	-2.025	49.017	**46.993**	46.809	12.015
2013		0.184	**0.184**	-1.157	56.733	**55.575**	55.391	12.694
2014		0.184	**0.184**	-0.290	64.448	**64.158**	63.974	13.090
2015		0.184	**0.184**	0.578	72.163	**72.741**	72.557	13.256
2016		0.184	**0.184**	0.578	72.163	**72.741**	72.557	11.836
2017		0.184	**0.184**	0.578	72.163	**72.741**	72.557	10.568
2018		0.184	**0.184**	0.578	72.163	**72.741**	72.557	9.435
2019		0.184	**0.184**	0.578	72.163	**72.741**	72.557	8.424
2020		0.184	**0.184**	0.578	72.163	**72.741**	72.557	7.522
2021		0.184	**0.184**	0.578	72.163	**72.741**	72.557	6.716
							NPV =	**257.740**
							IRR =	**557.6%**
							FYRR=	**1810.0%**
							MIRR =	**42.1%**

Table 7-4: Summary of Economic Analysis

Case 2: Parking Structure

YEAR	PROJECT COSTS (million USD)			PROJECT BENEFITS (million USD)			NET BENEFITS	
	Investment Cost	Operation and Maintenance	Total Cost	Total VOC Benefits	Total VOT Benefits	Total Benefits	Total Net	Discounted Net at 12%
2000	6.796		**6.796**			**0**	-6.796	-6.796
2001	6.796		**6.796**			**0**	-6.796	-6.068
2002		0.663	**0.663**	3.958	-0.244	**3.714**	3.051	2.432
2003		0.663	**0.663**	-3.386	1.581	**-1.805**	-2.468	-1.757
2004		0.663	**0.663**	-2.353	0.368	**-1.9855**	-2.649	-1.683
2005		0.663	**0.663**	-1.32	-0.846	**-2.166**	-2.829	-1.605
2006		0.663	**0.663**	-1.726	-0.388	**-2.114**	-2.777	-1.407
2007		0.663	**0.663**	-2.132	0.070	**-2.062**	-2.725	-1.233
2008		0.663	**0.663**	-2.538	0.528	**-2.01**	-2.673	-1.080
2009		0.663	**0.663**	-2.944	0.986	**-1.958**	-2.621	-0.945
2010		0.663	**0.663**	-3.350	1.444	**-1.906**	-2.569	-0.827
2011		0.663	**0.663**	-3.239	2.130	**-1.109**	-1.772	-0.509
2012		0.663	**0.663**	-3.128	2.817	**-0.312**	-0.975	-0.250
2013		0.663	**0.663**	-3.018	3.503	**0.486**	-0.177	-0.041
2014		0.663	**0.663**	-2.907	4.190	**1.283**	0.620	0.127
2015		0.663	**0.663**	-2.796	4.876	**2.08**	1.417	0.259
2016		0.663	**0.663**	-2.796	4.876	**2.08**	1.417	0.231
2017		0.663	**0.663**	-2.796	4.876	**2.08**	1.417	0.206
2018		0.663	**0.663**	-2.796	4.876	**2.08**	1.417	0.184
2019		0.663	**0.663**	-2.796	4.876	**2.08**	1.417	0.165
2020	-5.246	0.663	**-4.583**	-2.796	4.876	**2.08**	6.663	0.691
2021		0.663	**0.663**	-2.796	4.876	**2.08**	1.417	0.131
							NPV =	**-19.774**
							IRR =	**NEG**

Table 7-5: Summary of Economic Analysis

Case 3: Grade Separation Group I

YEAR	PROJECT COSTS (*million USD*)			PROJECT BENEFITS (*million USD*)			NET BENEFITS	
	Construction Cost	Operation and Maintenance	Total Cost	Total VOC Benefits	Total VOT Benefits	Total Benefits	Total Net	Discounted
1999	10.592		**10.592**			**0**	-10.592	-10.592
2000	10.592		**10.592**			**0**	-10.592	-9.457
2001	10.592		**10.592**			**0**	-10.592	-8.444
2002		0.42	**0.42**	-0.163	11.161	**10.998**	10.578	7.529
2003		0.42	**0.42**	-5.434	.194	**-5.628**	-6.048	-3.844
2004		0.42	**0.42**	-4.764	-2.684	**-7.448**	-7.868	-4.465
2005		0.42	**0.42**	-4.094	-5.174	**-9.268**	-9.688	-4.908
2006		0.42	**0.42**	-3.439	-2.128	**-5.567**	-5.987	-2.708
2007		0.42	**0.42**	-2.784	0.918	**-1.866**	-2.286	-0.923
2008		0.42	**0.42**	-2.130	3.964	**1.834**	1.414	0.510
2009		0.42	**0.42**	-1.475	7.010	**5.535**	5.115	1.647
2010		0.42	**0.42**	-0.820	10.056	**9.236**	8.816	2.534
2011		0.42	**0.42**	-0.276	11.441	**11.165**	10.745	2.758
2012		0.42	**0.42**	0.267	12.826	**13.094**	12.674	2.904
2013		0.42	**0.42**	0.811	14.212	**15.022**	14.602	2.988
2014		0.42	**0.42**	1.354	15.597	**16.951**	16.531	3.020
2015		0.42	**0.42**	1.898	16.982	**18.880**	18.460	3.011
2016		0.42	**0.42**	1.898	16.982	**18.880**	18.460	2.689
2017		0.42	**0.42**	1.898	16.982	**18.880**	18.460	2.401
2018		0.42	**0.42**	1.898	16.982	**18.880**	18.460	2.143
2019		0.42	**0.42**	1.898	16.982	**18.880**	18.460	1.914
2020	-11.331	0.42	**-10.911**	1.898	16.982	**18.880**	29.791	2.757
2021		0.42	0.42	1.898	16.982	18.880	18.460	1.526
							NPV =	**-5.010**
							IRR =	**10.8%**
							FYRR=	**26.4%**

Table 7-6: Summary of Economic Analysis
Case 3: Grade Separation Group II + Group I

YEAR	PROJECT COSTS (million USD)			PROJECT BENEFITS (million USD)			NET BENEFITS	
	Construction Cost	Operation and Maintenance	Total Cost	Total VOC Benefits	Total VOT Benefits	Total Benefits	Total Net	Discounted Net at 12%
1999	10.592		**10.592**			**0**	-10.592	-10.592
2000	10.592		**10.592**			**0**	-10.592	-9.457
2001	23.018		**23.018**			**0**	-23.018	-18.350
2002	12.426	0.42	**12.846**	-0.163	11.161	**10.998**	-1.848	-1.315
2003		0.794	**0.794**	-2.794	5.62	**2.826**	2.032	1.291
2004		0.794	**0.794**	0.049	7.877	**7.926**	7.132	4.047
2005		0.794	**0.794**	2.891	10.134	**13.025**	12.231	6.197
2006		0.794	**0.794**	2.267	10.946	**13.213**	12.419	5.618
2007		0.794	**0.794**	1.643	11.758	**13.401**	12.607	5.092
2008		0.794	**0.794**	1.019	12.570	**13.589**	12.795	4.614
2009		0.794	**0.794**	0.395	13.382	**13.777**	12.983	4.180
2010		0.794	**0.794**	-0.229	14.194	**13.965**	13.171	3.786
2011		0.794	**0.794**	-0.568	15.803	**15.235**	14.441	3.707
2012		0.794	**0.794**	-0.907	17.412	**16.506**	15.712	3.601
2013		0.794	**0.794**	-1.245	19.022	**17.776**	16.982	3.475
2014		0.794	**0.794**	-1.584	20.631	**19.047**	18.253	3.335
2015		0.794	**0.794**	-1.923	22.240	**20.317**	19.523	3.185
2016		0.794	**0.794**	-1.923	22.240	**20.317**	19.523	2.843
2017		0.794	**0.794**	-1.923	22.240	**20.317**	19.523	2.539
2018		0.794	**0.794**	-1.923	22.240	**20.317**	19.523	2.267
2019		0.794	**0.794**	-1.923	22.240	**20.317**	19.523	2.024
2020	-21.813	0.794	**-21.019**	-1.923	22.240	**20.317**	41.336	3.826
2021		0.794	**0.794**	-1.923	22.240	**20.317**	19.523	1.613
2022		0.794	**0.794**	-1.923	22.240	**20.317**	19.523	1.441
							NPV =	**28.965**
							IRR =	**18.2%**
							FYRR=	**3.3%**

7.2.6 Grade Separation Group I + Group II + Group III – Case 3

Similarly, the addition of Group III in the years 2003 and 2004, create substantial benefits to the users in term of Reductions in travel times and travel costs as shown in Table 7-7. The total benefits are sizeable compared to the total costs, and the economic indicators support this conclusion. The NPV, IRR, and FYRR for this case are $87.54 millions, 21.7%, and 9.0% respectively. The 16 intersections collectively create positive impacts on travel in a system wide context. Similar to Group I + Group II case, the introduction of benefits of Group I and Group II prior to the opening of group III is considered part of the economic analysis as shown in Table 7-7.

7.2.7 All Cases Combined – Case 4

All the economic indicators for this combined case are positive and sizable as shown in Table 7-8. The NPV, IRR, and FYRR are $337.72 millions, 41.7%, and 49.8% respectively. All the cases combined, collectively over time, produce substantial benefits to the users, and their returns on investments are quite impressive.

7.3 Summary of Economic Results

Table 7-9 summarizes the economic results of all the cases including their investment costs. Indicators of economic viability rank the cases as follows:

1. Parking Controls – Case 2
2. All Cases Combined – Case 4
3. Traffic Management – Case 1
4. Grade Separation Group I + II + II – Case 3
5. Grade Separation Group I +II – Case 3
6. Grade Separation Group I – Case 3
7. Parking Structures – Case 2.

Since some of these cases are combined, and the implementation of one case depends on the implementation of another, the priority ranking, considering the implementation constraints are:

1. Parking Controls – Case 2
2. Traffic Management – Case 1
3. Grade Separation Group I – Case 3
4. Grade Separation Group I +II – Case 3
5. Grade Separation Group I + II + II – Case 3.

Table 7-7: Summary of Economic Analysis
Case 3: Grade Separation Group I + Group II + Group III

YEAR	PROJECT COSTS (million USD)			PROJECT BENEFITS (million USD)			NET BENEFITS	
	Construction Cost	Operation and Maintenance	Total Cost	Total VOC Benefits	Total VOT Benefits	Total Benefits	Total Net	Discounted Net at 12%
1999	10.592		**10.592**			**0**	-10.592	-10.592
2000	10.592		**10.592**			**0**	-10.592	-9.457
2001	23.018		**23.018**			**0**	-23.018	-18.350
2002	22.903	0.42	**23.323**	-0.163	11.161	**10.998**	-12.325	-8.772
2003	10.477	0.794	**11.271**	-2.794	5.62	**2.826**	-8.445	-5.367
2004	10.477	0.794	**11.271**	-0.358	7.310	**6.952**	-4.319	-2.451
2005		1.297	**1.297**	2.078	9.000	**11.078**	9.781	4.955
2006		1.297	**1.297**	3.348	12.774	**16.122**	14.825	6.706
2007		1.297	**1.297**	4.617	16.548	**21.165**	19.868	8.025
2008		1.297	**1.297**	5.887	20.322	**26.209**	24.912	8.984
2009		1.297	**1.297**	7.157	24.096	**31.253**	29.956	9.645
2010		1.297	**1.297**	8.427	27.870	**36.2967**	35.000	10.062
2011		1.297	**1.297**	9.696	29.930	**39.626**	38.329	9.838
2012		1.297	**1.297**	10.966	31.990	**42.956**	41.659	9.547
2013		1.297	**1.297**	12.236	34.050	**46.286**	44.989	9.206
2014		1.297	**1.297**	13.505	36.110	**49.615**	48.318	8.828
2015		1.297	**1.297**	14.775	38.170	**52.945**	51.648	8.425
2016		1.297	**1.297**	14.775	38.170	**52.945**	51.648	7.522
2017		1.297	**1.297**	14.775	38.170	**52.945**	51.648	6.716
2018		1.297	**1.297**	14.775	38.170	**52.945**	51.648	5.997
2019		1.297	**1.297**	14.775	38.170	**52.945**	51.648	5.354
2020	-36.916	1.297	**-35.619**	14.775	38.170	**52.945**	88.564	8.197
2021		1.297	**1.297**	14.775	38.170	**52.945**	51.648	4.268
2022		1.297	**1.297**	14.775	38.170	**52.945**	51.648	3.811
2023		1.297	**1.297**	14.775	38.170	**52.945**	51.648	3.403
2024		1.297	**1.297**	14.775	38.170	**52.945**	51.648	3.038
							NPV =	**87.538**
							IRR =	**21.7%**
							FYRR =	**9.0%**

Table 7-8: Summary of Economic Analysis
Case 4: All Cases Combined (Parking Structures Excluded)

YEAR	PROJECT COSTS (million USD)			PROJECT BENEFITS (million USD)			NET BENEFITS	
	Construction Cost	Operation and Maintenance	Total Cost	Total VOC Benefits	Total VOT Benefits	Total Benefits	Total Net	Discounted Net at 12%
1999	22.044	0	**22.044**			**0**	-22.044	-22.044
2000	22.9645	0	**22.965**			**0**	-22.9645	-20.504
2001	23.9385	2.318	**26.257**	-0.227	13.776	**13.549**	-12.7075	-10.130
2002	22.9027	2.922	**25.825**	6.874	36.793	**43.667**	17.8423	12.700
2003	10.4767	3.296	**13.773**	-13.943	52.135	**38.192**	24.419	15.519
2004	10.4767	3.296	**13.773**	-6.017	52.921	**46.903**	33.131	18.799
2005	0	3.799	**3.799**	1.909	53.706	**55.615**	51.816	26.251
2006	0	3.799	**3.799**	2.107	57.836	**59.944**	56.145	25.397
2007	0	3.799	**3.799**	2.306	61.967	**64.273**	60.474	24.424
2008	0	3.799	**3.799**	2.504	66.097	**68.601**	64.802	23.368
2009	0	3.799	**3.799**	2.703	70.228	**72.930**	69.131	22.258
2010	0	3.799	**3.799**	2.901	74.358	**77.259**	73.460	21.118
2011	0	3.799	**3.799**	3.100	81.955	**85.055**	81.256	20.856
2012	0	3.799	**3.799**	3.298	89.552	**92.850**	89.051	20.408
2013	0	3.799	**3.799**	3.496	97.149	**100.645**	96.846	19.817
2014	0	3.799	**3.799**	3.695	104.746	**108.441**	104.642	19.118
2015	0	3.799	**3.799**	3.893	112.343	**116.236**	112.437	18.341
2016	0	3.799	**3.799**	3.893	112.343	**116.236**	112.437	16.376
2017	0	3.799	**3.799**	3.893	112.343	**116.236**	112.437	14.621
2018	0	3.799	**3.799**	3.893	112.343	**116.236**	112.437	13.055
2019	0	3.799	**3.799**	3.893	112.343	**116.236**	112.437	11.656
2020	-39.005	3.799	**-35.206**	3.893	112.343	**116.236**	151.442	14.017
2021	0	1.481	**1.481**	3.893	112.343	**116.236**	114.755	9.484
2022	0	1.297	**1.297**	3.893	112.343	**116.236**	114.939	8.481
2023	0	1.297	**1.297**	3.893	112.343	**116.236**	114.939	7.572
2024	0	1.297	**1.297**	3.893	112.343	**116.236**	114.939	6.761
							NPV =	337.721
							IRR =	41.7%
							FYRR=	463.8%

Table 7-9: Summary of Economic Analysis Results

Analysis Scenarios	Project Description	Investment Cost (Thousands)	Economic Internal Rate Of Return %	Net Present Value ($ million)	First Year Rate of Return (%)
Improvement Case- 1	Traffic lights & traffic control center & elimination of parking at intersections	22,905	34.1	59.225	41.3
Improvement Case- 2	Parking controls	1,841	557.6	257.74	1810.10
	Parking structures	13,592	-	-19.77	19.8
Improvement Case- 3 Group I	Grade Separations at: -Galerie Semaan -Hayek -Dora -Mkalles -Tayouneh	31,776	10.8	-5.01	26.4
Group I & II	Grade Separations at: -Beit al-Atfal -Mar Mkhael -Msharrafieh -Airport	56,628	18.2	28.965	3.3
Groups I, II, & III	Grade Separations at: -Jal el-Dib -Antelias -Bechara el-Khoury -Adlieh -Museum -Samy el-Solh -Old Saida Rd close to Khaldeh	88,058	21.7	87.54	9.0
All Improvement Programs	A combined case of all improvement programs (excluding Parking Structures)	112,803	41.7	337.721	463.8

7.4 Reductions in Emissions

STEAM produces estimates of pollutant emissions, in terms of hydrocarbons (HC), carbon monoxide (CO), nitrogen oxide (NOx), particulate matters (PM 10), and carbon dioxide (CO2). The reductions in emissions for each pollutant are shown in Table 7-10 for the various cases and for the different analysis years namely 2001, 2002, 2003, 2005, 2010 and 2015 where applicable.

The reductions in hydrocarbon (HC), carbon monoxide (CO), and carbon dioxide (CO2) emissions are noticeable for all the cases and for all the analysis years. This is mainly due to savings in travel times and to increases in vehicular speeds as a result of the proposed improvement programs. This is not the same for the nitrogen oxide (NOx) and particulate matters (PM 10) emissions, which increase for most cases and for most analysis years. These increases could be attributed to the increase in vehicular miles-of travel (VMT) and particularly in truck VMT.

Table 7-10 shows also the percentage decreases in HC, CO, and CO2 emissions which range from a high of 4.45% to a low of 0.02%. Similarly, the percentage increases in NOx and PM 10 emissions range from a high of 3.53% to a low of 0.02%.

The reductions in these emissions, as Table 7-10 show, increase as the travel demand increases till the year 2010, and then start to decrease due to low emission rates in the out years, which outpace the increase in the demand for travel.

Overall, these small reductions or increases in emissions could slightly add to or subtract from the economic value of the investments in these programs. But, they are not substantial enough to influence the prioritization of the proposed investments, nor to alter their worthiness.

TABLE 7 - 10
REDUCTION IN EMISSIONS (Tons / year and Percentage of Change)

Analysis Scenarios	Project Description		Year 2001					Year 2002					Year 2003				
			HC	CO	NOx	PM10	CO_2	HC	CO	NOx	PM10	CO_2	HC	CO	NOx	PM10	CO_2
Improvement Case - 1	Traffic lights + Traffic control center + elimination of parking at intersections	Tons*	49.8	899.0	(8.1)	(0.5)	10.6	45.4	625.4	14.6	0.6	9.6	24.2	616.5	(40.6)	(1.7)	(0.6)
		%	0.66	1.13	(0.15)	(0.25)	0.84	0.56	0.73	0.26	0.28	0.69	0.27	0.70	(0.56)	(0.60)	(0.04)
Improvement Case - 2a	Parking Controls	Tons*						131.4	2083.0	4.9	(0.1)	27.2	148.3	2388	(7.1)	(0.6)	26.3
		%						1.62	2.42	0.80	(0.04)	1.97	1.67	2.72	(0.09)	(0.02)	1.77
Improvement Case - 2b	Parking Structures	Tons*						46.8	461.9	43.0	2.0	8.8	(0.06)	207.2	(42.2)	(0.6)	(0.28)
		%						2.58	0.53	0.76	0.90	0.64	(5.2)	0.23	(0.57)	(1.7)	(4.4)
Improvement Case - 3 Group I	Grade Separations at: - Galerie Semaan - Hayek - Mkalles - Dora - Tayouneh	Tons*						21.1	335.8	(1.7)	(0.2)	5.4	192.1	159.6	(405.6	(16.5)	52.0
		%						0.26	0.39	(0.03)	(0.09)	0.39	0.02	0.61	(1.1)	(1.1)	0.43
- Group II + Group I	Grade Separations at: - Beit Al Atfal - Msharafieh - Mar Mkhael - Airport	Tons*											289.4	1072	(493)	(20)	73.4
		%											0.38	0.96	(0.66)	(0.68)	0.14
- Group III + Group II + Group I	Grade Separation at: -Jal El Dib - Adlieh -Antelias -Sami Solh -Bechara Khoury -Museum -Bchamoun Aramoun	Tons*															
		%															
All Improvement Programs	A combined case of all improvement programs	Tons*															
		%															

* CO_2 Emissions in (1000 Tons/Year)
* ( ) indicates increases in Emissions

TABLE 7 - 10 (Continued)
REDUCTION IN EMISSIONS (Tons / year and Percentage of Change)

Analysis Scenarios	Project Description		Year 2005					Year 2010					Year 2015				
			HC	CO	NOx	PM10	CO_2	HC	CO	NOx	PM10	CO_2	HC	CO	NOx	PM10	CO_2
Inprovement Case - 1	Traffic lights + Traffic control center + elimination of parking at intersections	Tons*	22.6	45.3	31.9	1.2	3.8	42.8	1345	(32)	(1.7)	7.2	43.9	645.8	(1.3)	(0.5)	17.3
		%	0.27	0.05	0.48	0.47	0.26	0.46	1.29	(0.46)	(0.65)	0.41	0.54	0.75	(0.02)	(0.23)	0.78
Inprovement Case - 2a	Parking Controls	Tons*	71.5	860.0	21.2	0.8	12.0	93.0	2092	(26.9)	(2.0)	20.6	81.4	1136	9.2	(0.4)	31.2
		%	0.86	1.03	0.32	0.31	0.83	1.01	2.01	(0.39)	(0.55)	1.17	1.00	1.31	0.16	(0.18)	1.40
Inprovement Case - 2b	Parking Structures	Tons*	4.1	146.7	(13.9)	(0.7)	1.4	4.1	405.4	(27.7)	(1.3)	0.4	25.1	80.6	(15.3)	(0.8)	1.6
		%	0.01	0.17	(0.21)	(0.27)	0.09	0.04	0.39	(0.39)	(0.5)	0.02	0.30	0.10	(0.26)	(0.37)	0.07
Improvement Case - 3 - Group I	Grade Separations at: - Galerie Semaan - Hayek - Mkalles - Dora - Tayouneh	Tons*	(46.5)	(500.4)	(43.0)	(1.7)	(10.2)	27.5	273.6	(3.9)	(0.6)	10.1	26.7	304.2	13.0	0.4	9.2
		%	(0.56)	(0.6)	(0.65)	(0.67)	(0.7)	(0.29)	0.26	(0.05)	(0.23)	0.58	0.32	0.35	0.22	0.18	0.41
- Group II + Group I	Grade Separations at: - Beit Al Atfal - Msharafieh - Mar Mkhael - Airport	Tons*	65.5	664.0	37.2	1.0	14.1	49.8	1053	3.0	(0.4)	11.2	16.8	282.0	(8.7)	(0.7)	7.5
		%	0.79	0.79	0.56	0.39	0.97	0.53	1.01	0.04	(0.15)	0.64	0.20	0.32	(0.15)	(0.32)	0.34
- Group III + Group II + Group I	Grade Separation at: -Jal El Dib - Adlieh -Antelias -Sami Solh -Bechara Khoury -Museum -Bchamoun Aramoun	Tons*	45.5	508.7	18.6	0.8	8.7	(11.8)	2035	(194.8	(7.9)	(13.3)	122.1	1244	90.3	3.6	37.8
		%	0.55	0.61	0.28	0.31	0.60	(0.12)	1.96	(2.8)	(3.03)	(0.76)	1.51	1.44	1.56	1.60	1.70
All Improvement Programs	A combined case of all improvement programs	Tons*	244.2	3847	(9.7)	(0.5)	47.3	128.3	5011	(211.6	(9.2)	10.0	147.9	1993	27.1	0.2	52.3
		%	3.01	4.45	(0.01)	(0.23)	2.13	1.39	4.80	(3.06)	(3.53)	0.57	1.83	2.31	0.47	0.09	2.30

* CO_2 Emissions in (1000 Tons/Year)
* ( ) indicates increases in Emissions

8. ROBUSTNESS OF ECONOMIC ANALYSIS RESULTS

8.1 Introduction

The preparatory studies for the BUTP commenced in early 1998. Later in the year there was a change in government which carried with it substantial changes in policy. Implementing toll motorways along the BOT formula is not currently a scenario under consideration. Moreover, the adopted tight budget, targeted at controlling the public debt, will cause delays in implementing some planned projects, which require expensive expropriations. In general, projects under implementation are progressing at a slower pace, which marks the tempo of the current conditions.

Firstly, the robustness of the economic analysis results presented earlier will be tested against new information on the progress of on-going highway projects in the study area and current government sentiment against toll facilities.

Secondly, a check will be made on whether the additional investment in any one grade separation is a viable investment, on its own. It must be recalled that the economic analysis of the grade separation component demonstrates that the combined investment in them realize an IRR of 21.7%.

The third question to answer is at what level of share of public transport (mode split) the net benefits of the proposed investments cease to be viable.

The fourth robustness check is that related to traffic forecasts. The benefits of the various components of the project are a function of traffic volumes. It should be demonstrated that even if future traffic volumes prove to be much lower than the forecasted, the economic viability of the project components still holds.

Finally the economic analysis of the traffic management component showed a high IRR of 34.1%. In that analysis the investment cost in CCTV was included, but the benefits of CCTV surveillance were not calculated. The question on whether including CCTV surveillance in the traffic management component is warranted, and it will be addressed.

8.2 The Greater Beirut Highway Network: The Périphérique and Related Issues

The expected evolution of the highway network in the years 1998 - 2015 was provided to the Consultant by CDR in 1998. At that time the Périphérique and Northern Entrance were being planned as toll facilities. In the year 1997, the CDR hired TAMS-LOUIS BERGER to prepare revenue forecasts for these highways as toll facilities in preparation for tendering. Later, the Lebanese Government received an expression of interest from Kvaerner to build the two facilities, as toll roads, along the BOT formula. Kvaerner was asked to present their proposal by February 1999, and was granted exclusivity till that date. It was very clear since then that public funds for building these facilities will not be available, and they will be implemented only if treated as toll facilities and built along the BOT formula.

It could be argued that should the Périphérique and the Northern Entrance Highway be without toll, then they would attract more traffic from the adjacent street network. A reduction in the traffic on the street network might reduce the viability of the grade separation component of the BUTP to a level below acceptable levels of IRR.

In the following we will investigate the sensitivity of the previous traffic forecasts considering the possibility of constructing the Périphérique and Northern Entrance from public funds and without toll.

Moreover significant changes as to the network configuration along the Northern Entrance were relayed to the Consultant in early 1999.

Only part of the Northern Entrance Highway is currently being considered for implementation. which is the Charles Helou to Nahr El-Mott. while the section from Nahr El-Mott to Dbayeh is not being considered. The connection of the Périphérique at its Northern end with the Coastal Highway will now occur in Dbayeh to the North of the proposed Nakkash Bridge (instead at Antelias). The extension of the Périphérique to the North (A2) would occur at the same location.

The so-called Maritime Boulevard extending from Nahr Beirut to Dbayeh. which was planned as a boulevard serving Linord and Joseph Khoury developments. is now being upgraded and some of its intersections grade-separated to serve through traffic also (instead of the more costly Northern Entrance Motorway).

Table 8-1 summarizes the current expected implementation schedule of the non-toll configuration of the Périphérique and Northern Entrance roads and highways and their revised configuration.

It should be noted that predicting to complete the Northern Section of the Périphérique by the year 2006 is very optimistic indeed under current conditions. considering that detailed engineering is yet to be prepared and ROW expropriation must be completed before commencing construction. Accordingly. assuming funds are available for ROW expropriation and for construction. implementation can at best commence in the year 2002. The duration of construction is unlikely to be less than 4 years.

An austere budget for 1999 was promulgated by end of July 1999. Accordingly. an entirely new scheduling of highway projects in the Greater Beirut Area should be considered. Moreover, there has been also some slippage in the schedule of executing the highways and penetrators in Greater Beirut. yet nothing beyond the expected in public works projects. The opportunity presents itself now to check the sensitivity of our previous traffic forecasts. done in 1998. to this change in schedule and the robustness of the corresponding economic viability ratios. to these changes.

CDR has provided the Consultant recently with an updated list of highway projects in Greater Beirut and their expected date to be put in service. Table 8-2 summarizes the updated schedule of the highway and penetrator projects in Greater Beirut.

In order to assess the impact of the changes in the network configuration and its schedule of implementation (including all roads being without toll). a rerun of the emme/2 model was made for the years 2005. 2010. and 2015. Table 8-3 compares for each of the 16 intersections candidate to receive a grade separation the peak-hour traffic forecast for the years 2005. 2010. and 2015 according to the new set of information with that for the same years corresponding to the network and implementation schedule previously adopted in the Economic Analysis Draft Report (March 1999).

For the year 2005 there was a consistent increase in traffic ranging between 4.28% and 42.62%. similarly for the year 2010 the increase in peak-hour traffic ranges between 1.60% and 45.56%. By the year 2015. when many of the proposed highway projects would be in service. some intersections show a decrease in peak-hour traffic. reaching as

TABLE 8-1
PERIPHERIQUE AND NORTHERN ENTRANCE
REVISED IMPLEMENTATION SCHEDULE

Section	Year to be put in service		Comments
	CDR Information 1998	CDR Information 1999	
Périphérique:			GOL is considering phasing of Périphérique under non-toll analysis in two sections
• Khaldeh - Hazmieh / Southern Section	2004	2011	
• Hazmieh - Antelias / Northern Section	2004	2006	
Northern Entrance:			
• Charles Helou - Nahr El Mott - Dbayeh	2004		Northern Entrance to be connected to Périphérique's Northern Section after its completion
• Charles Helou - Nahr El Mott (Only)		2011	
Boulevard Maritime:			GOL has obtained funds to build it as a relief coastal boulevard and provide access to Linord and Joseph Khoury developments
• *Nahr Beirut - Nakkash Bridge*	Not in Network	2004	
• *Nakkash Bridge - Dbayeh*	Not in Network	2001	
A2 Highway	Not in Network	2016	An extension of the Périphérique to the North

TABLE 8-2
GREATER BEIRUT AREA HIGHWAY PROJECTS
REVISED IMPLEMENTATION SCHEDULE

Project Designation	**Year to be put in service**		**Comments**
	CDR Information 1998	**CDR Information 1999**	
PN1 Borj Hammoud - Nabaa	1999	2001	Under construction, due to delay in 1999 budget
PN2 Borj Hammoud - Baouchriyeh	2009	2011	Could be deferred further due to high cost of expropriation
PN3 Rd. Parallel to Nahr Beirut	1999	2001	Under construction
Damascus Road - Sayyad A3	1999	2001	Under construction
North Urban Bypass (Tahwita - Tayouneh)	1998	2000	Under construction
Hazmieh Airport Road	2000	2001	Under construction
Kafaat Road Choueifat: • Kafaat / Lebanese University • Lebanese University / Choueifat	 1998 2000	 2001 2006	 Under construction
Khaldeh - Cocody 1 & 2	1998	2002	Under construction

TABLE 8-3

PEAK HOUR TRAFFIC AT INTERSECTIONS TO BE GRADE SEPARATED

Year 2005 - All Improvements Combined			
	Old Runs	Adjusted Schedule	Difference* %
Sodeco	6,920	7,893	14.06%
Adlieh	9,738	12,747	30.90%
Mathaf	7,745	8,126	4.92%
Sami Solh	4,969	6,087	22.50%
Tayouneh	7,384	8,800	19.18%
Airport	8,450	9,570	13.25%
Mcharrafieh	5,422	6,102	12.54%
Mar Mikhael	6,168	7,252	17.57%
Galerie Semaan	5,387	6,268	16.35%
Bchamoun/Aramoun	3,203	3,706	15.70%
Antelias	14,965	17,946	19.92%
Jal El Dib	15,078	21,504	42.62%
Beit El Atfal	8,320	8,676	4.28%
Dora	13,518	14,871	10.01%
Hayek	7,271	9,749	34.08%
Mkalles	5,612	6,628	18.10%

Year 2010 - All Improvements Combined			
	Old Runs	Adjusted Schedule	Difference* %
Sodeco	8,029	8,862	10.37%
Adlieh	11,863	12,635	6.51%
Mathaf	8,723	9,413	7.91%
Sami Solh	5,710	6,040	5.78%
Tayouneh	8,826	10,162	15.14%
Airport	9,173	11,083	20.82%
Mcharrafieh	5,843	8,505	45.56%
Mar Mikhael	7,187	10,042	39.72%
Galerie Semaan	6,487	9,303	43.41%
Bchamoun/Aramoun	3,853	4,815	24.97%
Antelias	16,843	17,112	1.60%
Jal El Dib	16,942	17,917	5.75%
Beit El Atfal	8,981	9,521	6.01%
Dora	14,380	16,583	15.32%
Hayek	7,872	8,413	6.87%
Mkalles	5,443	5,792	6.41%

Year 2015 - All Improvements Combined			
	Old Runs	Adjusted Schedule	Difference* %
Sodeco	9,054	8,881	-1.91%
Adlieh	13,737	13,191	-3.97%
Mathaf	9,448	9,223	-2.38%
Sami Solh	6,277	6,152	-1.99%
Tayouneh	10,193	9,875	-3.12%
Airport	10,579	10,226	-3.34%
Mcharrafieh	8,141	7,795	-4.25%
Mar Mikhael	9,178	8,761	-4.54%
Galerie Semaan	8,017	7,798	-2.73%
Bchamoun/Aramoun	4,443	4,421	-0.50%
Antelias	19,362	20,640	6.60%
Jal El Dib	19,538	21,615	10.63%
Beit El Atfal	9,679	9,447	-2.40%
Dora	16,103	14,223	-11.67%
Hayek	8,821	8,745	-0.86%
Mkalles	6,514	6,001	-7.88%

(-) denotes a decrease

much as 11.67% in Dora. while others show an increase reaching 10.63%. Excluding those two extreme cases. most of the reduction in traffic was less than 5%. The overall average change is a 1% decrease.

It is thus demonstrated that the effect of the delay in implementation schedule of the motorways and penetrators in GBA on the traffic forecasts at the proposed grade separations far out-weighs those expected from adopting a non-tolled Périphérique and Northern Entrance. The first increases the forecast while the other decreases it. There is a significant net increase till the year 2010 and beyond.

Since the IRR of the combined grade separation component was reported earlier at 21.7%. it is expected to be even higher with the new set of data due to the significant higher traffic forecast for the first 10 years of the life of the project.

It was thus demonstrated that the economic viability of the Grade Separation Component and the BUTP as a whole is robust. The changes in the modeling parameters (non-toll Périphérique and implementation schedule) result is a significant increase of traffic at all the junctions candidate for grade separations during the first 10 years of the project life. Thus much higher IRR is expected.

8.3 Marginal Benefit of Individual Grade Separations

Table 8-4 summarizes the average delay in seconds and total delay in hours during the peak-hour. in the year 2005. at each of the 16 intersections candidate to receive a grade separation. in case a grade separation was not provided. Excluding Sami Solh and Bchamoun/Aramoun. the expected average delay is far beyond tolerable levels in the year 2005. and is expected to increase far beyond that through the years.

The IRR of the marginal investment in grade separation at Sami Solh (all improvements combined) was calculated to be 25.1 % (Table 8-5). This is to be compared with an IRR of 34.1%. of all the improvements combined. That is for the least crowded interaction (Sami Solh). the marginal investment is a viable investment on its own at the network level. It is surmised that the IRR of the marginal investment in all other grade separations. taken each individually. is higher than that. since the average and total delays for all the other intersections are at least 45% and 57% respectively higher than that at Sami Solh and Bchamoun/Aramoun.

Thus it is demonstrated that the IRR of the combined investments (all improvements combined) component. and that of the marginal investment in each individual grade separation is above the limits of acceptance. based on the set of data used in producing the Draft Report. With the updated set of data. it was shown earlier that traffic would be significantly higher during the first 10 years of the life of the project. and thus the IRR would also be expected to be even higher.

TABLE 8-4

DELAY AT CANDIDATE INTERSECTIONS BEFORE IMPROVEMENTS

Grade Separation Location	Rank	2005 Average Delay per Vehicle (sec)	2005 Total Delay (hrs)
Jal El Dib	1	23.254	217.459
Antelias	2	22.737	182.819
Airport	3	13.093	35.089
Dora	4	4.427	27.126
Tayouneh	5	9.187	22.087
Adlieh	6	1.638	6.311
Hayek	7	1.638	4.179
Sodeco	8	1.909	4.162
Galerie Semaan	9	2.013	3.405
Mathaf	10	1.351	2.962
Mkalles	11	1.231	2.253
Mar Mikhael	12	1.124	2.223
Beit El Atfal	13	820	1.972
Mcharrafieh	14	2.645	1.539
Bchamoun / Aramoun	15	181	326
Sami Solh	16	124	207

TABLE 8-5

ANNUAL CASH FLOW AND ECONOMIC ANALYSIS OF THE MARGINAL INVESTMENT IN SAMI SOLH GRADE SEPARATION (ALL IMPROVEMENT CASES COMBINED)

YEAR	PROJECT COSTS (million USD)			BENEFITS (million USD)		
	Investment Cost	Operation and Maintenance	Total Cost	Total Benefits	Annual Net Benefits	Discounted Net at 12%
1999			**0**	**0**	0	0.000
2000			**0**	**0**	0	0.000
2001				**0**	0	0.000
2002				**0**	0	0.000
2003	0.858		**0.858**	**0.000**	-0.858	-0.545
2004	0.858		**0.858**	**0.000**	-0.858	-0.487
2005		0.034	**0.034**	**0.463**	0.429	0.217
2006		0.034	**0.034**	**0.477**	0.443	0.200
2007		0.034	**0.034**	**0.491**	0.457	0.185
2008		0.034	**0.034**	**0.506**	0.472	0.170
2009		0.034	**0.034**	**0.521**	0.487	0.157
2010		0.034	**0.034**	**0.537**	0.503	0.145
2011		0.034	**0.034**	**0.553**	0.519	0.133
2012		0.034	**0.034**	**0.569**	0.535	0.123
2013		0.034	**0.034**	**0.587**	0.553	0.113
2014		0.034	**0.034**	**0.604**	0.570	0.104
2015		0.034	**0.034**	**0.622**	0.588	0.096
2016		0.034	**0.034**	**0.641**	0.607	0.088
2017		0.034	**0.034**	**0.660**	0.626	0.081
2018		0.034	**0.034**	**0.680**	0.646	0.075
2019		0.034	**0.034**	**0.700**	0.666	0.069
2020		0.034	**0.034**	**0.721**	0.687	0.064
2021		0.034	**0.034**	**0.743**	0.709	0.059
2022		0.034	**0.034**	**0.765**	0.731	0.054
2023		0.034	**0.034**	**0.788**	0.754	0.050
2024	-1.166	0.034	**-1.132**	**0.812**	1.944	0.114
					NPV =	1.265
					IRR =	25.1%
					FYRR=	21.1%

8.4 Mode Split Values That Would Make Unfavorable the Net Benefits of the BUTP Project

The GBATP developed two contrasting scenarios:

Scenario A:

It consists of creating a "heavy" public transport network covering the Beirut Urban Agglomeration (BUA) such that all BUA residents will be within 1 km from a mass transit line. The heavy mass transit network include the Regional Railway (commuter service) between Jounieh and Damour, and 6 heavy mass transit lines: Central North-South, East-West, South-West North-East, Suburban Ring, North-South line between BCD and Hazmieh, and a special line to serve the Airport. This network will be systematically connected with the railway line (5 out of 6 lines will exchange with it).

In addition to this network, a complementary bus network will be operating to serve the outlying areas with feeder services to the main exchange and terminal stations. With such a network, the overall market of public transport will reach 33%.

Scenario B:

The only heavy mass transit system provided is the Regional Railway, the remaining Public Transport System will consist of a dense bus network. With such modal split assumptions, the public transport share will border 16%.

With the currently unlikely event of having the Regional Railway or other heavy rail transit put in service during the BUTP horizon, reaching a 16% share for transit, using bus-only, is an estimate on the high side.

Instead of re-running the complete forecasting and economic evaluation exercise for several other rates of transit share, the results of the forecasted peak-hour traffic at the intersections candidate for grade separating in case of a 26% share of public transport, which was proposed by the GBATP in 1995 (compared to 16% presented in the Economic Analysis Draft Report) are presented in Table 8-6. Table 8-6 shows that the change in traffic due jointly to an increase in the share of public transport and the change in network configuration and implementation schedule varies between an increase of 28.67% and a decrease of 25.12%. The highest decrease (at Antelias and Jal El Dib) occurs at the two heaviest trafficked intersections. The absolute value of peak-hour traffic (12000 and 14000) would still warrant grade separating at these two locations. At all other grade separations the forecasted decrease in traffic is less than 10% and would not make any of the grade separations unwarranted, taking into account the expected average delays in 2005 (see Table 8-4).

It should be noted here that the GBATP recommended a mass transit system that can achieve a share of 26% of total trips. It was estimated to require 20 years to achieve, with a total investment of US$ 2.5 billion. A positive development occurred in October 1999, where the Ministry of Transport received a grant from the US Trade and Development Agency, to be spent against a feasibility study of a mass transit corridor (Jounieh - Jiyeh). This study should be completed by the third quarter of the year 2000. Once mass transit gains political acceptance it must go through feasibility studies, preliminary and detailed engineering, arranging for its financing, and then construction. Taking everything into account, this ambitious mass transit system seems quite optimistic to expect to be in place by the year 2020. Finally, it should be emphasized that the BUTP investment (a total of $100 m) is not mutually exclusive with the required investment in mass transit ($2.5 b). The two investments are mutually supportive.

TABLE 8-6
FORECASTED 2010 TRAFFIC DUE TO THE COMBINED EFFECT OF HIGHER PUBLIC TRANSPORT SHARE AND THE CHANGE IN THE HIGHWAYS IMPLEMENTATION SCHEDULE

Grade Separation	Old Run 16% Transit Share (1)	Transit Share in 2020 26.6% (2)	% Change (2)-(1) / (1)	New Schedule 16% Transit Share (4)	New Schedule + Heavy Mass Transit (5)	% Change (5)-(1) / (1)
Sodeco	8.029	7.180	-10.6%	8.862	7.925	-1.30%
Adlieh	11.863	10.473	-11.7%	12.635	11.155	-5.97%
Mataaf	8.723	7.371	-15.5%	9.413	7.954	-8.82%
Sami Solh	5.710	4.938	-13.5%	6.040	5.223	-8.52%
Tayouneh	8.826	7.521	-14.8%	10.162	8.659	-1.89%
Airport	9.173	7.818	-14.8%	11.083	9.446	2.97%
Mcharafieh	5.843	5.165	-11.6%	8.505	7.518	28.67%
Mar Mikhael	7.187	6.176	-14.1%	10.042	8.629	20.07%
Galerie Semaan	6.487	5.561	-14.3%	9.303	7.975	22.94%
Bchamoun/Aramoun	3.853	3.624	-5.9%	4.815	4.529	17.54%
Antelias	16.843	12.413	-26.3%	17.112	12.611	-25.12%
Jal El Dib	16.942	13.385	-21.0%	17.917	14.155	-16.45%
Beit El Atfal	8.981	7.922	-11.8%	9.521	8.398	-6.49%
Dora	14.380	11,685	-18.7%	16.583	13.475	-6.29%
Hayek	7.872	7,040	-10.6%	8.413	7.524	-4.42%
Mkalles	5.443	4.639	-14.8%	5.792	4.936	-9.31%

8.5 Robustness of Results Should Future Traffic Volumes be Much Lower Than Forecasted

The benefits of all the project components vary directly with the increase in traffic volumes. To start with, the adopted traffic forecast was very modest in its expectations of growth rates. The area-wide annual average trip growth, over the period 1998 - 2020 is only 3.3%.

To test the robustness of the economic analysis, it will be tested for a zero growth in traffic starting by the year 2005, i.e. when all the components of the BUTP are expected to be in place. This is a scenario which can be characterized by extreme pessimism.

Under the extreme pessimism scenario, the amount of benefits attributed to various BUTP components will not increase starting with the year 2005.

Based on this scenario, the cashflow of the various cases and the corresponding economic indicators were recalculated. A summary is presented in Table 8-7. The detailed results are presented successively in Tables 8-8 through 8-11.

TABLE 8-7
SUMMARY OF RESULTS OF ECONOMIC VIABILITY INDICES FOR THE EXTREME PESSIMISTIC CASE

BUTP Component	IRR %	MIRR %	FYRR %
Traffic Management	28.4	16.1	41.3
Parking Controls	557.6	39.6	1810.0
Grade Separation	10.0	10.6	9.0
All Combined	39.0	20.8	49.8

Even under this extreme pessimism scenario, the individual and combined components are economically viable. In fact even higher IRR is expected for each of the components, since the delay in executing the committed projects will cause the benefits of the BUTP to increase.

TABLE 8-8
SUMMARY OF ECONOMIC ANALYSIS
EXTREME PESSIMISTIC SCENARIO
CASE 1: TRAFFIC MANAGEMENT

YEAR	PROJECT COSTS (million USD)			PROJECT BENEFITS (million USD)			NET BENEFITS	
	Investment Cost	Operation and Maintenance	Total Cost	Total VOC Benefits	Total VOT Benefits	Total Benefits	Total Net	Discounted Net at 12%
1999	11.452		**11.452**				-11.452	-11.452
2000	11.452		**11.452**				-11.452	-10.225
2001		2.318	**2.318**	-0.227	13.776	**13.549**	11.231	8.953
2002		2.318	**2.318**	1.479	10.054	**11.533**	9.215	6.559
2003		2.318	**2.318**	-3.028	9.345	**6.317**	3.999	2.541
2004		2.318	**2.318**	-0.279	7.740	**7.4605**	5.1425	2.918
2005		2.318	**2.318**	2.47	6.134	**8.604**	6.286	3.185
2006		2.318	**2.318**	2.47	6.134	**8.604**	6.286	2.843
2007		2.318	**2.318**	2.47	6.134	**8.604**	6.286	2.539
2008		2.318	**2.318**	2.47	6.134	**8.604**	6.286	2.267
2009		2.318	**2.318**	2.47	6.134	**8.604**	6.286	2.024
2010		2.318	**2.318**	2.47	6.134	**8.604**	6.286	1.807
2011		2.318	**2.318**	2.47	6.134	**8.604**	6.286	1.613
2012		2.318	**2.318**	2.47	6.134	**8.604**	6.286	1.441
2013		2.318	**2.318**	2.47	6.134	**8.604**	6.286	1.286
2014		2.318	**2.318**	2.47	6.134	**8.604**	6.286	1.148
2015		2.318	**2.318**	2.47	6.134	**8.604**	6.286	1.025
2016		2.318	**2.318**	2.47	6.134	**8.604**	6.286	0.916
2017		2.318	**2.318**	2.47	6.134	**8.604**	6.286	0.817
2018		2.318	**2.318**	2.47	6.134	**8.604**	6.286	0.730
2019		2.318	**2.318**	2.47	6.134	**8.604**	6.286	0.652
2020	-2.089	2.318	**0.229**	2.47	6.134	**8.604**	8.375	0.775
							NPV =	24.363
							IRR =	28.4%
							FYRR=	41.3%

TABLE 8-9
SUMMARY OF ECONOMIC ANALYSIS
EXTREME PESSIMISTIC SCENARIO
CASE 2: PARKING CONTROLS

YEAR	PROJECT COSTS (million USD)			PROJECT BENEFITS (million USD)			NET BENEFITS	
	Investment Cost	Operation and Maintenance	Total Cost	Total VOC Benefits	Total VOT Benefits	Total Benefits	Total Net	Discounted Net at 12%
2000	0.9205		**0.9205**				-0.9205	-0.921
2001	0.9205		**0.9205**				-0.9205	-0.822
2002		0.184	**0.184**	1.6	38.144	**39.744**	39.56	31.537
2003		0.184	**0.184**	0.699	35.783	**36.482**	36.298	25.836
2004		0.184	**0.184**	1.4325	28.146	**29.579**	29.395	18.681
2005		0.184	**0.184**	2.166	20.509	**22.675**	22.491	12.762
2006		0.184	**0.184**	2.166	20.509	**22.675**	22.491	11.395
2007		0.184	**0.184**	2.166	20.509	**22.675**	22.491	10.174
2008		0.184	**0.184**	2.166	20.509	**22.675**	22.491	9.084
2009		0.184	**0.184**	2.166	20.509	**22.675**	22.491	8.110
2010		0.184	**0.184**	2.166	20.509	**22.675**	22.491	7.242
2011		0.184	**0.184**	2.166	20.509	**22.675**	22.491	6.466
2012		0.184	**0.184**	2.166	20.509	**22.675**	22.491	5.773
2013		0.184	**0.184**	2.166	20.509	**22.675**	22.491	5.154
2014		0.184	**0.184**	2.166	20.509	**22.675**	22.491	4.602
2015		0.184	**0.184**	2.166	20.509	**22.675**	22.491	4.109
2016		0.184	**0.184**	2.166	20.509	**22.675**	22.491	3.669
2017		0.184	**0.184**	2.166	20.509	**22.675**	22.491	3.276
2018		0.184	**0.184**	2.166	20.509	**22.675**	22.491	2.925
2019		0.184	**0.184**	2.166	20.509	**22.675**	22.491	2.611
2020		0.184	**0.184**	2.166	20.509	**22.675**	22.491	2.332
2021		0.184	**0.184**	2.166	20.509	**22.675**	22.491	2.082
							NPV =	176.076
							IRR =	557.6%
							FYRR=	1810.0%
							MIRR =	39.6%

TABLE 8-10
SUMMARY OF ECONOMIC ANALYSIS
EXTREME PESSIMISTIC SCENARIO
CASE 3: GRADE SEPERATIONS COMBINED

YEAR	PROJECT COSTS (million USD)			PROJECT BENEFITS (million USD)			NET BENEFITS	
	Investment Cost	Operation and Maintenance	Total Cost	Total VOC Benefits	Total VOT Benefits	Total Benefits	Total Net	Discounted Net at 12%
1999	10.592		**10.592**				-10.592	-10.592
2000	10.592		**10.592**				-10.592	-9.457
2001	23.018		**23.018**				-23.018	-18.350
2002	22.903	0.42	**23.323**	-0.163	11.161	**10.998**	-12.325	-8.772
2003	10.477	0.794	**11.271**	-2.794	5.62	**2.826**	-8.445	-5.367
2004	10.477	0.794	**11.271**	-0.358	7.310	**6.952**	-4.319	-2.451
2005	-	1.297	**1.297**	2.078	9.000	**11.078**	9.781	4.955
2006		1.297	**1.297**	2.078	9.000	**11.078**	9.781	4.424
2007		1.297	**1.297**	2.078	9.000	**11.078**	9.781	3.950
2008		1.297	**1.297**	2.078	9.000	**11.078**	9.781	3.527
2009		1.297	**1.297**	2.078	9.000	**11.078**	9.781	3.149
2010		1.297	**1.297**	2.078	9.000	**11.078**	9.781	2.812
2011		1.297	**1.297**	2.078	9.000	**11.078**	9.781	2.511
2012		1.297	**1.297**	2.078	9.000	**11.078**	9.781	2.242
2013		1.297	**1.297**	2.078	9.000	**11.078**	9.781	2.001
2014		1.297	**1.297**	2.078	9.000	**11.078**	9.781	1.787
2015		1.297	**1.297**	2.078	9.000	**11.078**	9.781	1.595
2016		1.297	**1.297**	2.078	9.000	**11.078**	9.781	1.425
2017		1.297	**1.297**	2.078	9.000	**11.078**	9.781	1.272
2018		1.297	**1.297**	2.078	9.000	**11.078**	9.781	1.136
2019		1.297	**1.297**	2.078	9.000	**11.078**	9.781	1.014
2020	-36.916	1.297	**-35.619**	2.078	9.000	**11.078**	46.697	4.322
2021		1.297	**1.297**	2.078	9.000	**11.078**	9.781	0.808
2022		1.297	**1.297**	2.078	9.000	**11.078**	9.781	0.722
2023		1.297	**1.297**	2.078	9.000	**11.078**	9.781	0.644
2024		1.297	**1.297**	2.078	9.000	**11.078**	9.781	0.575
							NPV =	-10.116
							IRR =	10.0%
							FYRR=	9.0%

TABLE 8-11
SUMMARY OF ECONOMIC ANALYSIS
EXTREME PESSIMISTIC SCENARIO
CASE 4: ALL CASES COMBINED (Parking Structures Not Included)

YEAR	PROJECT COSTS (million USD)			PROJECT BENEFITS (million USD)			NET BENEFITS	
	Investment Cost	Operation and Maintenance	Total Cost	Total VOC Benefits	Total VOT Benefits	Total Benefits	Total Net	Discounted Net at 12%
1999	22.044		**22.044**				-22.044	-22.044
2000	22.9645		**22.965**				-22.9645	-20.504
2001	23.9385	2.318	**26.257**	-0.227	13.776	**13.549**	-12.7075	-10.130
2002	22.9027	2.922	**25.825**	6.874	36.793	**43.667**	17.8423	12.700
2003	10.4767	3.296	**13.773**	-13.943	52.135	**38.192**	24.419	15.519
2004	10.4767	3.296	**13.773**	-6.017	52.921	**46.903**	33.131	18.799
2005		3.799	**3.799**	1.909	53.706	**55.615**	51.816	26.251
2006		3.799	**3.799**	1.909	53.706	**55.615**	51.816	23.439
2007		3.799	**3.799**	1.909	53.706	**55.615**	51.816	20.928
2008		3.799	**3.799**	1.909	53.706	**55.615**	51.816	18.685
2009		3.799	**3.799**	1.909	53.706	**55.615**	51.816	16.683
2010		3.799	**3.799**	1.909	53.706	**55.615**	51.816	14.896
2011		3.799	**3.799**	1.909	53.706	**55.615**	51.816	13.300
2012		3.799	**3.799**	1.909	53.706	**55.615**	51.816	11.875
2013		3.799	**3.799**	1.909	53.706	**55.615**	51.816	10.603
2014		3.799	**3.799**	1.909	53.706	**55.615**	51.816	9.467
2015		3.799	**3.799**	1.909	53.706	**55.615**	51.816	8.452
2016		3.799	**3.799**	1.909	53.706	**55.615**	51.816	7.547
2017		3.799	**3.799**	1.909	53.706	**55.615**	51.816	6.738
2018		3.799	**3.799**	1.909	53.706	**55.615**	51.816	6.016
2019		3.799	**3.799**	1.909	53.706	**55.615**	51.816	5.372
2020	-39.005	3.799	**-35.206**	1.909	53.706	**55.615**	90.821	8.406
2021		1.481	**1.481**	1.909	53.706	**55.615**	54.134	4.474
2022		1.297	**1.297**	1.909	53.706	**55.615**	54.318	4.008
2023		1.297	**1.297**	1.909	53.706	**55.615**	54.318	3.579
2024		1.297	**1.297**	1.909	53.706	**55.615**	54.318	3.195
							NPV =	218.252
							IRR =	39.0%
							FYRR=	463.8%

8.6 Economic Return of the Investment in CCTV

The IRR of the traffic management component was reported at 34.1%. The calculation includes the investment and recurring costs associated with the CCTV component. but do not include any benefits attributed to it. Estimating monetized economic benefits of CCTV without availability of any historic data on this topic from Lebanon would be difficult to achieve. Alternatively. it is proposed to calculate the level of benefits. attributed to CCTV only. below which the marginal investment in CCTV would be less than 12%. Such a calculation should educate the decision on whether to keep the CCTV or delete it from the traffic management component.

The results of such an exercise are presented in Tables 8-12. it shows that if the CCTV is taken separately. and in order for the investment in it to realize an IRR of 12.1%. the annual stream of benefits should be $255.000 (no salvage value for CCTV installations is included). Are those benefits achievable?

CCTV surveillance will improve incident management on these heavily traveled corridors. Evidence from research done elsewhere is reported below.

The benefits of CCTV surveillance are discussed in several research reports issued by FHWA. such as:

"ITS Benefits. Review of Evaluation Methods and Reported Benefits" and "ITS Benefits: 1999 Update (Draft)".

These benefits include:

- Improve the safety of transportation system
  * reduce severity of collisions
  * reduce number and severity of fatalities and injuries.
- Increase the operational efficiency and capacity of transportation system
  * reduce disruptions due to incidents
  * maintain / increase roadway capacity.
- Enhance present and future productivity
  * increase coordination / integration of network operation. management and investment
  * reduce information-gathering costs
  * improve transportation systems plannings and ability to evolve with changes in system performance requirements and technology
  * decrease cost of freight movement to shippers.
- Enhance personal mobility. convenience and comfort of the transportation system
  * reduce costs incurred by fleet operators and others
  * improve the security of travel
  * reduce traveler stress. fatigue and confusion.

TABLE 8-12
DISCOUNTED CASH FLOW OF CCTV INVESTMENT ONLY THAT REALIZES AN IRR OF 12%

YEAR	PROJECT COSTS (million USD)			PROJECT BENEFITS (million USD)			NET BENEFITS	
	Investment Cost	Operation and Maintenance	Total Cost	Total VOC Benefits	Total VOT Benefits	Total Benefits	Total Net	Discounted Net at 12%
1999	0.525		**0.525**			**0**	-0.525	-0.525
2000	0.525		**0.525**			**0**	-0.525	-0.469
2001		0.105	**0.105**			**0.255**	0.15	0.120
2002		0.105	**0.105**			**0.255**	0.15	0.107
2003		0.105	**0.105**			**0.255**	0.15	0.095
2004		0.105	**0.105**			**0.255**	0.15	0.085
2005		0.105	**0.105**			**0.255**	0.15	0.076
2006		0.105	**0.105**			**0.255**	0.15	0.068
2007		0.105	**0.105**			**0.255**	0.15	0.061
2008		0.105	**0.105**			**0.255**	0.15	0.054
2009		0.105	**0.105**			**0.255**	0.15	0.048
2010		0.105	**0.105**			**0.255**	0.15	0.043
2011		0.105	**0.105**			**0.255**	0.15	0.039
2012		0.105	**0.105**			**0.255**	0.15	0.034
2013		0.105	**0.105**			**0.255**	0.15	0.031
2014		0.105	**0.105**			**0.255**	0.15	0.027
2015		0.105	**0.105**			**0.255**	0.15	0.024
2016		0.105	**0.105**			**0.255**	0.15	0.022
2017		0.105	**0.105**			**0.255**	0.15	0.020
2018		0.105	**0.105**			**0.255**	0.15	0.017
2019		0.105	**0.105**			**0.255**	0.15	0.016
2020		0.105	**0.105**			**0.255**	0.15	0.014
							NPV =	0.007
							IRR =	12.1%
							FYRR=	12.0%

- Reduce energy consumption and environmental costs
  * reduce vehicle emissions due to non-securing / incident congestion
  * reduce noise pollution
  * reduce neighborhood traffic intrusiveness.

Not all these benefits are measurable: some could be measured. whereas others are anecdotal.

A Case Study on San Antonio Tx. provides the following insights[1].

Metropolitan San Antonio. Texas has a population of a comparable size to that of Greater Beirut. but is of a larger area almost 4 times that of Greater Beirut. The study focuses on 26 miles of freeways included in Phase I of the Trans Guide. Fifty nine video cameras. more than 800 inductive loop detectors. 359 lane control signals. 51 variable message signs. and approximately 70 miles of fiber optic cable were required to adequately instrument the first phase of the San Antonio ATMS program. It is to be recalled that CCTV component of the BUTP. which is being evaluated. includes 50 CCTV cameras. Specifically. the Case Study examines the perceived benefits derived from the sharing of video data.

The benefits associated with the use of video data for traffic management can be summarized by the following statements:

- seeing is believing; and
- a picture is worth a thousand words.

The use of real-time video data enables Trans Guide to:

* verify an incident.
* accurately determine the severity of an incident.
* quickly identify the location of the incident: and
* select the most appropriate response to the incident.

Real-time video ensures the system's accuracy. because operators can see what is happening. The use of video eliminates potential problems due to incomplete or contradicting information.

A Before-and-After Analysis of Trans Guide shows that benefits related to incident management are:

- response time for minor incidents dropped by 19 percent.
- response time for major incidents dropped by 21 percent: and
- simulation results estimated delay fuel consumption savings at $1.65 per year.

There were also savings that were realized by the San Antonio Police Department (SAPD). Video sharing allows the SAPD to effectively use their limited resources by eliminating unnecessary trips to investigate false calls. providing the exact location of incidents. and providing prompt and accurate response to incidents.

Studies in Los Angeles. California. also reported reduction in delay of 50% and estimated benefit-to-cost at 5:1 to 6:1. thanks to the combination of detectors. CCTV and incident management team.

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[1] Dave Novak. "A Case Study: Benefits Associated with the Sharing of ATMS - Related Video Data in San Antonio". Center for Transportation Research. Virginia Tech. August 1998.

The CCTV system proposed for inclusion in BUTP Traffic Management Component will be realizing more benefits when additional integration of ATMS components are deployed in the future.

8.7 Fiscal Impacts of BUTP Components

8.7.1 Traffic Management Component

The traffic management component would require operation and maintenance whose cost is summarized as follows:

Table 8-13

Fiscal Impact - Traffic Management Component
USD (1000)

Component	Annual Operation	Annual Maintenance	Total
Signals	110	1.357	1.467
Traffic Control Center and CCTV	236	726	962
Total	346	2.083	2.429

8.7.2 Parking Control

The fiscal impact of the Parking Control is limited to the annual maintenance of the equipment estimated at $200.000 per year. The operations will be sub-contracted. The parking fees will cover the operation costs. In fact financial simulations show that Parking Control could be a net cash generator.

8.7.3 Grade Separation Component

The 16 proposed grade separations would each require maintenance. The annual maintenance of each was reported in Table 5-7. Their combined annual maintenance cost is $1.236.000.

9. RISK ANALYSIS

9.1 Key Input Variables of Risk Analysis

STEAM performs risk analysis by establishing "Probability Density Functions" for key input variables based on subjective and statistical analysis. The user enters the high and low factors for key input variables to be multiplied by the mean value to establish the "Probability Density Function". Table 9-1 shows the low and high factors for the following key input variables:

i) In-vehicle Value of Time for auto, truck, and transit

ii) Discount rate

iii) Fuel Prices

iv) Fuel Consumption rates

v) Capital Costs, Salvage Value, and Operation Costs.

The table shows that the selected factors to be multiplied by the mean value of each key variable are 1.5 for high value and 0.7 for low value. That is the regular input-data for each of the above key variables is considered to be the mean value and is then increased by 50% and decreased by 30% to establish the probability distribution for that variable. The risk analysis methodology then uses a Monte Carlo simulation process to generate the probability distribution of each output variable from repeated samplings of the generated "probability density function" of each key variable. This methodology allows all inputs to be varied simultaneously within their distributions, thus avoiding the problems inherent in conventional sensitivity analysis of using "high" and "low" cases.

Except for changes in demand, which is exogenous to STEAM and treated in the previous chapter, the chosen variables are the key ones that may experience different values from their mean expected value. The values of 50% increase and the lower value of 30% decrease are estimated to give upper and lower limits of the probability distribution function of each key variable. It is important to give a broader range of values so that the risk analysis would be meaningful. It is also consistent with most transportation investments, where the expected mean value is always underestimated compared to being overestimated. Moreover, a very tight distribution of 1.3 and .85 would not have allowed to give meaningful results for the three risk scenarios that have been conducted. On the other hand a very large distribution from the mean, such as 1.8 and .5 would have diluted the importance of the risk analysis by creating unrealistic results. The 1.5 and .7 factors had created the right mix of extremes for the distribution of the key variables and allowed to choose three risk scenarios with meaningful results.

Table 9-1: Risk Analysis Input Variables

Risk Analysis Input Variables	Low*	High*
In-Veh. Value of Time – Auto (Factor)	0.7	1.5
In-Veh. Value of Time - Truck (Factor)	0.7	1.5
In-Veh. Value of Time – Transit (Factor)	0.7	1.5
Discount Rate	0.024	0.200
Fuel Consumption Rate (Factor)	0.7	1.5
Fuel Prices (Factor)	0.7	1.5
Capital Cost (Factor)	0.7	1.5
Salvage Value (Factor)	0.7	1.5
Operating Cost (Factor)	0.7	1.5

*Factor: Multiplied by the Mean Value, except for the Discount Rate.

The result of the risk analysis is a forecast of future outcomes and the probability or odds of their occurrence.

9.2 Risk Analysis Results

The risk analysis for the various improvement cases is conducted for a selected representative year. Since all the project cases have a benefit period of 20 years, and since most of them will become operational in the early years of the next millenium. The best analysis year as a representative year will be the year 2010. Also, the year 2010 represents the mid-point in the demand level between the year 2000 and 2020.

The results of the risk analysis runs for the year 2010 for all seven cases are shown in Tables 9-2 to 9-8. the results are presented to provide the following information:

1. The value of total annual benefits and total annual costs for the different percentiles (1st, 5th, 10th, 20th, 30th, 40th, 50th, 60th, 70th, 80th, 90th, 95th, & 99th) including the mean and the median.

2. The probability distribution at equal intervals of total annual benefits and total annual costs.

3. The values of the main economic indicators, IRR, NPV, and FYRR for various scenarios, such as worse case scenario, possible risky scenario, and likely/expected scenario. These scenarios are obtained from the probability distribution for various percentile levels as follows:

   - Worse Case Scenario: is the scenario where the probability to exceed the annual benefits is 80%, while the probability to exceed annual costs is only 20%. For example, in the Traffic Management Case (Table 9-2), the probability to exceed 80% (20th percentile) of total annual benefits is $11.97 M, while the probability to exceed 20% (80th percentile) of total annual costs is $7.23 M.

   - Possible Risky Scenario: is the scenario where the probability to exceed the annual benefits is 70% and the annual costs is 30%. In the Traffic Management Case these values are $13.47 M and $6.68 M respectively.

   - Likely/Expected Scenario: is the scenario where the probability to exceed the annual benefits is 50% and the annual costs is 50%, that is representing the median values. In the Traffic Management Case these values are $15.67 M for annual benefits and $5.94 M for annual costs.

These values of total annual benefits and total annual costs for each scenario (a, b, and c) are used to determine the economic indicators NPV, IRR, and FYRR. The summary results for the three possible scenarios for the seven improvement cases are shown in Table 9-9.

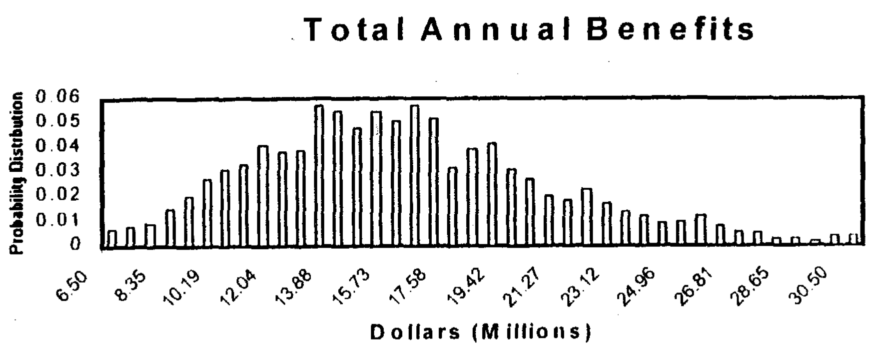
Under worse case conditions, the Parking Controls Case, the Traffic Management Case, and the All Improvements Case continue to show good economic indicators and good returns on investment. It is The Grade Separation Improvement Cases that start to show weak economic indicators in terms of NPV and IRR. However, the situation changes for the Grade Separation Cases under the probable risky scenario. Under this scenario the three Grade Separation Cases all show positive NPV and IRR's (higher than 12%) signaling economically viable cases. The Parking Structure Case does not show any positive economic indicators under all possible scenarios.

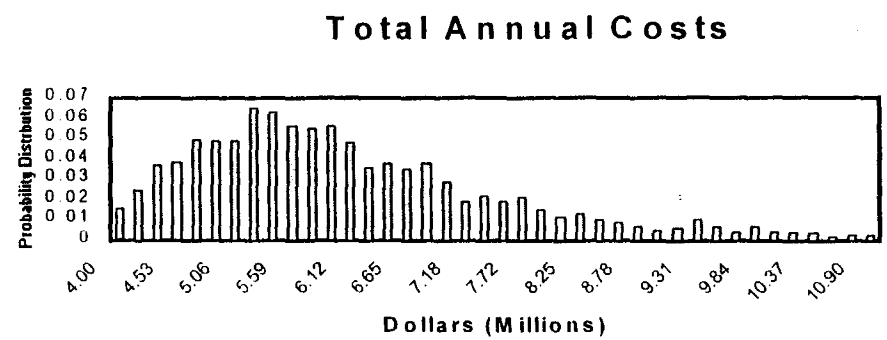
Table 9-2: Risk Analysis: Case 1 – Traffic Management
(2010 – As Representative Year)

1. Risk Analysis Output

	Mean	Median	Percentiles: 1st	5th	10th	20th	30th	40th	50th	60th	70th	80th	90th	95th	99th
Total Annual Benefits ($M)	16.51	15.67	6.71	8.99	10.28	11.97	13.47	14.53	15.67	16.14	18.12	19.85	22.66	25.37	30.27
Total Annual Costs ($M)	6.43	5.94	4.12	4.45	4.69	5.06	5.36	5.63	5.94	6.25	6.68	7.23	8.17	9.17	10.86

2. Probability Distribution





3. Economic Indicators

	IRR (%)	NPV ($Mil)	FYRR (%)
Worse Case Scenario[a]	21.8	35.4	22.16
Possible Risky Scenario[b]	26.8	50.72	26.99
Likely / Expected Scenario[c]	35.1	72.68	35.32

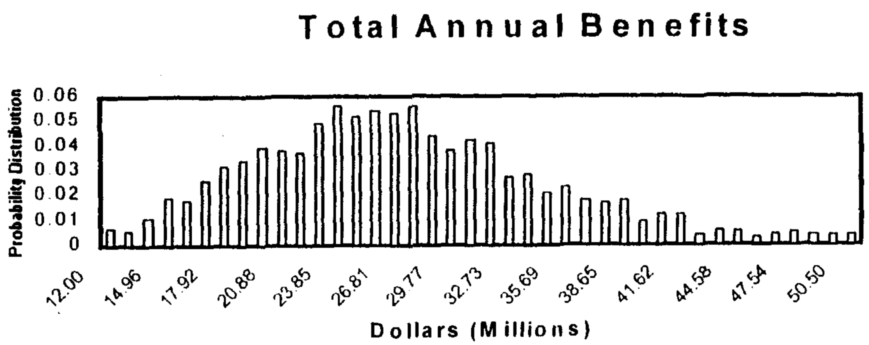
	Probability of Exceed for various scenarios a, b, c: Ann. Benefits	Ann. Costs
a	80 %	20 %
b	70 %	30 %
c	50 %	50 %

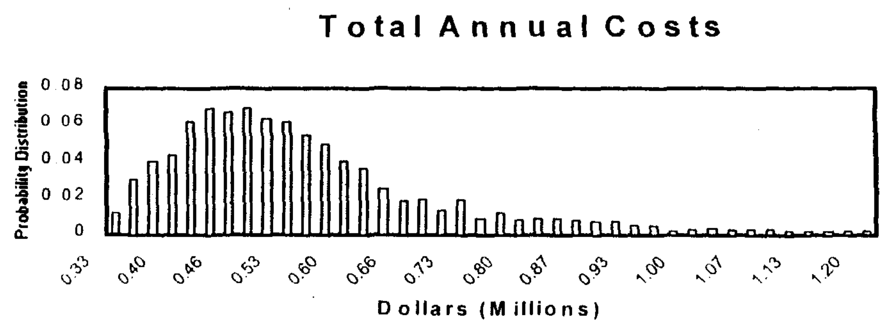
Table 9-3: Risk Analysis: Case 2 – Parking Controls
(2010 – As Representative Year)

1. Risk Analysis Output

	Mean	Median	Percentiles 1st	5th	10 th	20 th	30 th	40 th	50 th	60 th	70 th	80 th	90 th	95 th	99 th
Total Annual Benefits ($M)	28.69	27.36	13.16	16.79	18.88	21.49	23.85	25.55	27.36	28.99	31.27	33.95	38.49	42.81	50.34
Total Annual Costs ($M)	0.55	0.50	0.32	0.36	0.38	0.42	0.44	0.47	0.50	0.53	0.57	0.62	0.72	0.81	1.06

2. Probability Distribution





3. Economic Indicators

	IRR (%)	NPV ($Mil)	FYRR (%)
Worse Case Scenario[a]	465	154.47	464.15
Possible Risky Scenario[b]	553	173.90	560.12
Likely / Expected Scenario[c]	710	200.64	732.53

	Probability of Exceed for various scenarios a, b, c: Ann. Benefits	Ann. Costs
a	80 %	20 %
b	70 %	30 %
c	50 %	50 %

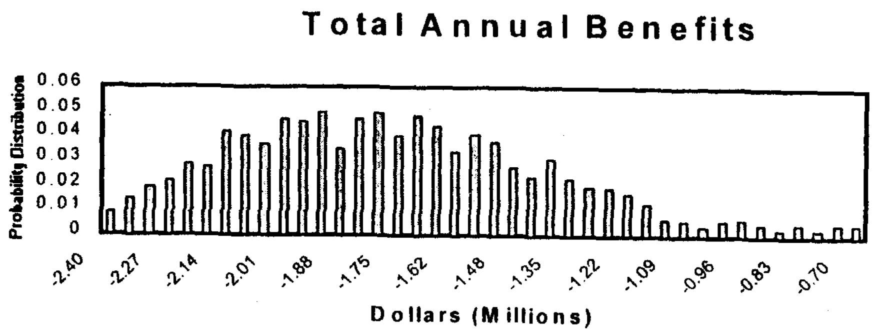
Table 9-4: Risk Analysis: Case 2 – Parking Structures

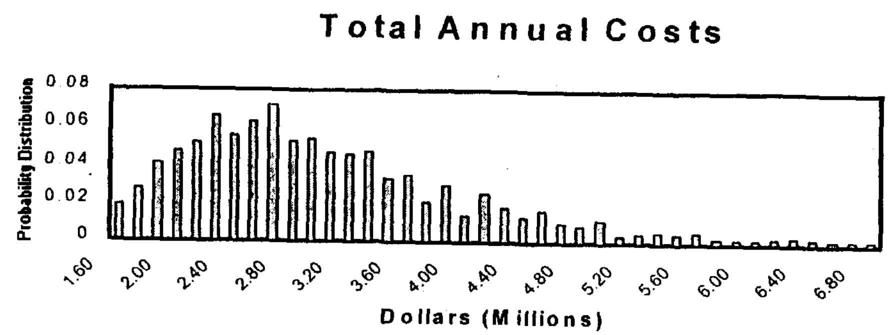
(2010 – As Representative Year)

1. Risk Analysis Output

	Mean	Median	Percentiles: 1st	5th	10 th	20 th	30 th	40 th	50 th	60 th	70 th	80 th	90 th	95 th	99 th
Total Annual Benefits ($M)	-1.79	-1.86	-2.5	-2.37	-2.29	-2.16	-2.05	-1.96	-1.86	-1.76	-1.55	-1.52	-1.33	-1.16	-0.74
Total Annual Costs ($M)	3.24	2.85	1.57	1.81	1.97	2.22	2.44	2.64	2.85	3.09	3.38	3.79	4.45	5.13	6.76

2. Probability Distribution





3. Economic Indicators

	IRR (%)	NPV ($Mil)	FYRR (%)
Worse Case Scenario[a]	Neg.	-45.41	-7.63
Possible Risky Scenario[b]	Neg.	-40.56	-8.12
Likely / Expected Scenario[c]	Neg.	-35.18	-8.74

	Probability of Exceed for various scenarios a, b, c	
	Ann. Benefits	Ann. Costs
a	80 %	20 %
b	70 %	30 %
c	50 %	50 %

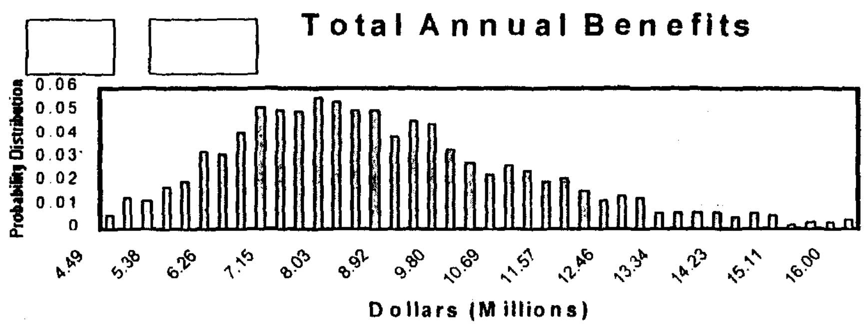
Table 9-5: Risk Analysis: Case 3 – Grade Separation Group I

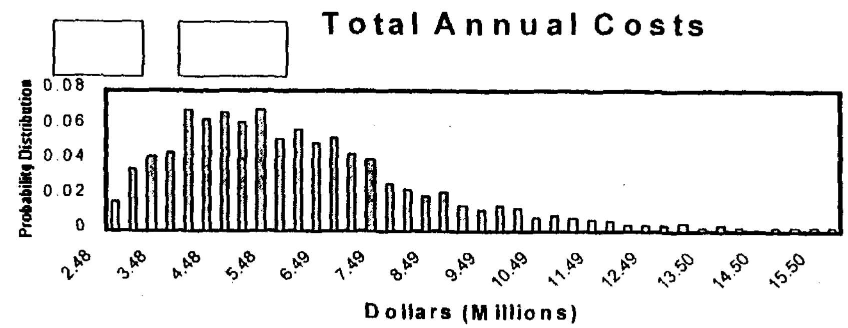
(2010 – As Representative Year)

1. Risk Analysis Output

	Mean	Median	Percentiles 1st	5th	10 th	20 th	30 th	40 th	50 th	60 th	70 th	80 th	90 th	95 th	99 th
Total Annual Benefits ($M)	9.18	8.66	4.57	5.60	6.20	6.95	7.54	8.13	8.66	9.27	9.90	10.87	12.20	13.48	15.96
Total Annual Costs ($M)	6.52	5.57	2.54	3.08	3.48	4.07	4.56	5.06	5.57	6.15	6.76	7.66	9.37	10.95	15.48

2. Probability Distribution





3. Economic Indicators

	IRR (%)	NPV ($Mil)	FYRR (%)
Worse Case Scenario[a]	10.5	-5.30	12.14
Possible Risky Scenario[b]	13.8	5.83	14.93
Likely / Expected Scenario[c]	20.1	23.08	20.81

	Probability of Exceed for various scenarios a, b, c	
	Ann. Benefits	Ann. Costs
a	80 %	20 %
b	70 %	30 %
c	50 %	50 %

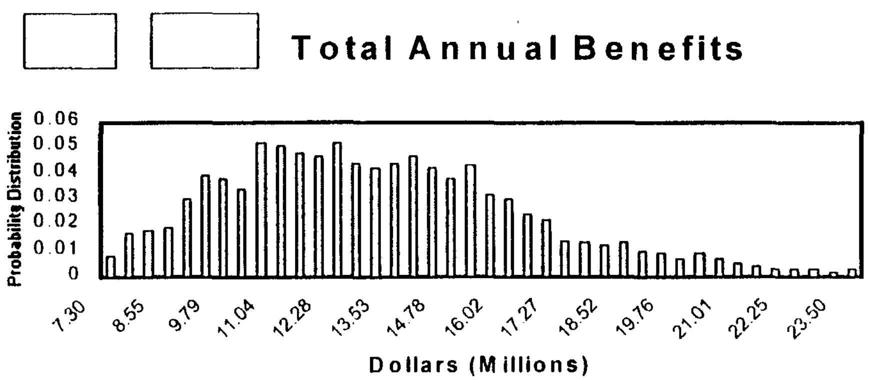
Table 9-6: Risk Analysis: Case 3 – Grade Separation Group I + II

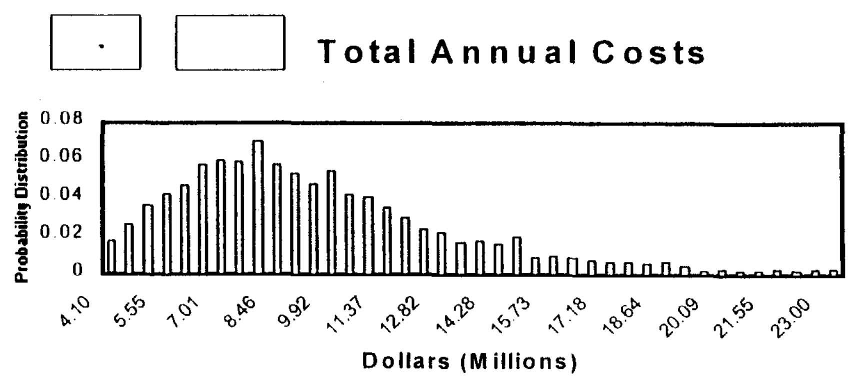
(2010 – As Representative Year)

1. Risk Analysis Output

	Mean	Median	1st	5th	10th	20th	30th	40th	50th	60th	70th	80th	90th	95th	99th
			Percentiles												
Total Annual Benefits ($M)	13.63	12.94	7.40	8.47	9.37	10.46	11.25	12.11	12.94	13.84	14.73	15.84	17.78	19.61	23.34
Total Annual Costs ($M)	10.24	8.91	4.00	4.90	5.55	6.55	7.35	8.14	8.91	9.83	10.80	12.27	14.72	17.12	22.99

1. Probability Distribution





2. Economic Indicators

	IRR (%)	NPV ($Mil)	FYRR (%)
Worse Case Scenario[a]	9.65	-13.52	11.41
Possible Risky Scenario[b]	12.7	3.36	13.94
Likely / Expected Scenario[c]	18.9	30.10	19.44

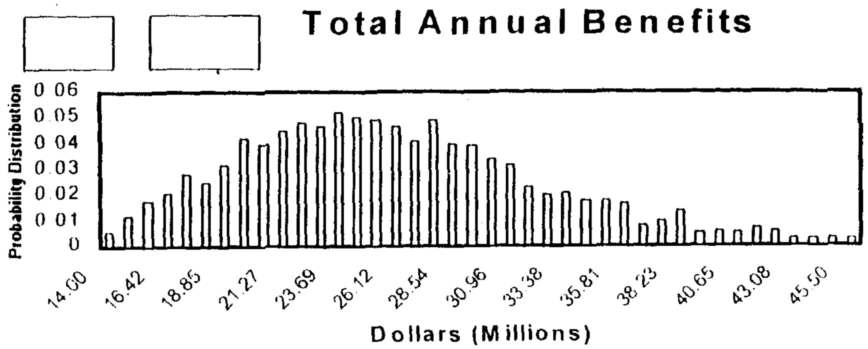
	Probability of Exceed for various scenarios a, b, c	
	Ann. Benefits	Ann. Costs
a	80 %	20 %
b	70 %	30 %
c	50 %	50 %

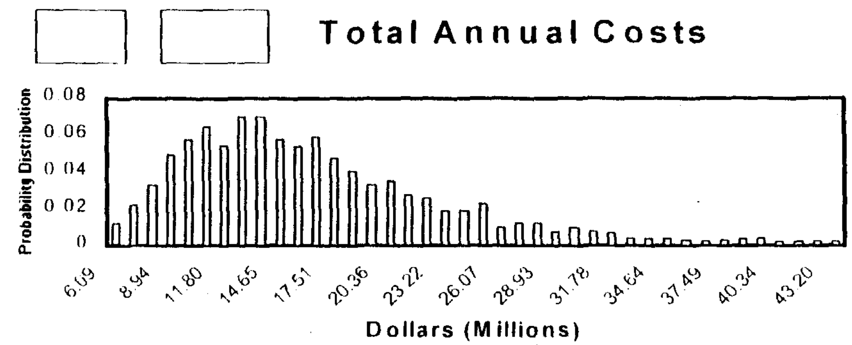
Table 9-7: Risk Analysis: Case 3 – Grade Separation Group I + II + III (2010 – As Representative Year)

1. Risk Analysis Output

	Mean	Median	Percentiles 1st	5th	10 th	20 th	30 th	40 th	50 th	60 th	70 th	80 th	90 th	95 th	99 th
Total Annual Benefits ($M)	26.77	25.46	14.08	16.76	18.22	20.56	22.27	23.92	25.46	27.27	29.03	31.32	35.13	38.53	45.44
Total Annual Costs ($M)	18.02	15.32	6.08	8.14	9.25	10.91	12.47	13.79	15.32	16.96	18.96	21.80	26.51	30.91	43.14

2. Probability Distribution





3. Economic Indicators

	IRR (%)	NPV ($Mil)	FYRR (%)
Worse Case Scenario[a]	10.6	-9.26	12.69
Possible Risky Scenario[b]	14.7	24.72	15.72
Likely / Expected Scenario[c]	21.8	75.74	22.24

	Probability of Exceed for various scenarios a, b, c	
	Ann. Benefits	Ann. Costs
a	80 %	20 %
b	70 %	30 %
c	50 %	50 %

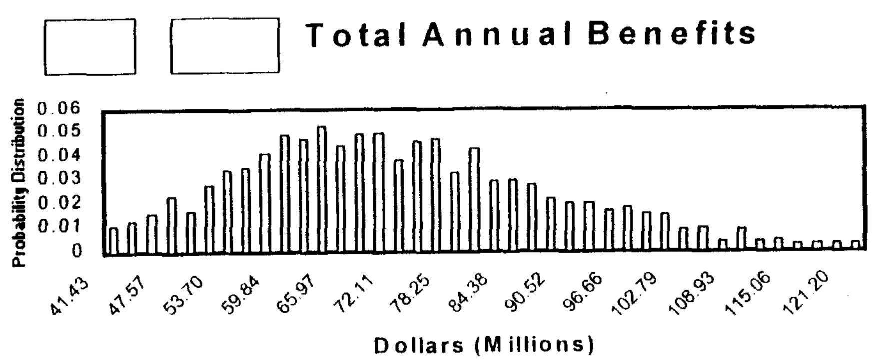
Table 9-8: Risk Analysis: Case 4-Combined Case of All Improvements

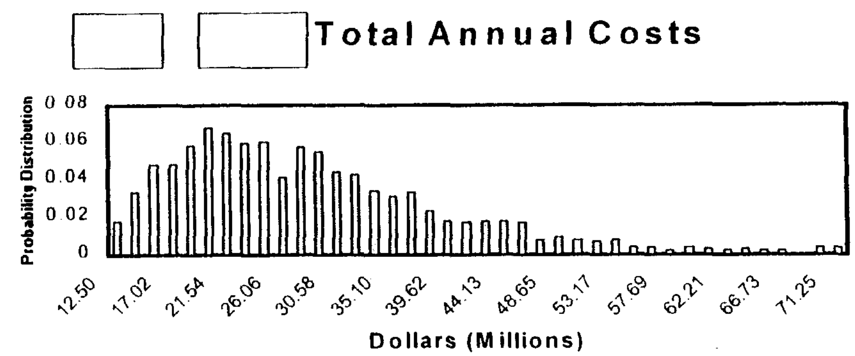
(2010 – As Representative Year)

1. Risk Analysis Output

	Mean	Median	Percentiles 1st	5th	10th	20th	30th	40th	50th	60th	70th	80th	90th	95th	99th
Total Annual Benefits ($M)	73.97	70.58	41.42	47.55	52.17	58.01	62.37	66.34	70.58	75.12	80.00	86.29	96.49	104.11	121.18
Total Annual Costs ($M)	31.75	27.60	12.20	15.64	17.43	20.40	22.64	25.00	27.60	30.49	33.71	38.23	.69	52.58	71.18

2. Probability Distribution





3. Economic Indicators

	IRR (%)	NPV ($Mil)	FYRR (%)
Worse Case Scenario[a]	19.85	147.76	20.31
Possible Risky Scenario[b]	24.40	214.09	24.77
Likely / Expected Scenario[c]	34.10	321.06	34.23

	Probability of Exceed for various scenarios a, b, c	
	Ann. Benefits	Ann. Costs
a	80 %	20 %
b	70 %	30 %
c	50 %	50 %

TABLE 9-9: Summary of Risk Analysis Results

Analysis Scenarios	Project Description	Internal Rate of Return (%)			Net Present Value ($ million)			First Year Rate Of Return (%)		
		a	b	c	a	b	c	a	b	c
Improvement Case- 1	Traffic lights & traffic control center & elimination of parking at intersections	21.8	26.8	35.1	35.40	50.72	72.68	22.16	26.99	35.32
Improvement Case- 2	Parking controls	465.11	553	710	154.47	173.90	200.64	464.15	560.12	732.53
	Parking structures	-	-	-	-45.41	-40.56	-35.18	-7.63	-8.12	-8.74
Improvement Case- 3 Group I	Grade Separations at: -Galerie Semaan -Hayek -Dora -Mkalles -Tayouneh	10.5	13.8	20.1	-5.30	5.83	23.08	12.14	14.93	20.81
Group I & II	Grade Separations at: -Beit al-Atfal -Mar Mkhael -Msharrafieh -Airport	9.65	12.7	18.9	-13.52	3.36	30.10	11.41	13.94	19.44
Groups I, II, & III	Grade Separations at: -Jal el-Dib -Antelias -Bechara el-Khoury -Adlieh -Museum -Samy el-Solh -Old Saida Rd close to Khaldeh	10.6	14.7	21.8	-9.26	24.72	75.74	12.69	15.72	22.24
All Improvement Programs	A combined case of all Improvement Programs	19.85	24.40	34.10	147.76	214.09	321.06	20.31	24.77	34.23

i) Worse case scenario

ii) Probable Risky scenario

iii) Likely/Expected scenario

In conclusion, the risk analysis shows that the Parking Control Case, the Traffic Management Case and the All Improvements Case are economically viable under all possible risky set of events including 50% increase to 30% decrease in value of travel time per market sector, capital and operating costs, fuel prices, fuel consumption rates, and discount rate. All possible scenarios (pessimistic, probable risky, and likely), indicate that the three cases remain economically viable, under the combined changing conditions of these key variables. The Grade Separation Cases are economically viable under all scenarios except for the worse case scenario, which is in all likelihood a rare event. Therefore, all these improvement cases, except for the Parking Structures, demonstrate sizable streams of benefits that exceed the costs under all possible risky scenarios.

9.3 Risk Analysis with Year 2005 as Representative Year

STEAM, in its current version, does not handle internally the variation in travel demand. It is conducted externally in the four-step travel demand process and then imported into STEAM for post-processing as trip files and network files. In order to estimate the impacts of lower demand on the economic viability of the proposed improvements, particularly under various risky conditions, the Consultant ran the risk analysis module in STEAM using the year 2005 as representative year instead of 2010. These runs would reflect an approximately a 15% reduction in demand from the mid-point year of 2010. Although, as stated earlier, 2005 is the year where almost all of the highway construction project in the Base Case Scenario become complete, thus impacting the total benefits accrued to the users from the BUTP proposed improvement programs. Therefore, 2005 may not be the best representative year under these conditions. In spite of these concerns it is worth running the risk analysis for year 2005 in order to highlight the extreme boundary condition of low demand.

The changes in the key input variables were kept the same as in Table 9-1, and the same procedures as well as the same three scenarios were utilized for the representative year 2005. The risk analysis results are shown in Tables 9-10 to 9-16 for the various improvement cases similar to the outputs for the year 2010.

Under the worse case scenario, with the year 2005 as representative year, the Parking Control Case, the Traffic Management Case, and the All Improvements Case all show positive Net Present Value (NPV) and an Internal Rate of Return (IRR) higher than 12%. These indicators provide that these three cases are economically viable under all possible conditions and scenarios. The Grade Separation Cases, particularly Group I, and Group I+ Group II show negative NPV's and low IRR's for the worse case scenario as well as for the possible risky scenario. The results are mixed for the most likely scenario with Group I−II showing positive indicators while Group I and Group III+II−I showing weak economic indicators. In other words, the decrease in demand does impact the economic viability of the Grade Separation Cases if treated independently. However, when they are combined with the Parking Improvement Case and with the Traffic Management Case, the All Improvement Case continue to show economic viability at all risk levels.

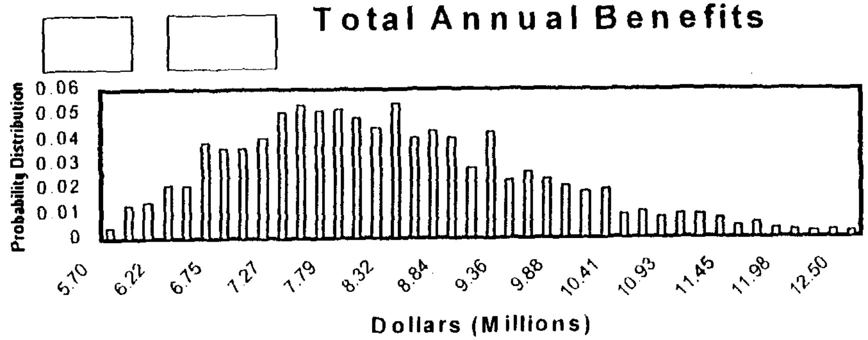
Table 9-10: Risk Analysis: Case 1 – Traffic Management

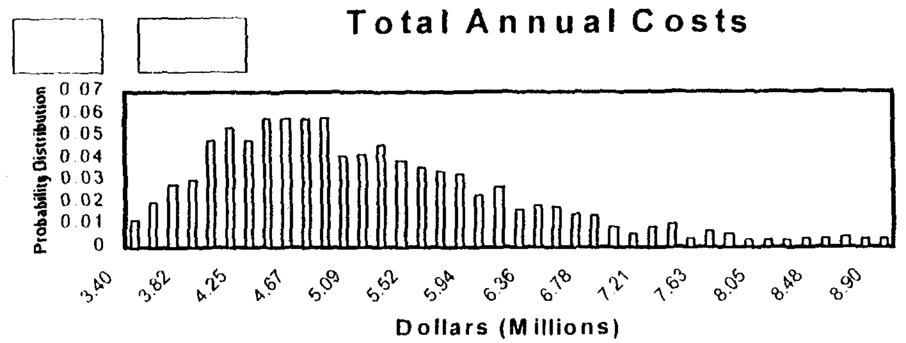
(2005 – As Representative Year)

1. Risk Analysis Output

	Mean	Median	Percentiles: 1st	5th	10 th	20 th	30 th	40 th	50 th	60 th	70 th	80 th	90 th	95 th	99 th
Total Annual Benefits ($M)	8.572	8.291	5.81	6.40	6.75	7.23	7.59	7.93	8.29	8.64	9.06	9.55	10.34	11.13	12.73
Total Annual Costs ($M)	5.457	5.095	3.48	3.80	4.03	4.34	4.61	4.85	5.10	5.40	5.74	6.14	6.88	7.59	8.98

2. Probability Distribution





3. Economic Indicators

	IRR (%)	NPV ($Mil)	FYRR (%)
Worse Case Scenario[a]	14.7	8.14	17.65
Possible Risky Scenario[b]	16.9	13.82	17.70
Likely / Expected Scenario[c]	21.7	23.83	21.76

	Probability of Exceed for various scenarios a, b, c: Ann. Benefits	Ann. Costs
a	80 %	20 %
b	70 %	30 %
c	50 %	50 %

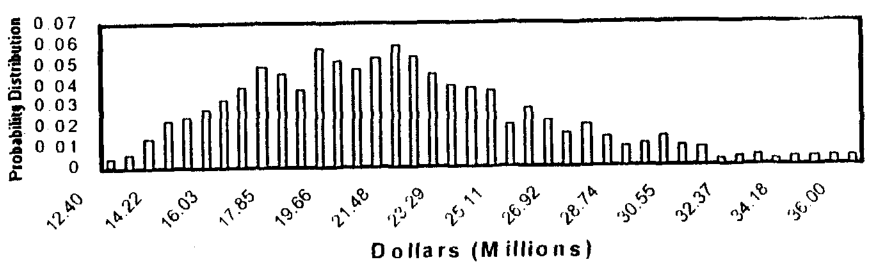
Table 9-11: Risk Analysis: Case 2 – Parking Controls

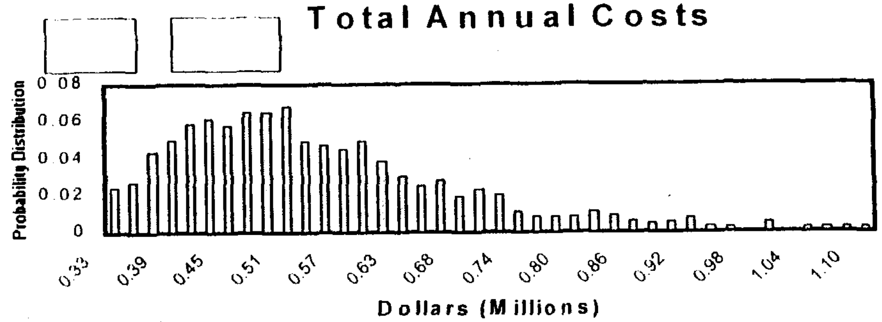
(2005 – As Representative Year)

1. Risk Analysis Output

	Mean	Median	Percentiles 1st	5th	10 th	20 th	30 th	40 th	50 th	60 th	70 th	80 th	90 th	95 th	99 th
Total Annual Benefits ($M)	22.084	21.273	12.69	14.83	15.99	17.58	18.92	20.09	21.27	22.25	23.53	25.23	28.03	30.66	36.03
Total Annual Costs ($M)	0.549	0.493	0.32	0.35	0.37	0.41	0.44	0.47	0.49	0.53	0.57	0.62	0.70	0.81	1.05

2. Probability Distribution





3. Economic Indicators

	IRR (%)	NPV ($Mil)	FYRR (%)
Worse Case Scenario[a]	346	114.81	345.35
Possible Risky Scenario[b]	450	137.07	444.13
Likely / Expected Scenario[c]	568	155.23	581.14

	Probability of Exceed for various scenarios a, b, c Ann. Benefits	Ann. Costs
a	80 %	20 %
b	70 %	30 %
c	50 %	50 %

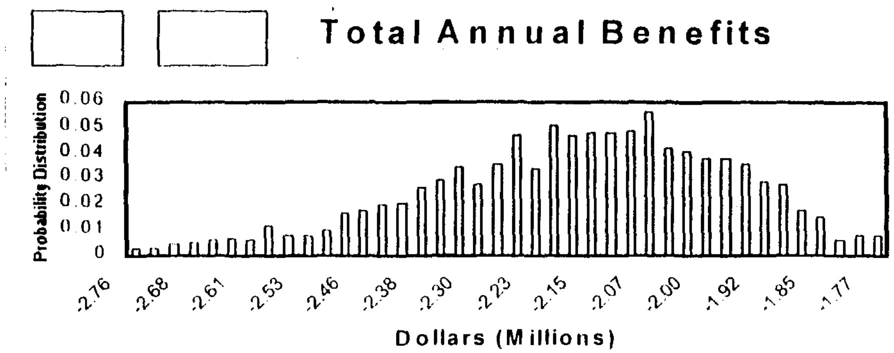
Table 9-12: Risk Analysis: Case 2 – Parking Structures

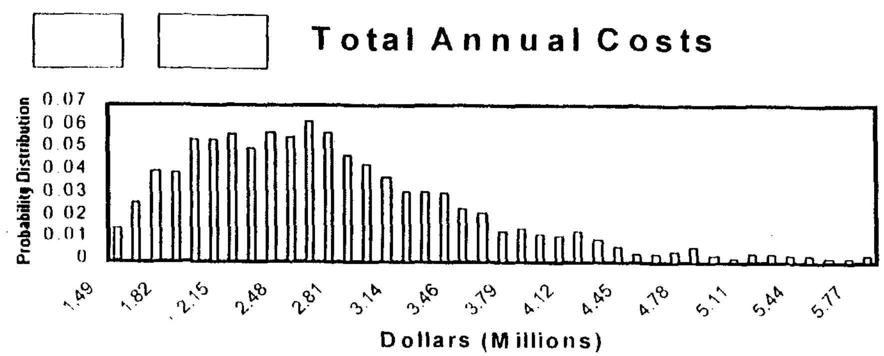
(2005 – As Representative Year)

1. Risk Analysis Output

	Mean	Median	Percentiles 1st	5th	10 th	20 th	30 th	40 th	50 th	60 th	70 th	80 th	90 th	95 th	99 th
Total Annual Benefits ($M)	-2.20	-2.17	-2.75	-2.56	-2.46	-2.35	-2.27	-2.22	-2.17	-2.11	-2.07	-2.01	-1.94	-1.88	-1.78
Total Annual Costs ($M)	2.90	2.60	1.48	1.68	1.82	2.03	2.23	2.43	2.60	2.79	3.04	3.36	0.94	4.52	5.74

2. Probability Distribution





3. Economic Indicators

	IRR (%)	NPV ($Mil)	FYRR (%)
Worse Case Scenario[a]	Neg.	-42.65	-9.36
Possible Risky Scenario[b]	Neg.	-39.66	-9.99
Likely / Expected Scenario[c]	Neg.	-35.63	-11.17

	Probability of Exceed for various scenarios a, b, c Ann. Benefits	Ann. Costs
a	80 %	20 %
b	70 %	30 %
c	50 %	50 %

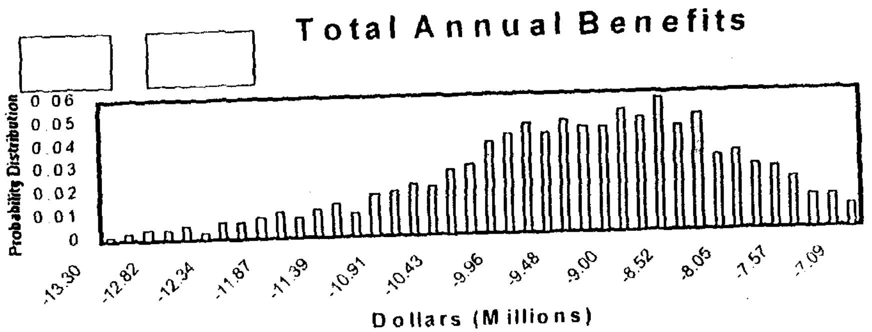
Table 9-13: Risk Analysis: Case 3 – Grade Separation Group I

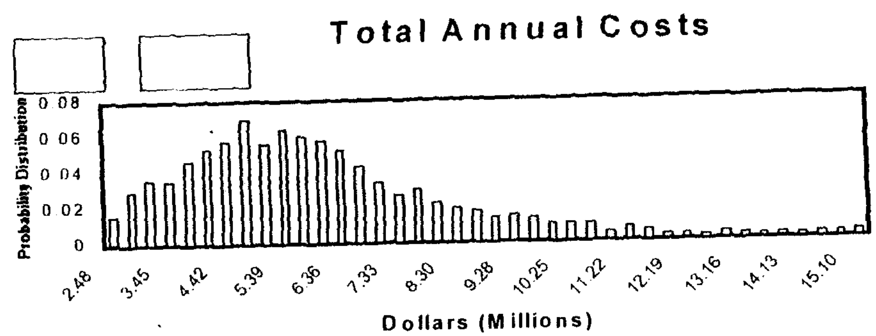
(2005 – As Representative Year)

1. Risk Analysis Output

	Mean	Median	Percentiles: 1st	5th	10 th	20 th	30 th	40 th	50 th	60 th	70 th	80 th	90 th	95 th	99 th
Total Annual Benefits ($M)	-9.53	-9.26	-13.23	-11.84	-11.16	-10.38	-9.95	-9.60	-9.26	-8.94	-8.66	-8.33	-7.87	-7.54	-7.09
Total Annual Costs ($M)	6.621	5.72	2.46	3.03	3.47	4.18	4.73	5.23	5.72	6.29	6.97	7.96	9.62	11.27	15.16

2. Probability Distribution





3. Economic Indicators

	IRR (%)	NPV ($Mil)	FYRR (%)
Worse Case Scenario[a]	Neg.	-136.0	-17.45
Possible Risky Scenario[b]	Neg.	-126.39	-19.11
Likely / Expected Scenario[c]	Neg.	-111.90	-21.67

	Probability of Exceed for various scenarios a, b, c: Ann. Benefits	Ann. Costs
a	80 %	20 %
b	70 %	30 %
c	50 %	50 %

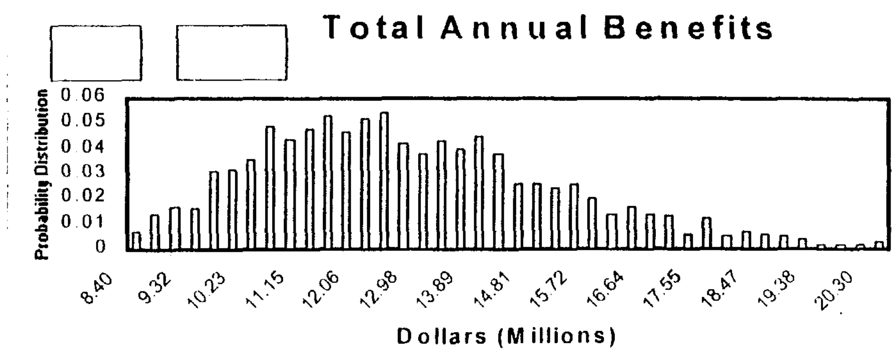
Table 9-14: Risk Analysis: Case 3 – Grade Separation Group I + II

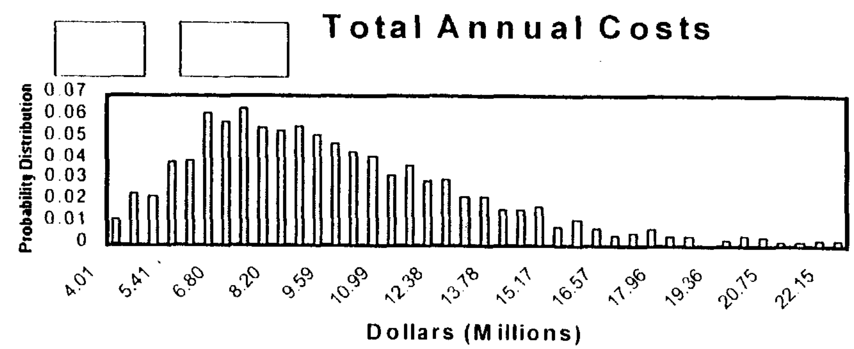
(2005 – As Representative Year)

1. Risk Analysis Output

	Mean	Median	Percentiles: 1st	5th	10 th	20 th	30 th	40 th	50 th	60 th	70 th	80 th	90 th	95 th	99 th
Total Annual Benefits ($M)	13.17	12.59	8.53	9.49	10.04	10.80	11.43	12.04	12.59	13.28	14.01	14.92	16.31	17.48	20.29
Total Annual Costs ($M)	10.20	8.99	4.01	5.03	5.72	6.65	7.43	8.19	8.99	9.89	11.80	12.31	14.51	16.80	22.10

2. Probability Distribution





3. Economic Indicators

	IRR (%)	NPV ($Mil)	FYRR (%)
Worse Case Scenario[a]	10.00	-11.28	11.75
Possible Risky Scenario[b]	11.50	-2.76	12.96
Likely / Expected Scenario[c]	18.1	26.89	18.74

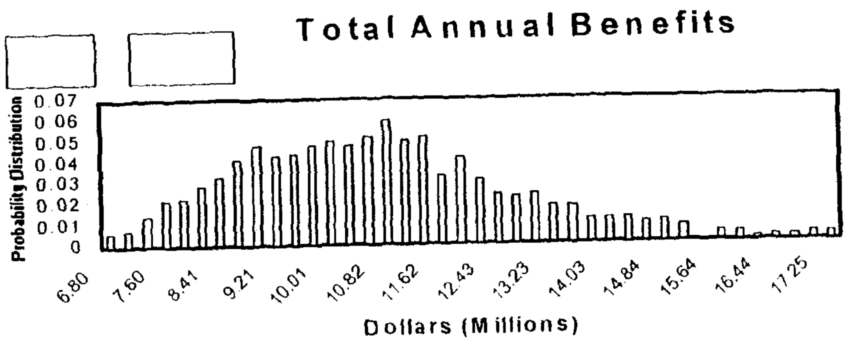
	Probability of Exceed for various scenarios a, b, c: Ann. Benefits	Ann. Costs
a	80 %	20 %
b	70 %	30 %
c	50 %	50 %

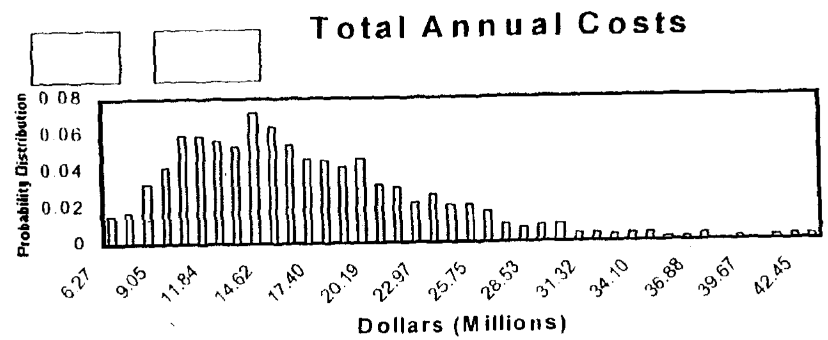
Table 9-15: Risk Analysis: Case 3 – Grade Separation Group I + II + III
(2005 – As Representative Year)

1. Risk Analysis Output

	Mean	Median	1st	5th	10th	20th	30th	40th	50th	60th	70th	80th	90th	95th	99th
			Percentiles												
Total Annual Benefits ($M)	10.99	10.62	6.85	7.74	8.28	8.98	9.57	10.11	10.62	11.07	11.64	12.38	13.62	14.76	17.21
Total Annual Costs ($M)	17.90	15.306	6.24	7.97	9.24	10.92	12.94	13.97	15.31	17.06	19.09	21.67	25.79	30.64	42.41

2. Probability Distribution





3. Economic Indicators

	IRR (%)	NPV ($Mil)	FYRR (%)
Worse Case Scenario[a]	1.08	-94.79	5.54
Possible Risky Scenario[b]	2.99	-71.11	6.71
Likely / Expected Scenario[c]	6.81	-35.03	9.28

	Probability of Exceed for various scenarios a, b, c	
	Ann. Benefits	Ann. Costs
a	80 %	20 %
b	70 %	30 %
c	50 %	50 %

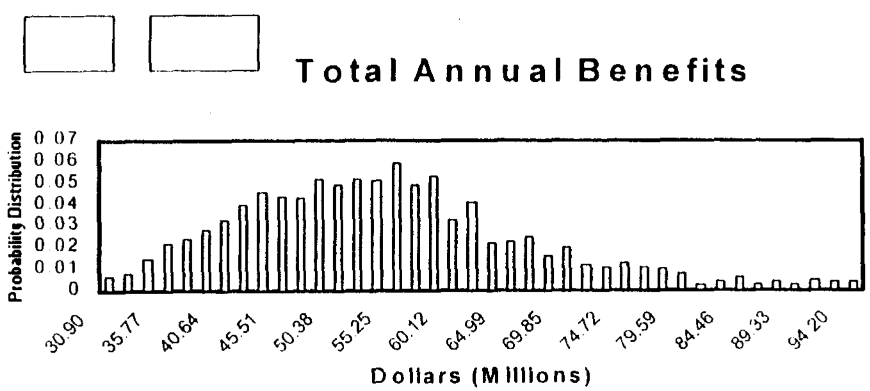
Table 9-16: Risk Analysis: Case 4-Combined Case-All Improvements

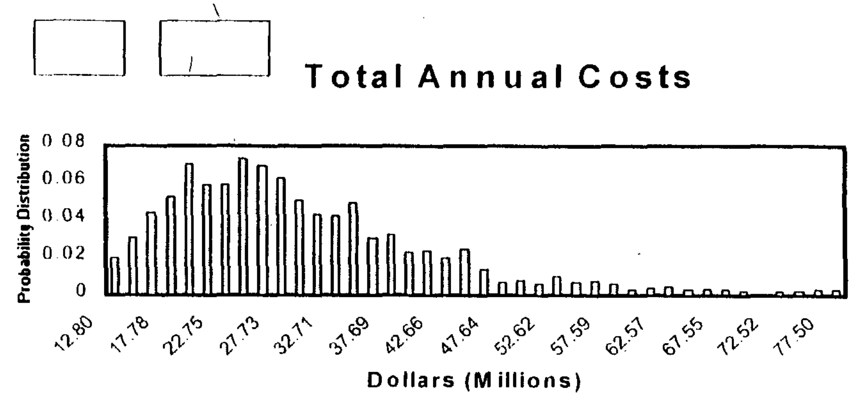
(2005 – As Representative Year)

1. Risk Analysis Output

	Mean	Median	Percentiles 1st	5th	10 th	20 th	30 th	40 th	50 th	60 th	70 th	80 th	90 th	95 th	99 th
Total Annual Benefits ($M)	56.24	54.0	30.98	36.42	39.69	44.02	47.62	50.80	54.00	56.73	60.18	64.79	72.38	79.38	94.18
Total Annual Costs ($M)	32.58	27.57	12.76	15.56	17.51	20.21	22.96	25.34	27.57	30.49	34.06	38.48	45.71	55.43	77.48

2. Probability Distribution





3. Economic Indicators

	IRR (%)	NPV ($Mil)	FYRR (%)
Worse Case Scenario[a]	14.3	41.38	15.31
Possible Risky Scenario[b]	18.1	101.29	18.71
Likely / Expected Scenario[c]	26.0	197.43	26.22

	Probability of Exceed for various scenarios a, b, c	
	Ann. Benefits	Ann. Costs
a	80 %	20 %
b	70 %	30 %
c	50 %	50 %

10. CONCLUSIONS

In the early 1990's, after 15 years of disorder, the major infrastructure systems in Lebanon in general, and in the Greater Beirut Area in particular, were in need for rehabilitation as they were hardly capable of handling the demand placed on them.

During the conflict years, there were important demographic changes and a redistribution of population and employment. There was also an increase in the reliance on the private car, in the absence of transit. In 1994 more than 90% of all person trips in Greater Beirut were served by the passenger car. Suburban growth of residential and commercial activities increased the average trip length. This combination of increased auto travel and trip length has placed a tremendous burden on the impoverished highway facilities in Greater Beirut Area. Traffic congestion is visible everywhere in the metropolitan area, particularly on the entrances to the city of Beirut from suburban areas and on the major arterial streets within the city. Traffic delays are excessive and travel speeds are for the majority of the day less than ten kilometers per hour.

The Council for Development and Reconstruction launched the construction of a series of new highways and expressways that were planned several decades ago. Concurrently a transport master plan for Greater Beirut was prepared. In the short-term, the plan's recommendations were addressed towards the improvement of the management and operation of existing facilities and a restarting of bus public transport, while medium- and long-term recommendations involved constructing balanced expressway and mass transit systems. The recommended expansion of the highway network included approximately 100 kilometers of expressways, freeways, and major arterials in and around Beirut. They are established to fill the gaps in the existing highway network, to contribute to the system continuity among the network elements, and to create a high-speed network that can move people and goods quickly from their origins to their destinations.

This medium range expansion strategy was expected to be completed by the year 2004. It includes the Northern Highway to Dbayeh and the Périphérique around Beirut. This expansion master plan is included in the Base Case scenario of the developed economic analysis methodology as documented in this report. The Base Case scenario varies from one year to another as these highway projects get built till the year 2009, when the full network is expected to become complete.

The change of government which occurred in Lebanon around the end of 1998 brought with it changes in the implementation schedule of the expressway projects. Projects that were expected to be completed by 2004, may not be realized before 2009, and those that were expected to be ready by 2009 may not be in service till beyond 2015. The robustness of the economic analysis under the changing implementation schedule was investigated.

On the other hand, no concrete steps were taken till now to start implementing the mass transit network proposed by the Greater Beirut Transportation Plan. It includes a regional rail line between Jounieh and Damour, two rail mass transit lines, and bus routes on their own right-of-way. Towards the end of 1999, the Ministry of Transport received a USTDA grant towards a feasibility study of a suburban mass transit corridor from Jounieh to Jiyeh. This feasibility study is expected to commence during the first quarter of the year 2000 and be completed during the fourth quarter of the same year.

The short-range strategy of improving the operation and management of existing facilities is very much needed to support the major road construction strategy. It also provides immediate results in relieving traffic congestion with low cost implications. These short-range improvement programs. which include the development of traffic control and management for the city of Beirut, the establishment of parking controls. and the construction of grade separations at major intersections are the focus of the BUTP.

The investments in these three improvement programs are mainly evaluated for their contribution to the direct benefits to the users. that is in terms of travel times and travel costs. Other direct user benefits. such as reduction in accidents. are expected to happen when traffic control and management are improved. But they are not assessed in this study because of lack of data on accident rates and accident costs in Lebanon. Indirect benefits to users and nonusers. such as reduction in emissions. are assessed in this study but are treated in more detail in the Environmental Impact Assessment Report. Each of the improvement programs resulted in the reduction of carbon monoxide and hydrocarbon. but produced a slight increase in particulate matters and in nitrogen oxide. These benefits or disbenefits were not monetized. because there is no data in Lebanon on the cost of reduction or increase in pollution. Besides. the percentages of these reductions on the total metropolitan network level are very small in most of the improvement cases and for all the analysis years such that their relative impacts on the worthiness of these investments are negligible. This is so because some of the components of the improvements proposed by the BUTP. the grade separations for example. are localised and so are their positive benefits regarding reduction of emissions. These benefits when taken at the total network level appear. proportionately. only marginal.

The impacts of the proposed investments on local businesses were not also assessed in this report. These investments are not expected to impact in any measurable way the overall business volume. While one might expect some small negative impacts on businesses in the immediate vicinity of some grade separations (fully investigated in the Social Impact Report). any reduction in sales in one area will be translated to an increase in another. within the metropolitan area. While the general overall reduction in congestion will improve the business climate and boost the image of the entire metropolitan area.

In the modeling effort which accompanied the preparation for the BUTP study. the travel demand forecasts of the Greater Beirut Transportation Plan produced in 1994. were adjusted to reflect the emerging growth trends. The rate of growth of the economy that was prevailing in 1994 and expected to continue was not sustained beyond 1996. The forecasts were adjusted to reflect the new trends. and thus are in a way conservative. should the economic and regional conditions witness significant improvements in the coming few years.

The impacts of the three improvement programs on the travel times and the travel costs of users are analyzed and assessed in this report. The users are divided into three market sectors: auto. bus and truck. The improvement programs are divided into seven separate cases:

Case 1 - Traffic Control and Management
Case 2a - Parking Controls
Case 2b - Parking structures
Case 3a - Grade Separations (Group I)
Case 3b - Grade Separations (Group I + Group II)
Case 3c - Grade Separations (Group III + Group II + Group I)
Case 4 - All Improvement Programs.

The results of the economic analysis show that the three proposed programs. representing the seven cases. are economically viable and produced good economic indicators in terms of Net Present Value (NPV). Internal rate of Return (IRR). and First Year Rate of Return (FYRR). except for the Parking Structures improvement case (Case 2b). The results of the Parking

Structures Case are expected since the initial capital costs are high and the economic benefits accrued to the users are low. However, this case could also show acceptable return on investment if analyzed from a financial point of view rather from a strict economic point of view, that is if the parking fees are considered in the stream of benefits to the provider.

The robustness of the results were checked with respect to changes in the following traffic forecasting parameters:

- the Périphérique and Northern Entrances will not be developed as toll roads.
- the construction schedule of the committed and planned highway projects, not included in the BUTP would sustain considerable delays.
- a stagnation of the national economy which would make the traffic forecasts over-estimated; and
- what improvement in public transport services would make the BUTP proposed investments superfluous?

The robustness checks support the viability of all the project components, parking structures excluded. It was also demonstrated that the grade separations combined, are a viable investment at the network level; and that the marginal investment in any one grade separation is also a viable investment on the network level.

Risk analysis is conducted on the seven cases for all possible combined sets of risky events, including 50% increase to 30% decrease in value of travel time per market sector, capital and operating costs, fuel consumption rates, fuel prices, and discount rate. The results show that under the combined changing conditions of these key variables, and for all possible scenarios (worse case, probable risky, and expected/ likely), the Parking Control Case, the Traffic Management Case, and All Improvements Case proved to be economically viable. The Grade Separation Cases are economically viable under all scenarios except for the worse case scenario, which is in all likelihood a rare event. Therefore, all these improvement cases except for the Parking Structures Case demonstrate sizeable stream of benefits that exceed costs under all possible risky scenarios.

In conclusion, the Consultant recommends to the Government of Lebanon that the proposed improvement programs be adopted and implemented with the following priorities:

First: The regulation of on-street parking, especially in business areas, should be given the highest priority as its implementation can start immediately, the required investments are modest, and the positive impacts are substantial.

Second: The traffic management schemes, including signal control, the traffic control, and ancillary investments should also be given high priority, due to their high benefits.

Third: The grade separation component should also be given priority. The junctions candidate for grade separation are not amenable to improvement via the traffic management component of BUTP only.

Fourth: Having given the highest priority to on-street parking regulation, the financial viability of off-street parking will become apparent to private investors. Public investment in off-street parking garages should not be a priority, except in specific cases, such as the provision of park-and-ride facilities as a component of a mass-transit investment.

ANNEXES

ANNEX
TO
CHAPTER 3

SAMPLE

STEAM INPUT DATA
FOR TRAFFIC MANAGEMENT – CASE 1
FOR VARIOUS
ANALYSIS YEARS

SCENARIO 2001 INPUT DATA (CASE 1)

SCENARIO ASSUMPTIONS

VALUE OF TIME	AUTO	TRUCK	CPOOL	L-BUS	X-BUS	L-RAIL	H-RAIL	OTHER
In-Vehicle ($/hr.)	3.85	3.61	0.00	2.57	0.00	0.00	0.00	0.00
Out-of-Vehicle ($/hr.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

FUEL COSTS	AUTO	TRUCK
Dollars Per Gallon	0.57	0.61

Include Fuel Cost in User Benefits TRUE

NON FUEL COSTS	AUTO	TRUCK
Dollars Per Gallon	0.164	0.802

Include Non-Fuel Op. Cost in User Benefits TRUE

FUEL CONSUMPTION RATES (g/mile)	AUTO	TRUCK	LOC.BUS	EX.BUS	L.RAIL (KWhr/Vehicle Mile)	H.RAIL
5 MPH	0.149	0.425	-	-	-	-
10 MPH	0.081	0.300	-	-	-	-
15 MPH	0.061	0.270	-	-	-	-
20 MPH	0.051	0.263	-	-	-	-
25 MPH	0.046	0.259	-	-	-	-
30 MPH	0.043	0.263	-	-	-	-
35 MPH	0.041	0.273	-	-	-	-
40 MPH	0.043	0.287	-	-	-	-
45 MPH	0.045	0.293	-	-	-	-
50 MPH	0.046	0.298	-	-	-	-
55 MPH	0.050	0.300	-	-	-	-
60 MPH	0.052	0.303	-	-	-	-
65 MPH	0.054	0.310	-	-	-	-
Average	-	-	0.305	0.000	0.000	0.000

HC EMISSION RATES (gr./mile)	AUTO	TRUCK	BUS	RAIL
5 MPH	5.099	12.000	-	-
10 MPH	3.299	9.420	-	-
15 MPH	2.700	7.559	-	-
20 MPH	2.400	6.210	-	-
25 MPH	2.099	5.190	-	-
30 MPH	1.860	4.469	-	-
35 MPH	1.710	3.900	-	-
40 MPH	1.590	3.509	-	-
45 MPH	1.470	3.210	-	-
50 MPH	1.440	2.890	-	-
55 MPH	1.440	2.819	-	-
60 MPH	1.529	2.819	-	-
65 MPH	1.649	2.819	-	-
Average	-	-	7.559	0.000

CO EMISSION RATES (gr./mile)	AUTO	TRUCK	BUS	RAIL
5 MPH	61.409	43.740	-	-
10 MPH	37.250	30.160	-	-
15 MPH	29.140	21.760	-	-
20 MPH	24.660	16.440	-	-
25 MPH	18.810	12.990	-	-
30 MPH	14.910	10.740	-	-
35 MPH	14.500	9.300	-	-
40 MPH	12.030	8.430	-	-
45 MPH	10.080	7.990	-	-
50 MPH	9.100	7.930	-	-
55 MPH	9.100	8.230	-	-
60 MPH	11.080	8.950	-	-
65 MPH	14.560	10.180	-	-
Average	-	-	21.760	0.000

NO EMISSION RATES (gr./mile)	AUTO	TRUCK	BUS	RAIL
5 MPH	2.240	21.600	-	-
10 MPH	2.000	17.920	-	-
15 MPH	1.920	15.400	-	-
20 MPH	1.880	13.720	-	-
25 MPH	1.940	12.660	-	-
30 MPH	1.960	12.100	-	-
35 MPH	1.980	12.000	-	-
40 MPH	2.000	12.320	-	-
45 MPH	2.020	13.100	-	-
50 MPH	2.140	14.440	-	-
55 MPH	2.440	16.480	-	-
60 MPH	2.720	19.500	-	-
65 MPH	3.020	23.920	-	-
Average	-	-	15.400	0.000

PM10 EMISSION RATES (gr./mile)	AUTO	TRUCK	BUS	RAIL
Average	0.068	0.959	0.959	0.000

COST PER TON OF EMISSIONS($/Ton)	HC	CO	NOx	PM10
Average	0.0	0.0	0.0	0.0

EMISSIONS PER COLD START	HC	CO	NOx	PM10
Auto (gr./start)	6.940	91.000	1.720	0.000
Truck (gr./start)	0.000	0.000	0.000	0.000

COLD STARTS PER VEHICLE TRIP	STARTS
Auto (starts/trip)	0.40
Truck (starts/trip)	0.00

GREENHOUSE GAS EMIS. RATES	TONS/M.BTU
Auto (CO2 tons/mill.BTU)	0.07900
Truck (CO2 tons/mill.BTU)	0.07900
Bus (CO2 tons/mill.BTU)	0.07900
Rail (CO2 tons/mill.BTU)	0.00000

GREENHOUSE GAS EMIS. COSTS	$/Ton
CO2 Emissions	0.00

COST PER ACCIDENT ($/accident)	FATAL	INJURY	PDO
Internal Accident Cost	0	0	0
External Accident Cost	0	0	0

FATALITY RATES (fat/100 mil.VMT)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.00	0.00	-	-
2nd Highway Class	0.00	0.00	-	-
3rd Highway Class	0.00	0.00	-	-
4th Highway Class	0.00	0.00	-	-
5th Highway Class	0.00	0.00	-	-
6th Highway Class	0.00	0.00	-	-
Average	-	-	0.000	0.000

INJURY RATES (inj/100 mil.VMT)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.00	0.00	-	-
2nd Highway Class	0.00	0.00	-	-
3rd Highway Class	0.00	0.00	-	-
4th Highway Class	0.00	0.00	-	-
5th Highway Class	0.00	0.00	-	-
6th Highway Class	0.00	0.00	-	-
Average	-	-	0.000	0.000

PDO CRASH RATES (pdo/100 mil.VMT)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.00	0.00	-	-
2nd Highway Class	0.00	0.00	-	-

	AUTO	TRUCK	BUS	RAIL
3rd Highway Class	0.00	0.00	-	-
4th Highway Class	0.00	0.00	-	-
5th Highway Class	0.00	0.00	-	-
6th Highway Class	0.00	0.00	-	-
Average	-	-	0.000	0.000

NOISE COSTS ($/mile)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.000	0.000	-	-
2nd Highway Class	0.000	0.000	-	-
3rd Highway Class	0.000	0.000	-	-
4th Highway Class	0.000	0.000	-	-
5th Highway Class	0.000	0.000	-	-
6th Highway Class	0.000	0.000	-	-
Average	-	-	0.000	0.000

OTHER MILEAGE EXT.COST ($/mile)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.000	0.000	-	-
2nd Highway Class	0.000	0.000	-	-
3rd Highway Class	0.000	0.000	-	-
4th Highway Class	0.000	0.000	-	-
5th Highway Class	0.000	0.000	-	-
6th Highway Class	0.000	0.000	-	-
Average	-	-	0.000	0.000

NON-MILEAGE EXTERNAL COSTS	AUTO	TRUCK	CPOOL	L-BUS	X-BUS	L-RAIL	H-RAIL	OTHER
Total ($)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TRANSIT AGENCY UNIT COSTS	L.BUS	EX.BUS	L.RAIL	H.RAIL
$/Vehicle Mile	0.000	0.000	0.000	0.000
$/Vehicle Hour	0.000	0.000	0.000	0.000
$/Peak Vehicle	0.000	0.000	0.000	0.000

TRANSIT DEMAND	L.BUS	EX.BUS	L.RAIL	H.RAIL
Vehicle Miles (1,000)	0.00	0.00	0.00	0.00
Vehicle Hours (1,000)	0.00	0.00	0.00	0.00
Peak Vehicles (1,000)	0.00	0.00	0.00	0.00

DISCOUNT RATE	VALUE
Discount Rate	0.1190

INVESTMENT COSTS	1ST	2ND	3RD	4TH	5TH	TOTAL
Capital Costs (1,000$)	22905	0	0	0	0	22905
Mid Point Construction	2000	0	0	0	0	-
Year Opening	2000	0	0	0	0	-
Useful Life	20	0	0	0	0	-
Salvage Value (1,000$)	2545	0	0	0	0	-
Ext. Const. Cost (1,000$)	0	0	0	0	0	-
Other Operating and Maintenance Costs (1,000$)						2089

SCENARIO 2002 INPUT DATA (CASE 1)

SCENARIO ASSUMPTIONS

VALUE OF TIME	AUTO	TRUCK	CPOOL	L-BUS	X-BUS	L-RAIL	H-RAIL	OTHER
In-Vehicle ($/hr.)	3.77	3.53	0.00	2.52	0.00	0.00	0.00	0.00
Out-of-Vehicle ($/hr.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

FUEL COSTS	AUTO	TRUCK
Dollars Per Gallon	0.57	0.61

Include Fuel Cost in User Benefits TRUE

NON FUEL COSTS	AUTO	TRUCK
Dollars Per Gallon	0.164	0.801

Include Non-Fuel Op. Cost in User Benefits TRUE

FUEL CONSUMPTION RATES(g/mile)	AUTO	TRUCK	LOC.BUS	EX.BUS	L.RAIL (KWhr/Vehicle Mile)	H.RAIL
5 MPH	0.149	0.425	-	-	-	-
10 MPH	0.081	0.300	-	-	-	-
15 MPH	0.061	0.270	-	-	-	-
20 MPH	0.052	0.263	-	-	-	-
25 MPH	0.046	0.259	-	-	-	-
30 MPH	0.043	0.263	-	-	-	-
35 MPH	0.041	0.273	-	-	-	-
40 MPH	0.043	0.297	-	-	-	-
45 MPH	0.045	0.293	-	-	-	-
50 MPH	0.046	0.298	-	-	-	-
55 MPH	0.050	0.300	-	-	-	-
60 MPH	0.052	0.303	-	-	-	-
65 MPH	0.054	0.310	-	-	-	-
Average	-	-	0.305	0.000	0.000	0.000

HC EMISSION RATES (gr./mile)	AUTO	TRUCK	BUS	RAIL
5 MPH	5.098	12.000	-	-
10 MPH	3.299	9.420	-	-
15 MPH	2.700	7.559	-	-
20 MPH	2.400	6.210	-	-
25 MPH	2.098	5.190	-	-
30 MPH	1.860	4.467	-	-
35 MPH	1.710	3.900	-	-
40 MPH	1.590	3.509	-	-
45 MPH	1.470	3.210	-	-
50 MPH	1.440	2.890	-	-
55 MPH	1.440	2.819	-	-
60 MPH	1.529	2.819	-	-
65 MPH	1.649	2.819	-	-
Average	-	-	7.559	0.000

CO EMISSION RATES (gr./mile)	AUTO	TRUCK	BUS	RAIL
5 MPH	61.409	43.740	-	-
10 MPH	37.250	30.159	-	-
15 MPH	29.138	21.760	-	-
20 MPH	24.659	16.440	-	-
25 MPH	18.809	12.989	-	-
30 MPH	14.909	10.739	-	-
35 MPH	14.500	9.300	-	-
40 MPH	12.029	8.430	-	-
45 MPH	10.079	7.988	-	-
50 MPH	9.100	7.929	-	-
55 MPH	9.100	8.229	-	-
60 MPH	11.079	8.949	-	-
65 MPH	14.560	10.180	-	-
Average	-	-	21.760	0.000

CO EMISSION RATES (gr./mile)	AUTO	TRUCK	BUS	RAIL
5 MPH	2.240	21.600	-	-
10 MPH	2.000	17.920	-	-
15 MPH	1.919	15.399	-	-
20 MPH	1.878	13.720	-	-
25 MPH	1.940	12.659	-	-
30 MPH	1.960	12.100	-	-
35 MPH	1.980	12.000	-	-
40 MPH	2.000	12.319	-	-
45 MPH	2.019	13.100	-	-
50 MPH	2.140	14.439	-	-
55 MPH	2.440	16.479	-	-
60 MPH	2.720	19.500	-	-
65 MPH	3.019	23.920	-	-
Average	-	-	15.400	0.000

PM10 EMISSION RATES (gr./mile)	AUTO	TRUCK	BUS	RAIL
Average	0.068	0.959	0.958	0.000

COST PER TON OF EMISSIONS($/Ton)	HC	CO	NOx	PM10
Average	0.0	0.0	0.0	0.0

EMISSIONS PER COLD START	HC	CO	NOx	PM10
Auto (gr./start)	6.940	91.000	1.720	0.000
Truck (gr./start)	0.000	0.000	0.000	0.000

COLD STARTS PER VEHICLE TRIP	STARTS
Auto (starts/trip)	0.40
Truck (starts/trip)	0.00

GREENHOUSE GAS EMIS. RATES	TONS/M.BTU
Auto (CO2 tons/mill.BTU)	0.07900
Truck (CO2 tons/mill.BTU)	0.07900
Bus (CO2 tons/mill.BTU)	0.07900
Rail (CO2 tons/mill.BTU)	0.00000

GREENHOUSE GAS EMIS. COSTS	$/Ton
CO2 Emissions	0.00

COST PER ACCIDENT ($/accident)	FATAL	INJURY	PDO
Internal Accident Cost	0	0	0
External Accident Cost	0	0	0

FATALITY RATES (fat/100 mil.VMT)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.00	0.00	-	-
2nd Highway Class	0.00	0.00	-	-
3rd Highway Class	0.00	0.00	-	-
4th Highway Class	0.00	0.00	-	-
5th Highway Class	0.00	0.00	-	-
6th Highway Class	0.00	0.00	-	-
Average	-	-	0.000	0.000

INJURY RATES (inj/100 mil.VMT)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.00	0.00	-	-
2nd Highway Class	0.00	0.00	-	-
3rd Highway Class	0.00	0.00	-	-
4th Highway Class	0.00	0.00	-	-
5th Highway Class	0.00	0.00	-	-
6th Highway Class	0.00	0.00	-	-
Average	-	-	0.000	0.000

PDO CRASH RATES (pdo/100 mil.VMT)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.00	0.00	-	-

2nd Highway Class	0.00	0.00	-	-
3rd Highway Class	0.00	0.00	-	-
4th Highway Class	0.00	0.00	-	-
5th Highway Class	0.00	0.00	-	-
6th Highway Class	0.00	0.00	-	-
Average	-	-	0.000	0.000

NOISE COSTS ($/mile)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.000	0.000	-	-
2nd Highway Class	0.000	0.000	-	-
3rd Highway Class	0.000	0.000	-	-
4th Highway Class	0.000	0.000	-	-
5th Highway Class	0.000	0.000	-	-
6th Highway Class	0.000	0.000	-	-
Average	-	-	0.000	0.000

OTHER MILEAGE EXT.COST ($/mile)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.000	0.000	-	-
2nd Highway Class	0.000	0.000	-	-
3rd Highway Class	0.000	0.000	-	-
4th Highway Class	0.000	0.000	-	-
5th Highway Class	0.000	0.000	-	-
6th Highway Class	0.000	0.000	-	-
Average	-	-	0.000	0.000

NON-MILEAGE EXTERNAL COSTS	AUTO	TRUCK	CPOOL	L-BUS	X-BUS	L-RAIL	H-RAIL	OTHER
Total ($)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TRANSIT AGENCY UNIT COSTS	L.BUS	EX.BUS	L.RAIL	H.RAIL
$/Vehicle Mile	0.000	0.000	0.000	0.000
$/Vehicle Hour	0.000	0.000	0.000	0.000
$/Peak Vehicle	0.000	0.000	0.000	0.000

TRANSIT DEMAND	L.BUS	EX.BUS	L.RAIL	H.RAIL
Vehicle Miles (1,000)	0.00	0.00	0.00	0.00
Vehicle Hours (1,000)	0.00	0.00	0.00	0.00
Peak Vehicles (1,000)	0.00	0.00	0.00	0.00

DISCOUNT RATE	VALUE
Discount Rate	0.1190

INVESTMENT COSTS	1ST	2ND	3RD	4TH	5TH	TOTAL
Capital Costs (1,000$)	22905	0	0	0	0	22905
Mid Point Construction	2000	0	0	0	0	-
Year Opening	2000	0	0	0	0	-
Useful Life	20	0	0	0	0	-
Salvage Value (1,000$)	2545	0	0	0	0	-
Ext. Const. Cost (1,000$)	0	0	0	0	0	-
Other Operating and Maintenance Costs (1,000$)						2089

SCENARIO 2003 INPUT DATA (CASE1)

SCENARIO ASSUMPTIONS

VALUE OF TIME	AUTO	TRUCK	CPOOL	L-BUS	X-BUS	L-RAIL	H-RAIL	OTHER
In-Vehicle ($/hr.)	3.85	3.61	0.00	2.57	0.00	0.00	0.00	0.00
Out-of-Vehicle ($/hr.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

FUEL COSTS	AUTO	TRUCK
Dollars Per Gallon	0.57	0.61

Include Fuel Cost in User Benefits TRUE

NON FUEL COSTS	AUTO	TRUCK
Dollars Per Gallon	0.164	0.801

Include Non-Fuel Op. Cost in User Benefits TRUE

FUEL CONSUMPTION RATES(g/mile)	AUTO	TRUCK	LOC.BUS	EX.BUS	L.RAIL (KWhr/Vehicle Mile)	H.RAIL
5 MPH	0.149	0.425	-	-	-	-
10 MPH	0.081	0.300	-	-	-	-
15 MPH	0.061	0.270	-	-	-	-
20 MPH	0.052	0.263	-	-	-	-
25 MPH	0.046	0.259	-	-	-	-
30 MPH	0.043	0.263	-	-	-	-
35 MPH	0.041	0.273	-	-	-	-
40 MPH	0.043	0.287	-	-	-	-
45 MPH	0.045	0.293	-	-	-	-
50 MPH	0.046	0.298	-	-	-	-
55 MPH	0.050	0.300	-	-	-	-
60 MPH	0.052	0.303	-	-	-	-
65 MPH	0.054	0.310	-	-	-	-
Average	-	-	0.305	0.000	0.000	0.000

HC EMISSION RATES (gr./mile)	AUTO	TRUCK	BUS	RAIL
5 MPH	5.098	12.000	-	-
10 MPH	3.299	9.420	-	-
15 MPH	2.700	7.559	-	-
20 MPH	2.400	6.210	-	-
25 MPH	2.098	5.190	-	-
30 MPH	1.860	4.468	-	-
35 MPH	1.710	3.900	-	-
40 MPH	1.590	3.509	-	-
45 MPH	1.470	3.210	-	-
50 MPH	1.440	2.890	-	-
55 MPH	1.440	2.819	-	-
60 MPH	1.529	2.819	-	-
65 MPH	1.649	2.819	-	-
Average	-	-	7.559	0.000

CO EMISSION RATES (gr./mile)	AUTO	TRUCK	BUS	RAIL
5 MPH	61.409	43.740	-	-
10 MPH	37.250	30.159	-	-
15 MPH	29.139	21.760	-	-
20 MPH	24.659	16.440	-	-
25 MPH	18.809	12.989	-	-
30 MPH	14.909	10.739	-	-
35 MPH	14.500	9.300	-	-
40 MPH	12.029	8.430	-	-
45 MPH	10.079	7.989	-	-
50 MPH	9.100	7.929	-	-
55 MPH	9.100	8.229	-	-
60 MPH	11.079	8.949	-	-
65 MPH	14.560	10.180	-	-
Average	-	-	21.760	0.000

NO EMISSION RATES (gr./mile)	AUTO	TRUCK	BUS	RAIL
5 MPH	2.240	21.600	-	-
10 MPH	2.000	17.920	-	-
15 MPH	1.919	15.399	-	-
20 MPH	1.879	13.720	-	-
25 MPH	1.940	12.659	-	-
30 MPH	1.960	12.100	-	-
35 MPH	1.980	12.000	-	-
40 MPH	2.000	12.319	-	-
45 MPH	2.019	13.100	-	-
50 MPH	2.140	14.439	-	-
55 MPH	2.440	16.479	-	-
60 MPH	2.720	19.500	-	-
65 MPH	3.019	23.920	-	-
Average	-	-	15.400	0.000

PM10 EMISSION RATES (gr./mile)	AUTO	TRUCK	BUS	RAIL
Average	0.068	0.958	0.958	0.000

COST PER TON OF EMISSIONS($/Ton)	HC	CO	NOx	PM10
Average	0.0	0.0	0.0	0.0

EMISSIONS PER COLD START	HC	CO	NOx	PM10
Auto (gr./start)	6.940	91.000	1.720	0.000
Truck (gr./start)	0.000	0.000	0.000	0.000

COLD STARTS PER VEHICLE TRIP	STARTS
Auto (starts/trip)	0.40
Truck (starts/trip)	0.00

GREENHOUSE GAS EMIS. RATES	TONS/M.BTU
Auto (CO2 tons/mill.BTU)	0.07800
Truck (CO2 tons/mill.BTU)	0.07900
Bus (CO2 tons/mill.BTU)	0.07900
Rail (CO2 tons/mill.BTU)	0.00000

GREENHOUSE GAS EMIS. COSTS	$/Ton
CO2 Emissions	0.00

COST PER ACCIDENT ($/accident)	FATAL	INJURY	PDO
Internal Accident Cost	0	0	0
External Accident Cost	0	0	0

FATALITY RATES (fat/100 mil.VMT)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.00	0.00	-	-
2nd Highway Class	0.00	0.00	-	-
3rd Highway Class	0.00	0.00	-	-
4th Highway Class	0.00	0.00	-	-
5th Highway Class	0.00	0.00	-	-
6th Highway Class	0.00	0.00	-	-
Average	-	-	0.000	0.000

INJURY RATES (inj/100 mil.VMT)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.00	0.00	-	-
2nd Highway Class	0.00	0.00	-	-
3rd Highway Class	0.00	0.00	-	-
4th Highway Class	0.00	0.00	-	-
5th Highway Class	0.00	0.00	-	-
6th Highway Class	0.00	0.00	-	-
Average	-	-	0.000	0.000

PDO CRASH RATES (pdo/100 mil.VMT)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.00	0.00	-	-

2nd Highway Class	0.00	0.00	-	-
3rd Highway Class	0.00	0.00	-	-
4th Highway Class	0.00	0.00	-	-
5th Highway Class	0.00	0.00	-	-
6th Highway Class	0.00	0.00	-	-
Average	-	-	0.000	0.000

NOISE COSTS ($/mile)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.000	0.000	-	-
2nd Highway Class	0.000	0.000	-	-
3rd Highway Class	0.000	0.000	-	-
4th Highway Class	0.000	0.000	-	-
5th Highway Class	0.000	0.000	-	-
6th Highway Class	0.000	0.000	-	-
Average	-	-	0.000	0.000

OTHER MILEAGE EXT.COST ($/mile)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.000	0.000	-	-
2nd Highway Class	0.000	0.000	-	-
3rd Highway Class	0.000	0.000	-	-
4th Highway Class	0.000	0.000	-	-
5th Highway Class	0.000	0.000	-	-
6th Highway Class	0.000	0.000	-	-
Average	-	-	0.000	0.000

NON-MILEAGE EXTERNAL COSTS OTHER	AUTO	TRUCK	CPOOL	L-BUS	X-BUS	L-RAIL	H-RAIL
Total ($)	0.0	0.0	0.0	0.0	0.0	0.0	0.0

0.0

TRANSIT AGENCY UNIT COSTS	L.BUS	EX.BUS	L.RAIL	H.RAIL
$/Vehicle Mile	0.000	0.000	0.000	0.000
$/Vehicle Hour	0.000	0.000	0.000	0.000
$/Peak Vehicle	0.000	0.000	0.000	0.000

TRANSIT DEMAND	L.BUS	EX.BUS	L.RAIL	H.RAIL
Vehicle Miles (1,000)	0.00	0.00	0.00	0.00
Vehicle Hours (1,000)	0.00	0.00	0.00	0.00
Peak Vehicles (1,000)	0.00	0.00	0.00	0.00

DISCOUNT RATE	VALUE
Discount Rate	0.1190

INVESTMENT COSTS	1ST	2ND	3RD	4TH	5TH	TOTAL
Capital Costs (1,000$)	22905	0	0	0	0	22905
Mid Point Construction	2000	0	0	0	0	-
Year Opening	2000	0	0	0	0	-
Useful Life	20	0	0	0	0	-
Salvage Value (1,000$)	2545	0	0	0	0	-
Ext. Const. Cost (1,000$)	0	0	0	0	0	-
Other Operating and Maintenance Costs (1,000$)						2089

SCENARIO 2005 INPUT DATA (CASE 1)

SCENARIO ASSUMPTIONS

VALUE OF TIME	AUTO	TRUCK	CPOOL	L-BUS	X-BUS	L-RAIL	H-RAIL	OTHER
In-Vehicle ($/hr.)	4.00	3.74	0.00	2.67	0.00	0.00	0.00	0.00
Out-of-Vehicle ($/hr.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

FUEL COSTS	AUTO	TRUCK	
Dollars Per Gallon	0.57	0.60	
Include Fuel Cost in User Benefits			TRUE

NON FUEL COSTS	AUTO	TRUCK	
Dollars Per Gallon	0.164	0.801	
Include Non-Fuel Op. Cost in User Benefits			TRUE

FUEL CONSUMPTION RATES(g/mile)	AUTO	TRUCK	LOC.BUS	EX.BUS	L.RAIL (KWhr/Vehicle Mile)	H.RAIL (KWhr/Vehicle Mile)
5 MPH	0.135	0.425	-	-	-	-
10 MPH	0.071	0.300	-	-	-	-
15 MPH	0.054	0.270	-	-	-	-
20 MPH	0.048	0.263	-	-	-	-
25 MPH	0.041	0.259	-	-	-	-
30 MPH	0.037	0.263	-	-	-	-
35 MPH	0.037	0.273	-	-	-	-
40 MPH	0.039	0.287	-	-	-	-
45 MPH	0.041	0.293	-	-	-	-
50 MPH	0.041	0.298	-	-	-	-
55 MPH	0.045	0.300	-	-	-	-
60 MPH	0.046	0.303	-	-	-	-
65 MPH	0.048	0.310	-	-	-	-
Average	-	-	0.305	0.000	0.000	0.000

HC EMISSION RATES (gr./mile)	AUTO	TRUCK	BUS	RAIL
5 MPH	4.590	10.800	-	-
10 MPH	2.970	8.479	-	-
15 MPH	2.430	6.800	-	-
20 MPH	2.160	5.590	-	-
25 MPH	1.839	4.670	-	-
30 MPH	1.669	4.019	-	-
35 MPH	1.508	3.509	-	-
40 MPH	1.429	3.160	-	-
45 MPH	1.320	2.890	-	-
50 MPH	1.289	2.700	-	-
55 MPH	1.289	2.598	-	-
60 MPH	1.378	2.539	-	-
65 MPH	1.480	2.539	-	-
Average	-	-	6.800	0.000

CO EMISSION RATES (gr./mile)	AUTO	TRUCK	BUS	RAIL
5 MPH	55.298	39.368	-	-
10 MPH	33.528	27.138	-	-
15 MPH	26.229	19.579	-	-
20 MPH	22.190	14.800	-	-
25 MPH	16.930	11.699	-	-
30 MPH	13.420	9.670	-	-
35 MPH	13.050	8.369	-	-
40 MPH	10.829	7.590	-	-
45 MPH	9.069	7.190	-	-
50 MPH	8.189	7.138	-	-
55 MPH	8.189	7.408	-	-

	AUTO	TRUCK	BUS	RAIL
60 MPH	9.970	8.060	-	-
65 MPH	13.100	9.159	-	-
Average	-	-	19.580	0.000

NO EMISSION RATES (gr./mile)	AUTO	TRUCK	BUS	RAIL
5 MPH	2.019	19.440	-	-
10 MPH	1.799	16.128	-	-
15 MPH	1.730	13.959	-	-
20 MPH	1.690	12.350	-	-
25 MPH	1.750	11.390	-	-
30 MPH	1.758	10.990	-	-
35 MPH	1.779	10.800	-	-
40 MPH	1.799	11.090	-	-
45 MPH	1.820	11.788	-	-
50 MPH	1.929	13.000	-	-
55 MPH	2.200	14.630	-	-
60 MPH	2.450	17.548	-	-
65 MPH	2.720	21.530	-	-
Average	-	-	13.860	0.000

PM10 EMISSION RATES (gr./mile)	AUTO	TRUCK	BUS	RAIL
Average	0.061	0.864	0.864	0.000

COST PER TON OF EMISSIONS($/Ton)	HC	CO	NOx	PM10
Average	0.0	0.0	0.0	0.0

EMISSIONS PER COLD START	HC	CO	NOx	PM10
Auto (gr./start)	6.237	81.900	1.549	0.000
Truck (gr./start)	0.000	0.000	0.000	0.000

COLD STARTS PER VEHICLE TRIP	STARTS
Auto (starts/trip)	0.40
Truck (starts/trip)	0.00

GREENHOUSE GAS EMIS. RATES	TONS/M.BTU
Auto (CO2 tons/mill.BTU)	0.07800
Truck (CO2 tons/mill.BTU)	0.07900
Bus (CO2 tons/mill.BTU)	0.07900
Rail (CO2 tons/mill.BTU)	0.00000

GREENHOUSE GAS EMIS. COSTS	$/Ton
CO2 Emissions	0.00

COST PER ACCIDENT ($/accident)	FATAL	INJURY	PDO
Internal Accident Cost	0	0	0
External Accident Cost	0	0	0

FATALITY RATES (fat/100 mil.VMT)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.00	0.00	-	-
2nd Highway Class	0.00	0.00	-	-
3rd Highway Class	0.00	0.00	-	-
4th Highway Class	0.00	0.00	-	-
5th Highway Class	0.00	0.00	-	-
6th Highway Class	0.00	0.00	-	-
Average	-	-	0.000	0.000

INJURY RATES (inj/100 mil.VMT)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.00	0.00	-	-
2nd Highway Class	0.00	0.00	-	-
3rd Highway Class	0.00	0.00	-	-
4th Highway Class	0.00	0.00	-	-
5th Highway Class	0.00	0.00	-	-
6th Highway Class	0.00	0.00	-	-
Average	-	-	0.000	0.000

PDO CRASH RATES (pdo/100 mil.VMT)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.00	0.00	-	-
2nd Highway Class	0.00	0.00	-	-
3rd Highway Class	0.00	0.00	-	-
4th Highway Class	0.00	0.00	-	-
5th Highway Class	0.00	0.00	-	-
6th Highway Class	0.00	0.00	-	-
Average	-	-	0.000	0.000

NOISE COSTS ($/mile)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.000	0.000	-	-
2nd Highway Class	0.000	0.000	-	-
3rd Highway Class	0.000	0.000	-	-
4th Highway Class	0.000	0.000	-	-
5th Highway Class	0.000	0.000	-	-
6th Highway Class	0.000	0.000	-	-
Average	-	-	0.000	0.000

OTHER MILEAGE EXT.COST ($/mile)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.000	0.000	-	-
2nd Highway Class	0.000	0.000	-	-
3rd Highway Class	0.000	0.000	-	-
4th Highway Class	0.000	0.000	-	-
5th Highway Class	0.000	0.000	-	-
6th Highway Class	0.000	0.000	-	-
Average	-	-	0.000	0.000

NON-MILEAGE EXTERNAL COSTS	AUTO	TRUCK	CPOOL	L-BUS	X-BUS	L-RAIL	H-RAIL	OTHER
Total ($)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TRANSIT AGENCY UNIT COSTS	L.BUS	EX.BUS	L.RAIL	H.RAIL
$/Vehicle Mile	0.000	0.000	0.000	0.000
$/Vehicle Hour	0.000	0.000	0.000	0.000
$/Peak Vehicle	0.000	0.000	0.000	0.000

TRANSIT DEMAND	L.BUS	EX.BUS	L.RAIL	H.RAIL
Vehicle Miles (1,000)	0.00	0.00	0.00	0.00
Vehicle Hours (1,000)	0.00	0.00	0.00	0.00
Peak Vehicles (1,000)	0.00	0.00	0.00	0.00

DISCOUNT RATE	VALUE
Discount Rate	0.1190

INVESTMENT COSTS	1ST	2ND	3RD	4TH	5TH	TOTAL
Capital Costs (1,000$)	22905	0	0	0	0	22905
Mid Point Construction	2000	0	0	0	0	-
Year Opening	2000	0	0	0	0	-
Useful Life	20	0	0	0	0	-
Salvage Value (1,000$)	2545	0	0	0	0	-
Ext. Const. Cost (1,000$)	0	0	0	0	0	-
Other Operating and Maintenance Costs (1,000$)						2089

SCENARIO 2010 INPUT DATA (CASE 1)

SCENARIO ASSUMPTIONS

VALUE OF TIME	AUTO	TRUCK	CPOOL	L-BUS	X-BUS	L-RAIL	H-RAIL	OTHER
In-Vehicle ($/hr.)	4.64	4.34	0.00	3.09	0.00	0.00	0.00	0.00
Out-of-Vehicle ($/hr.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

FUEL COSTS	AUTO	TRUCK
Dollars Per Gallon	0.57	0.60

Include Fuel Cost in User Benefits TRUE

NON FUEL COSTS	AUTO	TRUCK
Dollars Per Gallon	0.164	0.801

Include Non-Fuel Op. Cost in User Benefits TRUE

FUEL CONSUMPTION RATES(g/mile)	AUTO	TRUCK	LOC.BUS	EX.BUS	L.RAIL	H.RAIL
					KWhr/Vehicle Mile	
5 MPH	0.103	0.425	-	-	-	-
10 MPH	0.056	0.300	-	-	-	-
15 MPH	0.043	0.270	-	-	-	-
20 MPH	0.035	0.263	-	-	-	-
25 MPH	0.032	0.259	-	-	-	-
30 MPH	0.029	0.263	-	-	-	-
35 MPH	0.028	0.273	-	-	-	-
40 MPH	0.029	0.297	-	-	-	-
45 MPH	0.028	0.293	-	-	-	-
50 MPH	0.032	0.298	-	-	-	-
55 MPH	0.034	0.300	-	-	-	-
60 MPH	0.035	0.303	-	-	-	-
65 MPH	0.037	0.310	-	-	-	-
Average	-	-	0.305	0.000	0.000	0.000

HC EMISSION RATES (gr./mile)	AUTO	TRUCK	BUS	RAIL
5 MPH	2.549	6.000	-	-
10 MPH	1.649	4.710	-	-
15 MPH	1.350	3.779	-	-
20 MPH	1.200	3.106	-	-
25 MPH	1.049	2.598	-	-
30 MPH	0.931	2.240	-	-
35 MPH	0.860	1.950	-	-
40 MPH	0.800	1.758	-	-
45 MPH	0.740	1.610	-	-
50 MPH	0.720	1.500	-	-
55 MPH	0.720	1.450	-	-
60 MPH	0.768	1.409	-	-
65 MPH	0.828	1.409	-	-
Average	-	-	3.779	0.000

CO EMISSION RATES (gr./mile)	AUTO	TRUCK	BUS	RAIL
5 MPH	30.716	21.970	-	-
10 MPH	19.628	15.079	-	-
15 MPH	14.569	10.880	-	-
20 MPH	12.329	8.220	-	-
25 MPH	9.409	6.500	-	-
30 MPH	7.460	5.360	-	-
35 MPH	7.250	4.650	-	-
40 MPH	6.019	4.217	-	-
45 MPH	5.039	4.000	-	-
50 MPH	4.550	3.970	-	-

55 MPH	4.550	4.119	-	-
60 MPH	5.539	4.480	-	-
65 MPH	7.280	5.090	-	-
Average	-	-	10.980	0.000

NOx EMISSION RATES (gr./mile)	AUTO	TRUCK	BUS	RAIL
5 MPH	1.139	10.800	-	-
10 MPH	1.000	8.960	-	-
15 MPH	0.958	7.697	-	-
20 MPH	0.939	6.960	-	-
25 MPH	0.970	6.329	-	-
30 MPH	0.980	6.050	-	-
35 MPH	0.990	6.000	-	-
40 MPH	1.000	6.157	-	-
45 MPH	1.008	6.550	-	-
50 MPH	1.070	7.217	-	-
55 MPH	1.220	9.239	-	-
60 MPH	1.360	9.750	-	-
65 MPH	1.508	11.960	-	-
Average	-	-	7.700	0.000

PM10 EMISSION RATES (gr./mile)	AUTO	TRUCK	BUS	RAIL
Average	0.034	0.469	0.469	0.000

COST PER TON OF EMISSIONS($/Ton)	HC	CO	NOx	PM10
Average	0.0	0.0	0.0	0.0

EMISSIONS PER COLD START	HC	CO	NOx	PM10
Auto (gr./start)	3.470	46.500	0.860	0.000
Truck (gr./start)	0.000	0.000	0.000	0.000

COLD STARTS PER VEHICLE TRIP	STARTS
Auto (starts/trip)	0.40
Truck (starts/trip)	0.00

GREENHOUSE GAS EMIS. RATES	TONS/M.BTU
Auto (CO2 tons/mill.BTU)	0.07800
Truck (CO2 tons/mill.BTU)	0.07900
Bus (CO2 tons/mill.BTU)	0.07900
Rail (CO2 tons/mill.BTU)	0.00000

GREENHOUSE GAS EMIS. COSTS	$/Ton
CO2 Emissions	0.00

COST PER ACCIDENT ($/accident)	FATAL	INJURY	PDO
Internal Accident Cost	0	0	0
External Accident Cost	0	0	0

FATALITY RATES (fat/100 mil.VMT)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.00	0.00	-	-
2nd Highway Class	0.00	0.00	-	-
3rd Highway Class	0.00	0.00	-	-
4th Highway Class	0.00	0.00	-	-
5th Highway Class	0.00	0.00	-	-
6th Highway Class	0.00	0.00	-	-
Average	-	-	0.000	0.000

INJURY RATES (inj/100 mil.VMT)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.00	0.00	-	-
2nd Highway Class	0.00	0.00	-	-
3rd Highway Class	0.00	0.00	-	-
4th Highway Class	0.00	0.00	-	-
5th Highway Class	0.00	0.00	-	-
6th Highway Class	0.00	0.00	-	-
Average	-	-	0.000	0.000

PDO CRASH RATES (pdo/100 mil.VMT)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.00	0.00	-	-
2nd Highway Class	0.00	0.00	-	-
3rd Highway Class	0.00	0.00	-	-
4th Highway Class	0.00	0.00	-	-
5th Highway Class	0.00	0.00	-	-
6th Highway Class	0.00	0.00	-	-
Average	-	-	0.000	0.000

NOISE COSTS ($/mile)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.000	0.000	-	-
2nd Highway Class	0.000	0.000	-	-
3rd Highway Class	0.000	0.000	-	-
4th Highway Class	0.000	0.000	-	-
5th Highway Class	0.000	0.000	-	-
6th Highway Class	0.000	0.000	-	-
Average	-	-	0.000	0.000

OTHER MILEAGE EXT.COST ($/mile)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.000	0.000	-	-
2nd Highway Class	0.000	0.000	-	-
3rd Highway Class	0.000	0.000	-	-
4th Highway Class	0.000	0.000	-	-
5th Highway Class	0.000	0.000	-	-
6th Highway Class	0.000	0.000	-	-
Average	-	-	0.000	0.000

NON-MILEAGE EXTERNAL COSTS	AUTO	TRUCK	CPOOL	L-BUS	X-BUS	L-RAIL	H-RAIL	OTHER
Total ($)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TRANSIT AGENCY UNIT COSTS	L.BUS	EX.BUS	L.RAIL	H.RAIL
$/Vehicle Mile	0.000	0.000	0.000	0.000
$/Vehicle Hour	0.000	0.000	0.000	0.000
$/Peak Vehicle	0.000	0.000	0.000	0.000

TRANSIT DEMAND	L.BUS	EX.BUS	L.RAIL	H.RAIL
Vehicle Miles (1,000)	0.00	0.00	0.00	0.00
Vehicle Hours (1,000)	0.00	0.00	0.00	0.00
Peak Vehicles (1,000)	0.00	0.00	0.00	0.00

DISCOUNT RATE	VALUE
Discount Rate	0.1200

INVESTMENT COSTS	1ST	2ND	3RD	4TH	5TH	TOTAL
Capital Costs (1,000$)	22905	0	0	0	0	22905
Mid Point Construction	2000	0	0	0	0	-
Year Opening	2000	0	0	0	0	-
Useful Life	20	0	0	0	0	-
Salvage Value (1,000$)	2545	0	0	0	0	-
Ext. Const. Cost (1,000$)	0	0	0	0	0	-
Other Operating and Maintenance Costs (1,000$)						2089

SCENARIO 2015 INPUT DATA (CASE 1)

SCENARIO ASSUMPTIONS

VALUE OF TIME	AUTO	TRUCK	CPOOL	L-BUS	X-BUS	L-RAIL	H-RAIL	OTHER
In-Vehicle ($/hr.)	4.31	4.03	0.00	2.87	0.00	0.00	0.00	0.00
Out-of-Vehicle ($/hr.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

FUEL COSTS	AUTO	TRUCK
Dollars Per Gallon	0.57	0.61
Include Fuel Cost in User Benefits		TRUE

NON FUEL COSTS	AUTO	TRUCK
Dollars Per Gallon	0.164	0.201
Include Non-Fuel Op. Cost in User Benefits		TRUE

FUEL CONSUMPTION RATES(g/mile)	AUTO	TRUCK	LOC.BUS	EX.BUS	L.RAIL	H.RAIL
					(KWhr/Vehicle Mile)	
5 MPH	0.119	0.425	-	-	-	-
10 MPH	0.064	0.300	-	-	-	-
15 MPH	0.045	0.270	-	-	-	-
20 MPH	0.041	0.263	-	-	-	-
25 MPH	0.037	0.259	-	-	-	-
30 MPH	0.034	0.263	-	-	-	-
35 MPH	0.032	0.273	-	-	-	-
40 MPH	0.034	0.287	-	-	-	-
45 MPH	0.035	0.293	-	-	-	-
50 MPH	0.037	0.298	-	-	-	-
55 MPH	0.039	0.300	-	-	-	-
60 MPH	0.041	0.303	-	-	-	-
65 MPH	0.043	0.310	-	-	-	-
Average	-	-	0.305	0.000	0.000	0.000

HC EMISSION RATES (gr./mile)	AUTO	TRUCK	BUS	RAIL
5 MPH	3.828	9.000	-	-
10 MPH	2.480	7.070	-	-
15 MPH	2.029	5.670	-	-
20 MPH	1.799	4.657	-	-
25 MPH	1.580	3.390	-	-
30 MPH	1.399	3.348	-	-
35 MPH	1.279	2.930	-	-
40 MPH	1.190	2.630	-	-
45 MPH	1.100	2.410	-	-
50 MPH	1.080	2.250	-	-
55 MPH	1.080	2.170	-	-
60 MPH	1.149	2.119	-	-
65 MPH	1.240	2.119	-	-
Average	-	-	5.670	0.000

CO EMISSION RATES (gr./mile)	AUTO	TRUCK	BUS	RAIL
5 MPH	46.080	32.810	-	-
10 MPH	27.940	22.620	-	-
15 MPH	26.229	16.319	-	-
20 MPH	18.500	12.329	-	-
25 MPH	14.109	9.739	-	-
30 MPH	11.180	8.060	-	-
35 MPH	10.880	6.980	-	-

40 MPH	9.020	6.320	-	-
45 MPH	7.559	5.986	-	-
50 MPH	6.828	5.947	-	-
55 MPH	6.828	6.170	-	-
60 MPH	8.310	6.710	-	-
65 MPH	10.920	7.638	-	-
Average	-	-	16.319	0.000

NO EMISSION RATES (gr./mile)	AUTO	TRUCK	BUS	RAIL
5 MPH	1.679	16.200	-	-
10 MPH	1.500	13.439	-	-
15 MPH	1.440	11.550	-	-
20 MPH	1.409	10.298	-	-
25 MPH	1.460	9.500	-	-
30 MPH	1.470	9.079	-	-
35 MPH	1.490	9.000	-	-
40 MPH	1.500	9.239	-	-
45 MPH	1.519	9.829	-	-
50 MPH	1.610	10.829	-	-
55 MPH	1.830	12.359	-	-
60 MPH	2.039	14.630	-	-
65 MPH	2.269	17.940	-	-
Average	-	-	11.550	0.000

PM10 EMISSION RATES (gr./mile)	AUTO	TRUCK	BUS	RAIL
Average	0.050	0.720	0.720	0.000

COST PER TON OF EMISSIONS($/Ton)	HC	CO	NOx	PM10
Average	0.0	0.0	0.0	0.0

EMISSIONS PER COLD START	HC	CO	NOx	PM10
Auto (gr./start)	5.198	68.250	1.289	0.000
Truck (gr./start)	0.000	0.000	0.000	0.000

COLD STARTS PER VEHICLE TRIP	STARTS
Auto (starts/trip)	0.40
Truck (starts/trip)	0.00

GREENHOUSE GAS EMIS. RATES	TONS/M.BTU
Auto (CO2 tons/mill.BTU)	0.07800
Truck (CO2 tons/mill.BTU)	0.07900
Bus (CO2 tons/mill.BTU)	0.07900
Rail (CO2 tons/mill.BTU)	0.00000

GREENHOUSE GAS EMIS. COSTS	$/Ton
CO2 Emissions	0.00

COST PER ACCIDENT ($/accident)	FATAL	INJURY	PDO
Internal Accident Cost	0	0	0
External Accident Cost	0	0	0

FATALITY RATES (fat/100 mil.VMT)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.00	0.00	-	-
2nd Highway Class	0.00	0.00	-	-
3rd Highway Class	0.00	0.00	-	-
4th Highway Class	0.00	0.00	-	-
5th Highway Class	0.00	0.00	-	-
6th Highway Class	0.00	0.00	-	-
Average	-	-	0.000	0.000

INJURY RATES (inj/100 mil.VMT)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.00	0.00	-	-
2nd Highway Class	0.00	0.00	-	-
3rd Highway Class	0.00	0.00	-	-
4th Highway Class	0.00	0.00	-	-

5th Highway Class	0.00	0.00	-	-
6th Highway Class	0.00	0.00	-	-
Average	-	-	0.000	0.000

PDO CRASH RATES (pdo/100 mil.VMT)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.00	0.00	-	-
2nd Highway Class	0.00	0.00	-	-
3rd Highway Class	0.00	0.00	-	-
4th Highway Class	0.00	0.00	-	-
5th Highway Class	0.00	0.00	-	-
6th Highway Class	0.00	0.00	-	-
Average	-	-	0.000	0.000

NOISE COSTS ($/mile)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.000	0.000	-	-
2nd Highway Class	0.000	0.000	-	-
3rd Highway Class	0.000	0.000	-	-
4th Highway Class	0.000	0.000	-	-
5th Highway Class	0.000	0.000	-	-
6th Highway Class	0.000	0.000	-	-
Average	-	-	0.000	0.000

OTHER MILEAGE EXT.COST ($/mile)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.000	0.000	-	-
2nd Highway Class	0.000	0.000	-	-
3rd Highway Class	0.000	0.000	-	-
4th Highway Class	0.000	0.000	-	-
5th Highway Class	0.000	0.000	-	-
6th Highway Class	0.000	0.000	-	-
Average	-	-	0.000	0.000

NON-MILEAGE EXTERNAL COSTS	AUTO	TRUCK	CPOOL	L-BUS	X-BUS	L-RAIL	H-RAIL	OTHER
Total ($)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TRANSIT AGENCY UNIT COSTS	L.BUS	EX.BUS	L.RAIL	H.RAIL
$/Vehicle Mile	0.000	0.000	0.000	0.000
$/Vehicle Hour	0.000	0.000	0.000	0.000
$/Peak Vehicle	0.000	0.000	0.000	0.000

TRANSIT DEMAND	L.BUS	EX.BUS	L.RAIL	H.RAIL
Vehicle Miles (1,000)	0.00	0.00	0.00	0.00
Vehicle Hours (1,000)	0.00	0.00	0.00	0.00
Peak Vehicles (1,000)	0.00	0.00	0.00	0.00

DISCOUNT RATE	VALUE
Discount Rate	0.1190

INVESTMENT COSTS	1ST	2ND	3RD	4TH	5TH	TOTAL
Capital Costs (1,000$)	22905	0	0	0	0	22905
Mid Point Construction	2000	0	0	0	0	-
Year Opening	2001	0	0	0	0	-
Useful Life	20	0	0	0	0	-
Salvage Value (1,000$)	2089	0	0	0	0	-
Ext. Const. Cost (1,000$)	0	0	0	0	0	-
Other Operating and Maintenance Costs (1,000$)						2545

STEAM SAMPLE OUTPUT

SCENARIO FILE BUTP 05 CS1.3.scn

File Name - C:\Program Files\STEAM\butp6\butp6_05 cs4comb rskal.scn
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SCENARIO ANNUAL RESULTS

1) TRAVEL DEMAND	AUTO	TRUCK	CPOOL	L BUS	X BUS	L RAIL	H-RAIL	OTHER	TOTAL
VMT (Million VMT/yr)									
Base Case	2727.9	74.8	0.0	0.0	0.0	0.0	0.0	0.0	2802.8
Improvement Case	2732.3	75.0	0.0	0.0	0.0	0.0	0.0	0.0	2807.3
Change	4.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	4.6
Person Trips (Million/yr)									
Base Case	964.9	14.9	0.0	78.4	0.0	0.0	0.0	0.0	1058.2
Improvement Case	964.9	14.9	0.0	78.4	0.0	0.0	0.0	0.0	1058.2
Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
In-Vehicle Travel Time (Million Person Hrs./yr)									
Base Case	214.0	3.6	0.0	11.4	0.0	0.0	0.0	0.0	229.0
Improvement Case	201.2	3.4	0.0	10.5	0.0	0.0	0.0	0.0	215.2
Change	-12.7	-0.2	0.0	-0.9	0.0	0.0	0.0	0.0	-13.8
Out-Of-Vehicle Travel Time (Million Person Hrs./yr)									
Base Case	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Improvement Case	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Travel Time (Million Person Hrs./yr)									
Base Case	214.0	3.6	0.0	11.4	0.0	0.0	0.0	0.0	229.0
Improvement Case	201.2	3.4	0.0	10.5	0.0	0.0	0.0	0.0	215.2
Change	-12.7	-0.2	0.0	-0.9	0.0	0.0	0.0	0.0	-13.8

2) TONS OF EMISSIONS	AUTO	TRUCK	CPOOL	L BUS	X BUS	L RAIL	H-RAIL	OTHER	TOTAL
VMT Related Emissions (Tons/yr)									
Base Case									
HC	6198.7	439.4	0.0	0.0	0.0	0.0	0.0	0.0	6638.1
CO	60779.5	1169.4	0.0	0.0	0.0	0.0	0.0	0.0	61948.8
NOx	5200.2	1008.9	0.0	0.0	0.0	0.0	0.0	0.0	6209.1

PM10	183.4	71.3	0.0	0.0	0.0	0.0	0.0	0.0	254.7
Improvement Case									
HC	5973.3	420.6	0.0	0.0	0.0	0.0	0.0	0.0	6394.0
CO	57000.7	1100.5	0.0	0.0	0.0	0.0	0.0	0.0	58101.2
NOx	5228.2	990.6	0.0	0.0	0.0	0.0	0.0	0.0	6218.8
PM10	183.7	71.4	0.0	0.0	0.0	0.0	0.0	0.0	255.2
Change									
HC	-225.4	-18.8	0.0	0.0	0.0	0.0	0.0	0.0	-244.2
CO	-3778.7	-68.9	0.0	0.0	0.0	0.0	0.0	0.0	-3847.6
NOx	27.9	-18.2	0.0	0.0	0.0	0.0	0.0	0.0	9.7
PM10	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.5

Cold Start Emissions (Tons/yr)

Base Case									
HC	1609.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1609.2
CO	21130.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21130.6
NOx	399.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	399.6
PM10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Improvement Case									
HC	1609.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1609.2
CO	21130.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21130.6
NOx	399.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	399.6
PM10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Change									
HC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NOx	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PM10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Combined VMT and Cold Start Emissions (Tons/yr)

Base Case									
HC	7807.9	439.4	0.0	0.0	0.0	0.0	0.0	0.0	8247.3
CO	81910.1	1169.4	0.0	0.0	0.0	0.0	0.0	0.0	83079.4
NOx	5599.9	1008.9	0.0	0.0	0.0	0.0	0.0	0.0	6608.7
PM10	183.4	71.3	0.0	0.0	0.0	0.0	0.0	0.0	254.7
Improvement Case									
HC	7582.5	420.6	0.0	0.0	0.0	0.0	0.0	0.0	8003.1
CO	78131.4	1100.5	0.0	0.0	0.0	0.0	0.0	0.0	79231.8
NOx	5627.8	990.6	0.0	0.0	0.0	0.0	0.0	0.0	6618.5
PM10	183.7	71.4	0.0	0.0	0.0	0.0	0.0	0.0	255.2

Change									
HC	-225.4	-18.8	0.0	0.0	0.0	0.0	0.0	0.0	-244.2
CO	-3778.7	-68.9	0.0	0.0	0.0	0.0	0.0	0.0	-3847.6
NOx	27.9	-18.2	0.0	0.0	0.0	0.0	0.0	0.0	9.7
PM10	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.5

3)EMISSION COSTS	AUTO	TRUCK	CPOOL	L-BUS	X-BUS	L-RAIL	H-RAIL	OTHER	TOTAL
VMT Related Emission Costs (1000$/yr)									
Base Case									
HC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NOx	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PM10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Improvement Case									
HC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NOx	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PM10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Change									
HC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NOx	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PM10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cold Start Emission Costs (1000$/yr)									
Base Case									
HC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NOx	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PM10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Improvement Case									
HC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NOx	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PM10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Change									
HC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NOx	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PM10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Combined VMT and Cold Start Emission Costs (1000$/yr)

Base Case									
HC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NOx	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PM10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Improvement Case									
HC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NOx	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PM10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Change									
HC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NOx	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PM10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Em. Costs(1000$/yr)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

4)GREENHOUSE GAS EMISSIONS	AUTO	TRUCK	CPOOL	L-BUS	X-BUS	L-RAIL	H-RAIL	OTHER	TOTAL
BTU Energy Consumption(100 Billion BTU/yr)									
Base Case	157.5	27.5	0.0	0.0	0.0	0.0	0.0	0.0	185.1
Improvement Case	151.5	27.5	0.0	0.0	0.0	0.0	0.0	0.0	179.0
Change	-6.0	-0.0	0.0	0.0	0.0	0.0	0.0	0.0	-6.1
CO2 Emissions (1,000 Tons/yr)									
Base Case	1228.9	217.6	0.0	0.0	0.0	0.0	0.0	0.0	1446.5
Improvement Case	1182.0	217.2	0.0	0.0	0.0	0.0	0.0	0.0	1399.2
Change	-46.9	-0.4	0.0	0.0	0.0	0.0	0.0	0.0	-47.3
Greenhouse Gas Emissions Costs(1000$/yr)									
Base Case	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Improvement Case	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

5)ACCIDENTS	AUTO	TRUCK	CPOOL	L-BUS	X-BUS	L-RAIL	H-RAIL	OTHER	TOTAL
Number of Accidents									
Fatalities									

Base Case	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Improvement Case	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Injuries									
Base Case	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Improvement Case	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Property-Damage-Only									
Base Case	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Improvement Case	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
External Accident Costs									
Fatalities (1000$/yr)									
Base Case	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Improvement Case	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Injuries (1000$/yr)									
Base Case	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Improvement Case	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Property-Damage-Only (1000$/yr)									
Base Case	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Improvement Case	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Ext. Acc.(1000$/yr)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

6) FUEL AND NON-FUEL COSTS	AUTO	TRUCK	CPOOL	L-BUS	X-BUS	L-RAIL	H-RAIL	OTHER	TOTAL
Gallons or Gallon Equivalent (1000gal./yr)									
Base Case	126036.1	19861.6	0.0	0.0	0.0	0.0	0.0	0.0	145897.7
Improvement Case	121227.7	19825.9	0.0	0.0	0.0	0.0	0.0	0.0	141053.5
Change	-4808.5	-35.7	0.0	0.0	0.0	0.0	0.0	0.0	-4844.2
Energy Costs (1000$/yr)									
Base Case	71840.6	11917.0	0.0	0.0	0.0	0.0	0.0	0.0	83757.5
Improvement Case	69099.8	11895.5	0.0	0.0	0.0	0.0	0.0	0.0	80995.3
Change	-2740.8	-21.4	0.0	0.0	0.0	0.0	0.0	0.0	-2762.3
Non-Fuel Operating Costs (1000$/yr) *1									
Base Case	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	AUTO	TRUCK	CPOOL	L-BUS	X-BUS	L-RAIL	H-RAIL	OTHER	TOTAL
Improvement Case	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

7) EXTERNAL COSTS	AUTO	TRUCK	CPOOL	L-BUS	X-BUS	L-RAIL	H-RAIL	OTHER	TOTAL
Noise Costs (1000$/yr)									
Base Case	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ImprovemNst Case	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Mileage Based External Costs (1000$/yr)									
Base Case	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ImprovemNst Case	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Non-Mileage Based External Costs (1000$/yr)									
Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
External Cost During Construction (1000$/yr)									
Change									0.0

8) USER BENEFITS	AUTO	TRUCK	CPOOL	L-BUS	X-BUS	L-RAIL	H-RAIL	OTHER	TOTAL
Benefits (1000$/yr)									
In-Vehicle Travel Time	50951.0	695.6	0.0	0.0	0.0	0.0	0.0	0.0	51646.6
Out-of-Veh.Travel Time	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fuel Costs *2	2740.8	21.4	0.0	0.0	0.0	0.0	0.0	0.0	2762.3
Non-Fuel Oper. Costs*2	-718.6	-134.9	0.0	0.0	0.0	0.0	0.0	0.0	-853.5
Out-of-Pocket Costs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Intern. Accident Cst.*2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	52973.2	582.1	0.0	0.0	0.0	0.0	0.0	0.0	53555.3
Revenue Transfers (1000$/yr)									
Transfers *2	-1802.2	-15.2	0.0	0.0	0.0	0.0	0.0	0.0	-1817.4

9) PUBLIC VEHICLE OPER. COSTS	AUTO	TRUCK	CPOOL	L-BUS	X-BUS	L-RAIL	H-RAIL	OTHER	TOTAL
Operating Costs(1000$/yr)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

10) CAPITAL COSTS	1ST	2ND	3RD	4TH	5TH	TOTAL
Capital Cost (1000$)	126396.0	0.0	0.0	0.0	0.0	126396.0
Salvage Value (1000$)	69030.0	0.0	0.0	0.0	0.0	69030.0
Annualized Cost (1000$)	22592.5	0.0	0.0	0.0	0.0	22592.5

Other Op/Maint. Cost (1000$/yr)	4689.0

11) SUMMARY

Benefits (1000$/yr)	TOTAL
User Benefits	53555.3
Revenue Transfers	-1817.4
Fuel Costs *1	0.0
Non-Fuel Op. Costs *1	0.0
Reduction in External Costs	
Emissions	0.0
Global Warming	0.0
Noise	0.0
Accident	0.0
Other Mileage Based	0.0
Other Non-Mileage Based	0.0
Construction Period	0.0
Subtotal	0.0
Total Benefits	51737.9
Costs To Public Agencies (1000$/yr)	
Capital Costs	22592.5
Public Vehicle Oper. Cost	0.0
Other Operating & Maint. Costs	4689.0
Total Costs to Public Agencies	27281.5
Net Annual Worth (1000$/yr)	24456.4
Benefit-Cost Ratio	1.90

SCENARIO ASSUMPTIONS

VALUE OF TIME	AUTO	TRUCK	CPOOL	L BUS	X BUS	L-RAIL	H-RAIL	OTHER
In-Vehicle ($/hr.)	4.00	3.74	0.00	2.67	0.00	0.00	0.00	0.00

Out-of-Vehicle ($/hr.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

FUEL COSTS	AUTO	TRUCK
Dollars Per Gallon	0.57	0.60

Include Fuel Cost in User Benefits TRUE

NON FUEL COSTS	AUTO	TRUCK
Dollars Per Gallon	0.164	0.801

Include Non-Fuel Op. Cost in User Benefits TRUE

FUEL CONSUMPTION RATES(g/mile)	AUTO	TRUCK	LOC.BUS	EX.BUS	L.RAIL	H.RAIL
					(KWhr/Vehicle Mile)	
5 MPH	0.135	0.425	-	-	-	-
10 MPH	0.071	0.300	-	-	-	-
15 MPH	0.054	0.270	-	-	-	-
20 MPH	0.048	0.263	-	-	-	-
25 MPH	0.041	0.259	-	-	-	-
30 MPH	0.037	0.263	-	-	-	-
35 MPH	0.037	0.273	-	-	-	-
40 MPH	0.039	0.287	-	-	-	-
45 MPH	0.041	0.293	-	-	-	-
50 MPH	0.041	0.298	-	-	-	-
55 MPH	0.045	0.300	-	-	-	-
60 MPH	0.046	0.303	-	-	-	-
65 MPH	0.048	0.310	-	-	-	-
Average	-	-	0.305	0.000	0.000	0.000

HC EMISSION RATES (gr./mile)	AUTO	TRUCK	BUS	RAIL
5 MPH	4.590	10.800	-	-
10 MPH	2.970	8.479	-	-
15 MPH	2.430	6.800	-	-
20 MPH	2.160	5.590	-	-
25 MPH	1.889	4.670	-	-
30 MPH	1.669	4.019	-	-
35 MPH	1.508	3.509	-	-
40 MPH	1.429	3.160	-	-
45 MPH	1.320	2.890	-	-
50 MPH	1.289	2.700	-	
55 MPH	1.289	2.598	-	-
60 MPH	1.378	2.539	-	-
65 MPH	1.480	2.539	-	
Average	-	-	6.800	0.000

CO EMISSION RATES (gr./mile)	AUTO	TRUCK	BUS	RAIL
5 MPH	55.298	39.368	-	-
10 MPH	33.528	27.138	-	-
15 MPH	26.229	19.579	-	
20 MPH	22.190	14.800	-	-
25 MPH	16.930	11.689	-	-
30 MPH	13.420	9.670	-	-
35 MPH	13.050	8.369	-	-
40 MPH	10.829	7.590	-	-
45 MPH	9.069	7.190	-	-
50 MPH	8.189	7.138	-	-
55 MPH	8.189	7.408	-	-
60 MPH	9.970	8.060	-	
65 MPH	13.100	9.159	-	-
Average	-	-	19.580	0.000

NO EMISSION RATES (gr./mile)	AUTO	TRUCK	BUS	RAIL
5 MPH	2.019	19.440	-	-
10 MPH	1.799	16.128	-	-
15 MPH	1.730	13.859	-	-
20 MPH	1.690	12.350	-	
25 MPH	1.750	11.390	-	
30 MPH	1.758	10.890	-	-
35 MPH	1.779	10.800	-	-
40 MPH	1.799	11.090	-	-
45 MPH	1.820	11.788	-	-
50 MPH	1.929	13.000	-	-
55 MPH	2.200	14.630	-	-
60 MPH	2.450	17.548	-	-
65 MPH	2.720	21.530	-	-
Average	-	-	13.860	0.000

PM10 EMISSION RATES (gr./mile)	AUTO	TRUCK	BUS	RAIL
Average	0.061	0.864	0.864	0.000

COST PER TON OF EMISSIONS($/Ton)	HC	CO	NOx	PM10
Average	0.0	0.0	0.0	0.0

EMISSIONS PER COLD START	HC	CO	NOx	PM10
Auto (gr./start)	6.237	81.900	1.549	0.000
Truck (gr./start)	0.000	0.000	0.000	0.000

COLD STARTS PER VEHICLE TRIP	STARTS
Auto (starts/trip)	0.40
Truck (starts/trip)	0.00

GREENHOUSE GAS EMIS. RATES	TONS/M.BTU
Auto (CO2 tons/mill.BTU)	0.07800
Truck (CO2 tons/mill.BTU)	0.07900
Bus (CO2 tons/mill.BTU)	0.07900
Rail (CO2 tons/mill.BTU)	0.00000

GREENHOUSE GAS EMIS. COSTS	$/Ton
CO2 Emissions	0.00

COST PER ACCIDENT ($/accident)	FATAL	INJURY	PDO
Internal Accident Cost	0	0	0
External Accident Cost	0	0	0

FATALITY RATES (fat/100 mil.VMT)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.00	0.00	-	-
2nd Highway Class	0.00	0.00	-	-
3rd Highway Class	0.00	0.00	-	-
4th Highway Class	0.00	0.00	-	-
5th Highway Class	0.00	0.00	-	-
6th Highway Class	0.00	0.00	-	-
Average	-	-	0.000	0.000

INJURY RATES (inj/100 mil.VMT)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.00	0.00	-	-
2nd Highway Class	0.00	0.00	-	-
3rd Highway Class	0.00	0.00	-	-
4th Highway Class	0.00	0.00	-	-
5th Highway Class	0.00	0.00	-	-
6th Highway Class	0.00	0.00	-	-
Average	-	-	0.000	0.000

PDO CRASH RATES (pdo/100 mil.VMT)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.00	0.00	-	-
2nd Highway Class	0.00	0.00	-	-
3rd Highway Class	0.00	0.00	-	-
4th Highway Class	0.00	0.00	-	
5th Highway Class	0.00	0.00	-	-

6th Highway Class	0.00	0.00	-	-
Average	-	-	0.000	0.000

NOISE COSTS ($/mile)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.000	0.000	-	-
2nd Highway Class	0.000	0.000	-	-
3rd Highway Class	0.000	0.000	-	-
4th Highway Class	0.000	0.000	-	-
5th Highway Class	0.000	0.000	-	-
6th Highway Class	0.000	0.000	-	-
Average	-	-	0.000	0.000

OTHER MILEAGE EXT.COST ($/mile)	AUTO	TRUCK	BUS	RAIL
1st Highway Class	0.000	0.000	-	-
2nd Highway Class	0.000	0.000	-	-
3rd Highway Class	0.000	0.000	-	-
4th Highway Class	0.000	0.000	-	-
5th Highway Class	0.000	0.000	-	-
6th Highway Class	0.000	0.000	-	-
Average	-	-	0.000	0.000

NON-MILEAGE EXTERNAL COSTS	AUTO	TRUCK	CPOOL	L-BUS	X-BUS	L-RAIL	H-RAIL	OTHER
Total ($)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TRANSIT AGENCY UNIT COSTS	L.BUS	EX.BUS	L.RAIL	H.RAIL
$/Vehicle Mile	0.000	0.000	0.000	0.000
$/Vehicle Hour	0.000	0.000	0.000	0.000
$/Peak Vehicle	0.000	0.000	0.000	0.000

TRANSIT DEMAND	L.BUS	EX.BUS	L.RAIL	H.RAIL
Vehicle Miles (1,000)	0.00	0.00	0.00	0.00
Vehicle Hours (1,000)	0.00	0.00	0.00	0.00
Peak Vehicles (1,000)	0.00	0.00	0.00	0.00

DISCOUNT RATE	VALUE
Discount Rate	0.1190

INVESTMENT COSTS	1ST	2ND	3RD	4TH	5TH	TOTAL
Capital Costs (1,000$)	126396	0	0	0	0	126396
Mid Point Construction	2001	0	0	0	0	-
Year Opening	2004	0	0	0	0	-

Useful Life	20	0	0	0	0	
Salvage Value (1,000$)	69030	0	0	0	0	
Ext. Const. Cost (1,000$)	0	0	0	0	0	
Other Operating and Maintenance Costs (1,000$)						4689

MARKET SECTORS - TOTAL # 3

Market Sector # 1

Name	Mkt#1
Mode	Auto
Base Vehicle Occupancy	1.649
Imp. Vehicle Occupancy	1.649
Expansion Factor	332.0
Speed Equation	Peak
Run Base Network	TRUE
Run Imp. Network	TRUE
Ignore Travel Times	FALSE
Base Network Input File	C:\Program Files\STEAM\butpx\butp5\bs-05-csl-net.nwk
Base Network Output File	C:\Program Files\STEAM\Bs_net.ttf
Imp. Network Input File	C:\Program Files\STEAM\butp6\ip-05-comb-net.nwk
Imp. Network Output File	C:\Program Files\STEAM\Ip_Net.ttf
Centroid File	C:\Program Files\STEAM\94.cnt
Base Trip Table	C:\Program Files\STEAM\BUTP\bs-05-csl-auto.trp
Imp. Trip Table	C:\Program Files\STEAM\BUTP\bs-05-csl-auto.trp
Use In-Vehicle File	FALSE
Use Out-of-Vehicle File	FALSE
Use Out-of-Pocket Cost	FALSE
Base In-Vehicle Time	NULL
Base Out-of-Vehicle Time	NULL
Base Out-of-Pocket Costs	NULL
Imp. In-Vehicle Time	NULL
Imp. Out-of-Vehicle Time	NULL
Imp. Out-of-Pocket Costs	NULL
Market Sector Output File	C:\Program Files\STEAM\Auto.mkt

Market Sector # 2

Name	Mkt#2
Mode	Truck
Base Vehicle Occupancy	1.000
Imp. Vehicle Occupancy	1.000
Expansion Factor	332.0

Speed Equation	Peak
Run Base Network	TRUE
Run Imp. Network	TRUE
Ignore Travel Times	FALSE
Base Network Input File	C:\Program Files\STEAM\butpx\butp5\bs-05-csl-net.nwk
Base Network Output File	C:\Program Files\STEAM\Bs_net.ttf
Imp. Network Input File	C:\Program Files\STEAM\butp6\ip-05-comb-net.nwk
Imp. Network Output File	C:\Program Files\STEAM\Ip_Net.ttf
Centroid File	C:\Program Files\STEAM\94.cnt
Base Trip Table	C:\Program Files\STEAM\BUTP\bs-05-csl-truck.trp
Imp. Trip Table	C:\Program Files\STEAM\BUTP\bs-05-csl-truck.trp
Use In-Vehicle File	FALSE
Use Out-of-Vehicle File	FALSE
Use Out-of-Pocket Cost	FALSE
Base In-Vehicle Time	NULL
Base Out-of-Vehicle Time	NULL
Base Out-of-Pocket Costs	NULL
Imp. In-Vehicle Time	NULL
Imp. Out-of-Vehicle Time	NULL
Imp. Out-of-Pocket Costs	NULL
Market Sector Output File	C:\Program Files\STEAM\Truck.mkt

Market Sector # 3

Name	Mkt#3
Mode	Local Bus
Base Vehicle Occupancy	30.000
Imp. Vehicle Occupancy	30.000
Expansion Factor	332.0
Speed Equation	Peak
Run Base Network	TRUE
Run Imp. Network	TRUE
Ignore Travel Times	FALSE
Base Network Input File	C:\Program Files\STEAM\butpx\butp5\bs-05-csl-net.nwk
Base Network Output File	C:\Program Files\STEAM\Bs_net.ttf
Imp. Network Input File	C:\Program Files\STEAM\butp6\ip-05-comb-net.nwk
Imp. Network Output File	C:\Program Files\STEAM\Ip_Net.ttf
Centroid File	C:\Program Files\STEAM\94.cnt
Base Trip Table	C:\Program Files\STEAM\BUTP\bs-05-csl-bus.trp
Imp. Trip Table	C:\Program Files\STEAM\BUTP\bs-05-csl-bus.trp
Use In-Vehicle File	FALSE
Use Out-of-Vehicle File	FALSE
Use Out-of-Pocket Cost	FALSE
Base In-Vehicle Time	NULL
Base Out-of-Vehicle Time	NULL
Base Out-of-Pocket Costs	NULL
Imp. In-Vehicle Time	NULL
Imp. Out-of-Vehicle Time	NULL

Imp. Out-of-Pocket Costs NULL
Market Sector Output File C:\Program Files\STEAM\Bus.mkt

RISK ANALYSIS INPUT VARIABLES	LOW	HIGH
In-Veh. Value of Time - Auto (Factor)	0.7	1.5
In-Veh. Value of Time - Truck (Factor)	0.7	1.5
In-Veh. Value of Time - Transit (Factor)	0.7	1.5
Out-Veh. Value of Time - Auto (Factor)	0.0	0.0
Out-Veh. Value of Time - Truck (Factor)	0.0	0.0
Out-Veh. Value of Time - Transit (Factor)	0.0	0.0
Discount Rate (Factor)	0.047	0.200
Fuel Consumption Rate Factor (Factor)	0.7	1.5
Fuel Prices Factor (Factor)	0.7	1.5
HC Cost Per Ton ($/Ton)	0.0	0.0
CO Cost Per Ton ($/Ton)	0.0	0.0
NOx Cost Per Ton ($/Ton)	0.0	0.0
PM10 Cost Per Ton ($/Ton)	0.0	0.0
HC Rate Factor (Factor))	0.0	0.0
CO Rate Factor (Factor)	0.0	0.0
NOx Rate Factor (Factor))	0.0	0.0
PM10 Rate Factor (Factor)	0.0	0.0
Fatalty Cost Factor (Factor)	0.0	0.0
Injury Cost Factor (Factor)	0.0	0.0
PDO Cost Factor (Factor)	0.0	0.0
Fatalty Rate Factor (Factor)	0.0	0.0
Injury Rate Factor (Factor)	0.0	0.0
PDO Rate Factor (Factor)	0.0	0.0
Noise Cost Factor (Factor)	0.0	0.0
Other External Cost Factor (Factor)	0.0	0.0
Capital Cost Factor (Factor)	0.7	1.5
Salvage Value Factor (Factor)	0.7	1.5
Operating Cost Factor (Factor)	0.7	1.5

RISK OUTPUT(PERCENTILES)	1ST	5TH	10TH	20TH	30TH	40TH	50TH	60TH	70TH	80TH	90TH	95TH	99TH
User Benefit($M)	30.98	36.42	39.69	44.02	47.62	50.80	54.00	56.73	60.18	64.79	72.38	79.38	94.18

Emission Costs($M)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Accident Costs($M)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Noise Costs($M)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Benefits($M)	29.16	34.61	37.87	42.20	45.80	48.98	52.18	54.92	58.37	62.97	70.56	77.56	92.37
Total Costs($M)	12.76	15.56	17.51	20.21	22.96	25.34	27.57	30.49	34.06	38.48	45.71	55.43	77.48
Benefit Cost Ratio	0.56	0.83	1.02	1.25	1.43	1.63	1.86	2.10	2.37	2.72	3.35	3.99	5.07

RISK OUTPUT(BAR HGHTS)*3	USER_BEN	EMISS	ACCID	NOISE	TOT_BEN	TOT_CST	BC_RATIO
Intervals							
1 -	0.0080	0.0000	0.0000	0.0000	0.0080	0.0310	0.0145
2 -	0.0155	0.0000	0.0000	0.0000	0.0155	0.0440	0.0325
3 -	0.0220	0.0000	0.0000	0.0000	0.0220	0.0520	0.0285
4 -	0.0240	0.0000	0.0000	0.0000	0.0240	0.0700	0.0435
5 -	0.0280	0.0000	0.0000	0.0000	0.0280	0.0585	0.0535
6 -	0.0330	0.0000	0.0000	0.0000	0.0330	0.0585	0.0540
7 -	0.0405	0.0000	0.0000	0.0000	0.0405	0.0740	0.0660
8 -	0.0465	0.0000	0.0000	0.0000	0.0465	0.0695	0.0600
9 -	0.0445	0.0000	0.0000	0.0000	0.0445	0.0630	0.0490
10 -	0.0430	0.0000	0.0000	0.0000	0.0430	0.0515	0.0515
11 -	0.0515	0.0000	0.0000	0.0000	0.0515	0.0440	0.0470
12 -	0.0495	0.0000	0.0000	0.0000	0.0495	0.0430	0.0475
13 -	0.0510	0.0000	0.0000	0.0000	0.0510	0.0480	0.0485
14 -	0.0505	0.0000	0.0000	0.0000	0.0505	0.0310	0.0420
15 -	0.0595	0.0000	0.0000	0.0000	0.0595	0.0315	0.0345
16 -	0.0490	0.0000	0.0000	0.0000	0.0490	0.0240	0.0385
17 -	0.0525	0.0000	0.0000	0.0000	0.0525	0.0250	0.0335
18 -	0.0320	0.0000	0.0000	0.0000	0.0320	0.0200	0.0275
19 -	0.0410	0.0000	0.0000	0.0000	0.0410	0.0250	0.0310
20 -	0.0330	0.0000	0.0000	0.0000	0.0330	0.0140	0.0210
21 -	0.0225	0.0000	0.0000	0.0000	0.0225	0.0075	0.0150
22 -	0.0235	0.0000	0.0000	0.0000	0.0235	0.0085	0.0155
23 -	0.0255	0.0000	0.0000	0.0000	0.0255	0.0060	0.0170
24 -	0.0160	0.0000	0.0000	0.0000	0.0160	0.0100	0.0115
25 -	0.0195	0.0000	0.0000	0.0000	0.0195	0.0070	0.0120
26 -	0.0120	0.0000	0.0000	0.0000	0.0120	0.0080	0.0075
27 -	0.0105	0.0000	0.0000	0.0000	0.0105	0.0065	0.0130
28 -	0.0125	0.0000	0.0000	0.0000	0.0125	0.0035	0.0070
29 -	0.0110	0.0000	0.0000	0.0000	0.0110	0.0040	0.0045
30 -	0.0100	0.0000	0.0000	0.0000	0.0100	0.0050	0.0070
31 -	0.0085	0.0000	0.0000	0.0000	0.0085	0.0035	0.0080
32 -	0.0020	0.0000	0.0000	0.0000	0.0020	0.0035	0.0055
33 -	0.0045	0.0000	0.0000	0.0000	0.0045	0.0030	0.0065
34 -	0.0055	0.0000	0.0000	0.0000	0.0055	0.0015	0.0020
35 -	0.0025	0.0000	0.0000	0.0000	0.0025	0.0005	0.0025
36 -	0.0035	0.0000	0.0000	0.0000	0.0035	0.0010	0.0015

37 -	0.0030	0.0000	0.0000	0.0000	0.0030	0.0010	0.0045
38 -	0.0045	0.0000	0.0000	0.0000	0.0045	0.0015	0.0020
39 -	0.0015	0.0000	0.0000	0.0000	0.0015	0.0000	0.0015
40 -	0.0000	0.0000	0.0000	0.0065	0.0205	0.0115	0.0000

NOTES

*1 These sections are not relevant if costs were considered in User Benefits

*2 These values may differ from those in Section 5 & 6;
Please refer to the User's Guide for explanation of internal benefits computations.

*3 Bar Heights are 40 evenly spaced intervals from the 1st to the 99th percentile value with the percentage of observations falling into each interval. This information is used to graph the risk analysis results.

ANNEX
TO
CHAPTER 6

TABLE A . 6 - 1
YEAR 2005 DAILY TRIP MATRIX
(PCU's)

From District	To District 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Row Total
1 East Beirut	39,204	9,850	10,233	30,605	8,707	23,734	12,487	3,117	6,141	11,527	1,752	694	3,918	2,752	1,988	988	12,343	180,040
2 Central Beirut	9,850	33,757	33,247	21,853	31,857	7,097	6,528	12,844	3,147	2,358	1,423	2,352	7,107	4,977	905	529	8,527	188,358
3 West Beirut	10,233	33,247	34,768	29,018	27,446	7,358	5,598	7,453	2,335	3,174	1,529	1,811	6,620	4,594	1,317	776	8,338	185,615
4 Borj Hammoud / Sin El Fil	30,605	21,853	29,018	45,417	19,387	20,951	15,771	5,682	6,123	8,558	2,494	1,294	6,120	4,629	2,635	1,188	12,363	234,088
5 Borj El Brajneh / Ghobeiry	8,707	31,857	27,446	19,387	55,170	5,714	9,613	12,989	1,323	1,990	2,105	3,582	7,244	5,767	1,411	858	9,777	204,940
6 Jdaideh / Baouchrieh	23,734	7,097	7,358	20,951	5,714	29,998	8,304	2,011	9,095	11,672	1,658	529	4,378	3,384	1,929	1,376	15,209	154,397
7 Hazmieh / Baabda	12,487	6,528	5,598	15,771	9,613	8,304	22,651	4,068	3,848	2,996	3,917	1,129	4,090	3,095	1,082	623	8,002	113,802
8 Khaldeh / Choueifat	3,117	12,844	7,453	5,682	12,989	2,011	4,068	14,751	705	976	1,941	4,843	3,411	2,576	623	341	4,453	82,784
9 Dbayeh / Antelias	6,141	3,147	2,335	6,123	1,323	9,095	3,848	705	17,333	5,597	388	164	2,158	1,305	682	470	8,558	69,372
10 Jal El Dib	11,527	2,358	3,174	8,558	1,990	11,672	2,996	976	5,597	12,540	776	200	2,123	1,382	882	517	6,165	73,433
11 Jamhour / Bchamoun	1,752	1,423	1,529	2,494	2,105	1,658	3,917	1,941	388	776	2,905	505	658	423	258	82	1,223	24,037
12 Damour	694	2,352	1,811	1,294	3,582	529	1,129	4,843	164	200	505	5,216	2,082	1,082	364	223	2,529	28,599
13 Southern Lebanon	3,918	7,107	6,620	6,120	7,244	4,378	4,090	3,411	2,158	2,123	658	2,082	176	1,829	435	235	4,813	57,397
14 Eastern Lebanon	2,752	4,977	4,594	4,629	5,767	3,384	3,095	2,576	1,305	1,382	423	1,082	1,829	435	305	117	3,770	42,422
15 Metn	1,988	905	1,317	2,635	1,411	1,929	1,082	623	682	882	258	364	435	305	35	35	1,388	16,274
16 High Metn	988	529	776	1,188	858	1,376	623	341	470	517	82	223	235	117	35	23	964	9,345
17 Northern Lebanon	12,343	8,527	8,338	12,363	9,777	15,209	8,002	4,453	8,558	6,165	1,223	2,529	4,813	3,770	1,388	964	2,282	110,704
Column Total	180,040	188,358	185,615	234,088	204,940	154,397	113,802	82,784	69,372	73,433	24,037	28,599	57,397	42,422	16,274	9,345	110,704	1,775,607

TABLE A . 6 - 2
YEAR 2010 DAILY TRIP MATRIX
(PCU's)

From District	To District 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Row Total
1 East Beirut	39,775	10,823	13,320	29,580	10,491	21,141	13,460	3,823	5,494	13,198	1,988	776	5,684	3,505	1,988	1,035	12,781	188,862
2 Central Beirut	10,823	34,783	33,678	22,963	30,816	7,394	7,513	13,234	4,076	2,743	1,541	2,435	8,578	5,683	1,200	682	10,581	198,723
3 West Beirut	13,320	33,678	40,096	31,446	26,682	8,296	6,948	7,594	2,794	3,856	1,729	1,800	8,362	5,417	1,729	1,023	11,381	206,151
4 Borj Hammoud / Sin El Fil	29,580	22,963	31,446	49,228	21,038	22,907	15,993	6,329	6,147	9,111	2,788	1,305	8,574	5,996	2,847	1,400	15,605	253,257
5 Borj El Brajneh / Ghobeiry	10,491	30,816	26,682	21,038	55,333	7,451	13,128	15,002	1,711	2,814	2,917	4,813	9,433	7,327	2,182	1,282	14,842	227,262
6 Jdaideh / Baouchrieh	21,141	7,394	8,296	22,907	7,451	36,171	8,896	2,376	10,508	14,410	1,776	623	6,437	4,255	2,047	1,352	15,575	171,615
7 Hazmieh / Baabda	13,460	7,513	6,948	15,993	13,128	8,896	24,693	5,915	5,120	3,420	4,352	1,588	6,178	3,977	1,423	811	10,256	133,671
8 Khaldeh / Choueifat	3,823	13,234	7,594	6,329	15,002	2,376	5,915	15,994	800	1,176	2,658	7,002	4,464	3,235	929	517	6,535	97,583
9 Dbayeh / Antelias	5,494	4,076	2,794	6,147	1,711	10,508	5,120	800	21,007	7,022	423	152	3,406	1,941	858	552	8,594	80,605
10 Jal El Dib	13,198	2,743	3,856	9,111	2,814	14,410	3,420	1,176	7,022	17,012	847	223	3,347	1,970	988	588	6,860	89,585
11 Jamhour / Bchamoun	1,988	1,541	1,729	2,788	2,917	1,776	4,352	2,658	423	847	3,529	729	952	576	294	105	1,611	28,815
12 Damour	776	2,435	1,800	1,305	4,813	623	1,588	7,002	152	223	729	8,334	3,164	1,670	600	352	4,041	39,607
13 Southern Lebanon	5,684	8,578	8,362	8,574	9,433	6,437	6,178	4,464	3,406	3,347	952	3,164	129	2,606	623	305	6,436	78,678
14 Eastern Lebanon	3,505	5,683	5,417	5,996	7,327	4,255	3,977	3,235	1,941	1,970	576	1,670	2,606	576	435	129	4,841	54,139
15 Metn	1,988	1,200	1,729	2,847	2,182	2,047	1,423	929	858	988	294	600	623	435	47	47	1,717	19,954
16 High Metn	1,035	682	1,023	1,400	1,282	1,352	811	517	552	588	105	352	305	129	47	35	1,211	11,426
17 Northern Lebanon	12,781	10,581	11,381	15,605	14,842	15,575	10,256	6,535	8,594	6,860	1,611	4,041	6,436	4,841	1,717	1,211	1,717	134,584
Column Total	188,862	198,723	206,151	253,257	227,262	171,615	133,671	97,583	80,605	89,585	28,815	39,607	78,678	54,139	19,954	11,426	134,584	2,014,517

TABLE A . 6 - 3
YEAR 2015 DAILY TRIP MATRIX
(PCU's)

From District	To District 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Row Total
1 East Beirut	40,410	11,948	17,047	28,185	12,547	18,034	14,572	4,729	4,729	15,214	2,247	917	7,802	4,447	2,000	1,070	13,240	199,138
2 Central Beirut	11,948	35,989	34,193	24,325	29,558	7,771	8,645	13,728	5,172	3,190	1,705	2,517	10,369	6,542	1,541	858	13,016	211,067
3 West Beirut	17,047	34,193	46,581	34,270	25,727	9,400	8,549	7,782	3,323	4,640	1,988	1,823	10,456	6,389	2,235	1,294	15,048	230,745
4 Borj Hammoud / Sin El Fil	28,185	24,325	34,270	53,756	22,791	25,291	16,236	7,048	6,142	9,790	3,235	1,294	11,503	7,637	3,152	1,694	19,489	275,838
5 Borj El Brajneh / Ghobeiry	12,547	29,558	25,727	22,791	55,527	9,502	17,344	17,350	2,135	3,785	3,894	6,342	12,081	9,185	3,100	1,800	20,938	253,606
6 Jdaideh / Baouchrieh	18,034	7,771	9,400	25,291	9,502	43,586	9,580	2,811	12,222	17,690	2,000	717	8,903	5,290	2,188	1,341	15,963	192,289
7 Hazmieh / Baabda	14,572	8,645	8,549	16,236	17,344	9,580	27,078	8,134	6,698	3,997	4,858	2,105	8,649	5,048	1,870	1,047	12,969	157,379
8 Khaldeh / Choueifat	4,729	13,728	7,782	7,048	17,350	2,811	8,134	17,460	894	1,411	3,535	9,609	5,723	4,064	1,317	729	9,071	115,395
9 Dbayeh / Antelias	4,729	5,172	3,323	6,142	2,135	12,222	6,698	894	25,395	8,695	494	152	4,911	2,694	1,070	647	8,629	94,002
10 Jal El Dib	15,214	3,190	4,640	9,790	3,785	17,690	3,997	1,411	8,695	22,441	917	270	4,801	2,676	1,117	635	7,707	108,976
11 Jamhour / Bchamoun	2,247	1,705	1,988	3,235	3,894	2,000	4,858	3,535	494	917	4,317	1,035	1,305	776	352	164	2,070	34,892
12 Damour	917	2,517	1,823	1,294	6,342	717	2,105	9,609	152	270	1,035	12,098	4,470	2,364	870	505	5,853	52,941
13 Southern Lebanon	7,802	10,369	10,456	11,503	12,081	8,903	8,649	5,723	4,911	4,801	1,305	4,470	70	3,547	847	400	8,401	104,238
14 Eastern Lebanon	4,447	6,542	6,389	7,637	9,185	5,290	5,048	4,064	2,694	2,676	776	2,364	3,547	741	576	141	6,130	68,247
15 Metn	2,000	1,541	2,235	3,152	3,100	2,188	1,870	1,317	1,070	1,117	352	870	847	576	58	70	2,123	24,486
16 High Metn	1,070	858	1,294	1,694	1,800	1,341	1,047	729	647	635	164	505	400	141	70	35	1,494	13,924
17 Northern Lebanon	13,240	13,016	15,048	19,489	20,938	15,963	12,969	9,071	8,629	7,707	2,070	5,853	8,401	6,130	2,123	1,494	1,058	163,199
Column Total	199,138	211,067	230,745	275,838	253,606	192,289	157,379	115,395	94,002	108,976	34,892	52,941	104,238	68,247	24,486	13,924	163,199	2,300,362

TABLE A . 6 - 4
YEAR 2020 DAILY TRIP MATRIX
(PCU's)

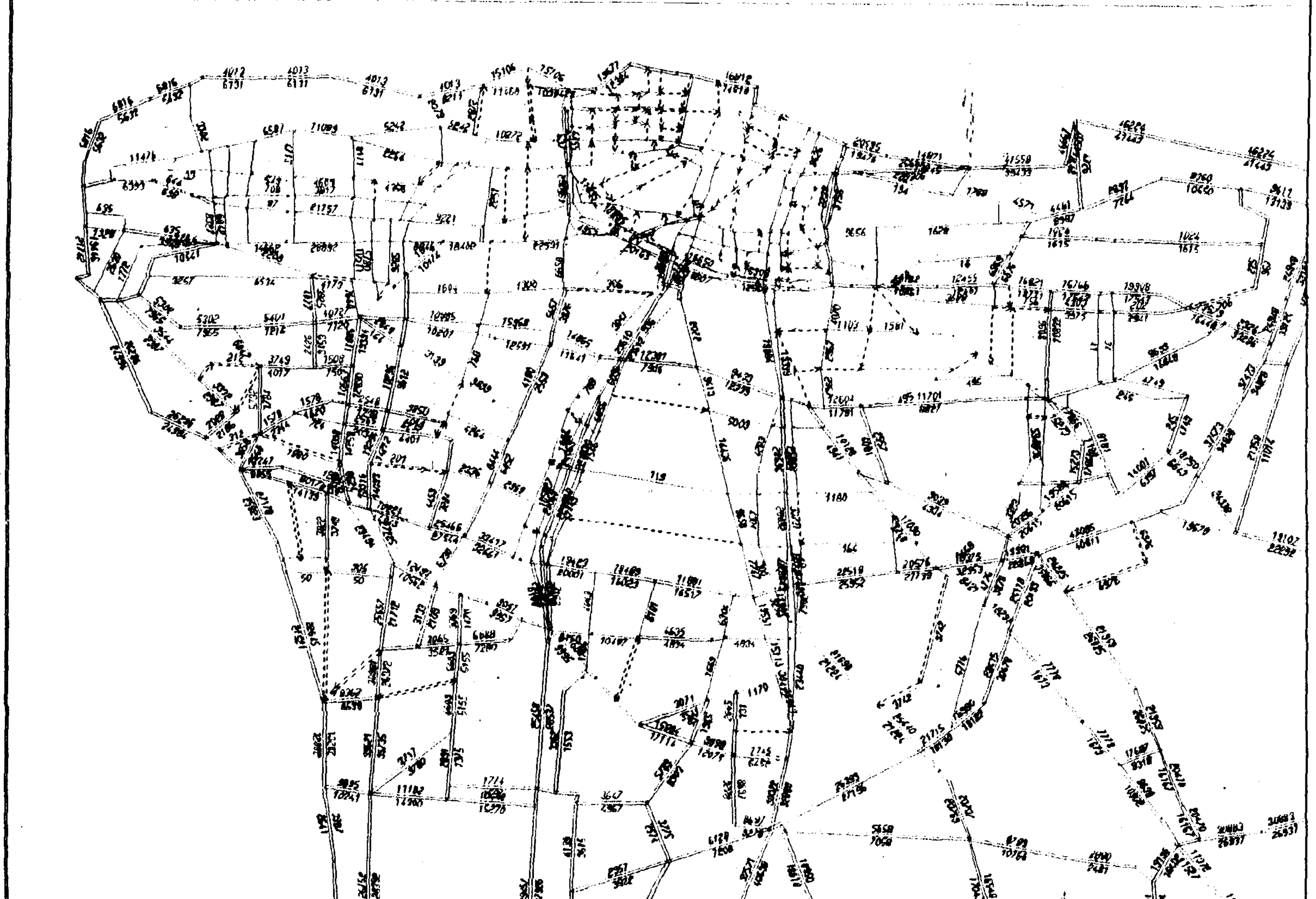
From District	To District 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Row Total
1 East Beirut	41,035	13,100	20,816	26,884	14,695	14,924	15,698	5,564	3,917	17,161	2,529	988	9,922	5,382	2,000	1,129	13,740	209,484
2 Central Beirut	12,570	37,162	34,767	25,718	28,270	8,175	9,830	14,177	6,284	3,661	1,847	2,617	12,128	7,384	1,882	1,058	15,500	223,030
3 West Beirut	20,816	34,767	53,021	37,108	24,824	10,552	10,224	8,001	3,853	5,493	2,176	1,823	12,528	7,402	2,747	1,564	18,708	255,607
4 Borj Hammoud / Sin El Fil	26,884	25,718	37,108	58,095	24,684	27,658	16,496	7,777	6,204	10,488	3,600	1,329	14,464	9,261	3,458	1,952	23,380	298,556
5 Borj El Brajneh / Ghobeiry	14,695	28,270	24,824	24,684	55,794	11,606	21,588	19,747	2,601	4,775	4,847	7,767	14,758	11,044	4,041	2,317	27,029	280,387
6 Jdaideh / Baouchrieh	14,924	8,175	10,552	27,658	11,606	50,990	10,301	3,264	13,931	20,977	2,176	800	11,398	6,314	2,358	1,305	16,389	213,118
7 Hazmieh / Baabda	15,698	9,830	10,224	16,496	21,588	10,301	29,511	10,347	8,216	4,550	5,370	2,629	11,150	6,114	2,288	1,282	15,700	181,294
8 Khaldeh / Choueifat	5,564	14,177	8,001	7,777	19,747	3,264	10,347	18,927	988	1,647	4,417	12,192	6,994	4,900	1,682	941	11,596	133,161
9 Dbayeh / Antelias	3,917	6,284	3,853	6,204	2,601	13,931	8,216	988	29,822	10,336	517	188	6,441	3,453	1,294	741	8,683	107,469
10 Jal El Dib	17,161	3,661	5,493	10,488	4,775	20,977	4,550	1,647	10,336	27,842	976	305	6,271	3,370	1,270	705	8,542	128,369
11 Jamhour / Bchamoun	2,529	1,847	2,176	3,600	4,847	2,176	5,370	4,417	517	976	5,058	1,305	1,647	988	411	176	2,529	40,569
12 Damour	988	2,617	1,823	1,329	7,767	800	2,629	12,192	188	305	1,305	15,841	5,782	3,070	1,152	658	7,695	66,141
13 Southern Lebanon	9,922	12,128	12,528	14,464	14,758	11,398	11,150	6,994	6,441	6,271	1,647	5,782	23	4,488	1,070	494	10,361	129,919
14 Eastern Lebanon	5,382	7,384	7,402	9,261	11,044	6,314	6,114	4,900	3,453	3,370	988	3,070	4,488	905	717	164	7,401	82,357
15 Metn	2,000	1,882	2,747	3,458	4,041	2,358	2,288	1,682	1,294	1,270	411	1,152	1,070	717	58	82	2,523	29,033
16 High Metn	1,129	1,058	1,564	1,952	2,317	1,305	1,282	941	741	705	176	658	494	164	82	47	1,788	16,403
17 Northern Lebanon	13,740	15,500	18,708	23,380	27,029	16,389	15,700	11,596	8,683	8,542	2,529	7,695	10,361	7,401	2,523	1,788	388	191,952
Column Total	208,954	223,560	255,607	298,556	280,387	213,118	181,294	133,161	107,469	128,369	40,569	66,141	129,919	82,357	29,033	16,403	191,952	2,586,849

SAMPLES OF EMME/2 OUTPUT

- **Year 1998 Calibration**
- **Year 2005 Base Case**
- **Year 2010 Improved Case 1 (Traffic Signals)**
- **Year 2015 Improved Case 2 (Parking Management)**
- **Year 2005 Improved Case 3 (Grade Separation I)**
- **Year 2010 Improved Case 4 (Grade Separation II)**
- **Year 2015 Improved Case 5 (Grade Separation III)**
- **Year 2015 Improved Case (Parking Structures)**
- **Year 2015 Combination of All Improvements**

BASE NETWORK

ATTRIB. @ADTS: ASSIGNED DAILY VOLUMES



LINKS:
!vdf=1

THRESHOLD:
UPPER: ******

WINDOW:
20.517/24.6995
26.75/29.3737

EMME/2 PROJECT: Beirut Urban Transport Project
SCENARIO 1998: 1998 Calibration - Roadway Network
ATTRIB. @adts: Assigned Daily Volumes

99-02-18 11:06
MODULE: 2.13
.........1k

FIGURE A. 6 - 1

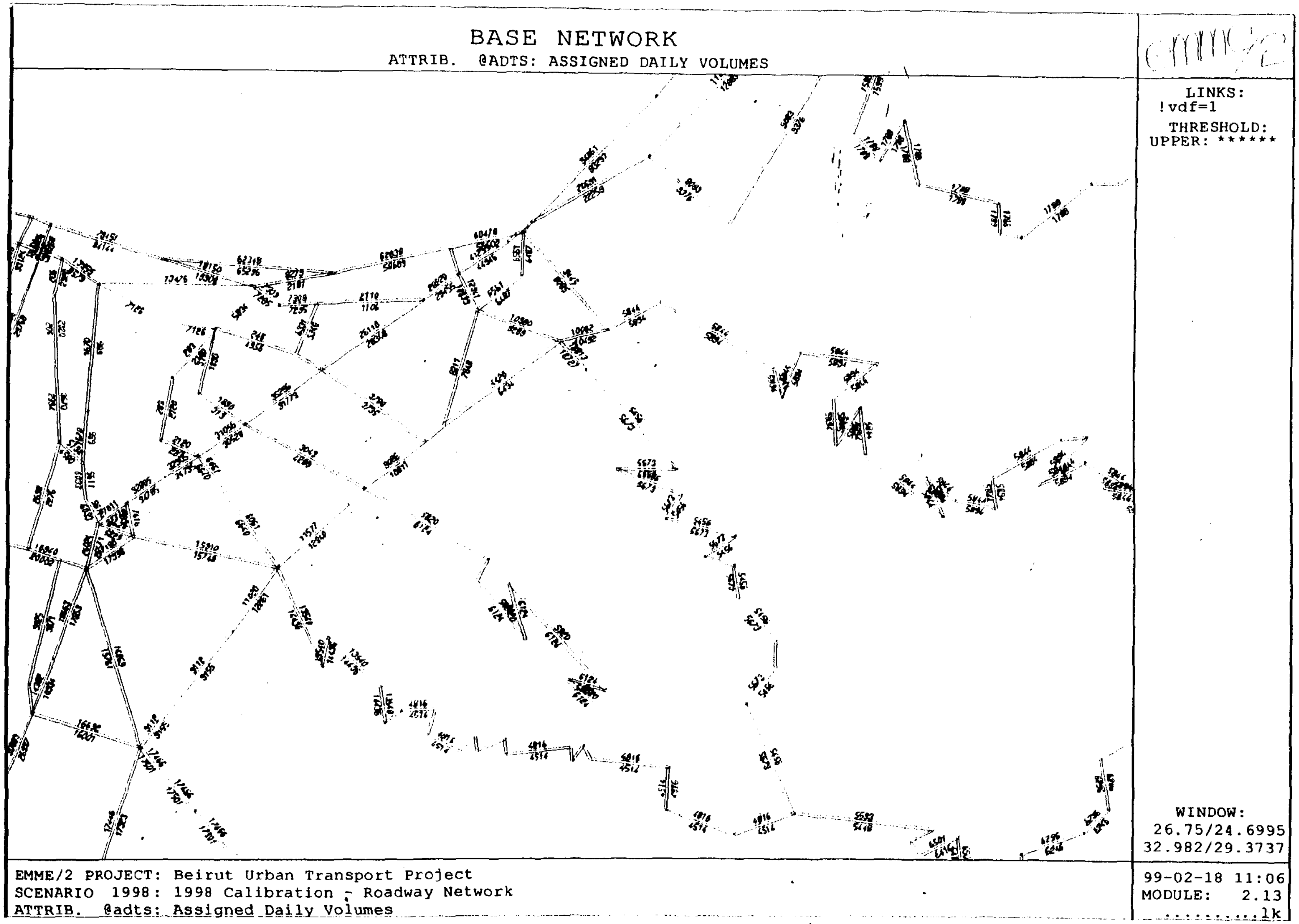
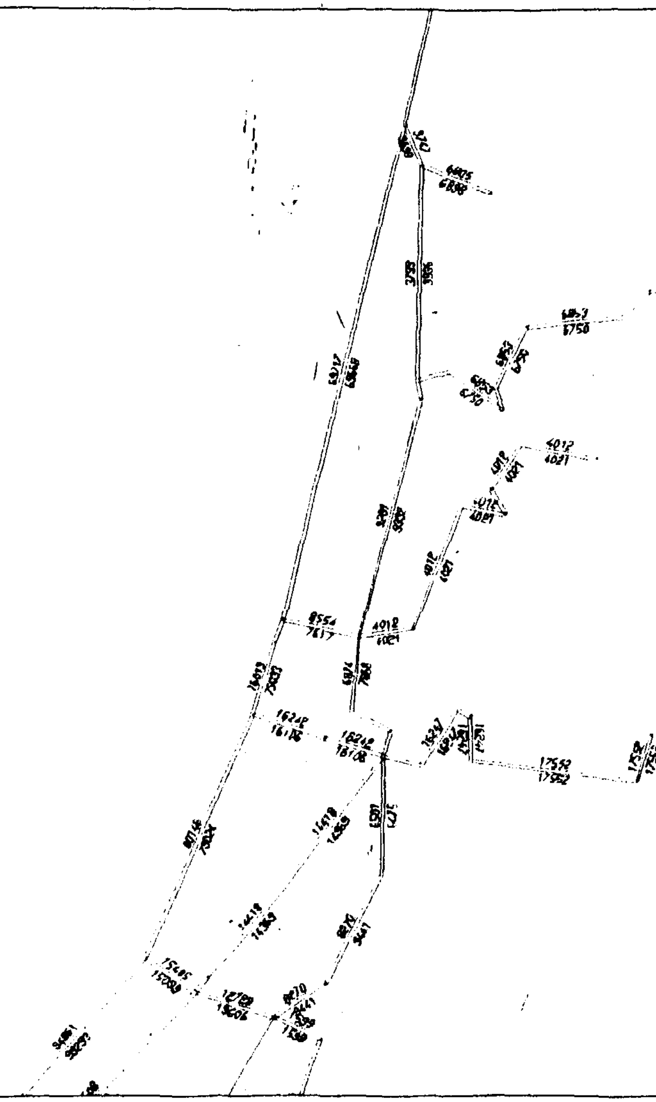

BASE NETWORK
ATTRIB. @ADTS: ASSIGNED DAILY VOLUMES
emme/2
LINKS:
!vdf=1
THRESHOLD:
UPPER: ******
WINDOW:
26.75/24.6995
32.982/29.3737
EMME/2 PROJECT: Beirut Urban Transport Project
SCENARIO 1998: 1998 Calibration - Roadway Network
ATTRIB. @adts: Assigned Daily Volumes
99-02-18 11:06
MODULE: 2.13
..........lk

FIGURE A. 6 - 2

BASE NETWORK
ATTRIB. @ADTS: ASSIGNED DAILY VOLUMES

emme2

LINKS:
!vdf=1
THRESHOLD:
UPPER: ******



WINDOW:
26.75/29.3737
32.982/ 34.048

EMME/2 PROJECT: Beirut Urban Transport Project
SCENARIO 1998: 1998 Calibration - Roadway Network
ATTRIB. @adts: Assigned Daily Volumes

99-02-18 11:06
MODULE: 2.13
..........lk

FIGURE A. 6 - 3

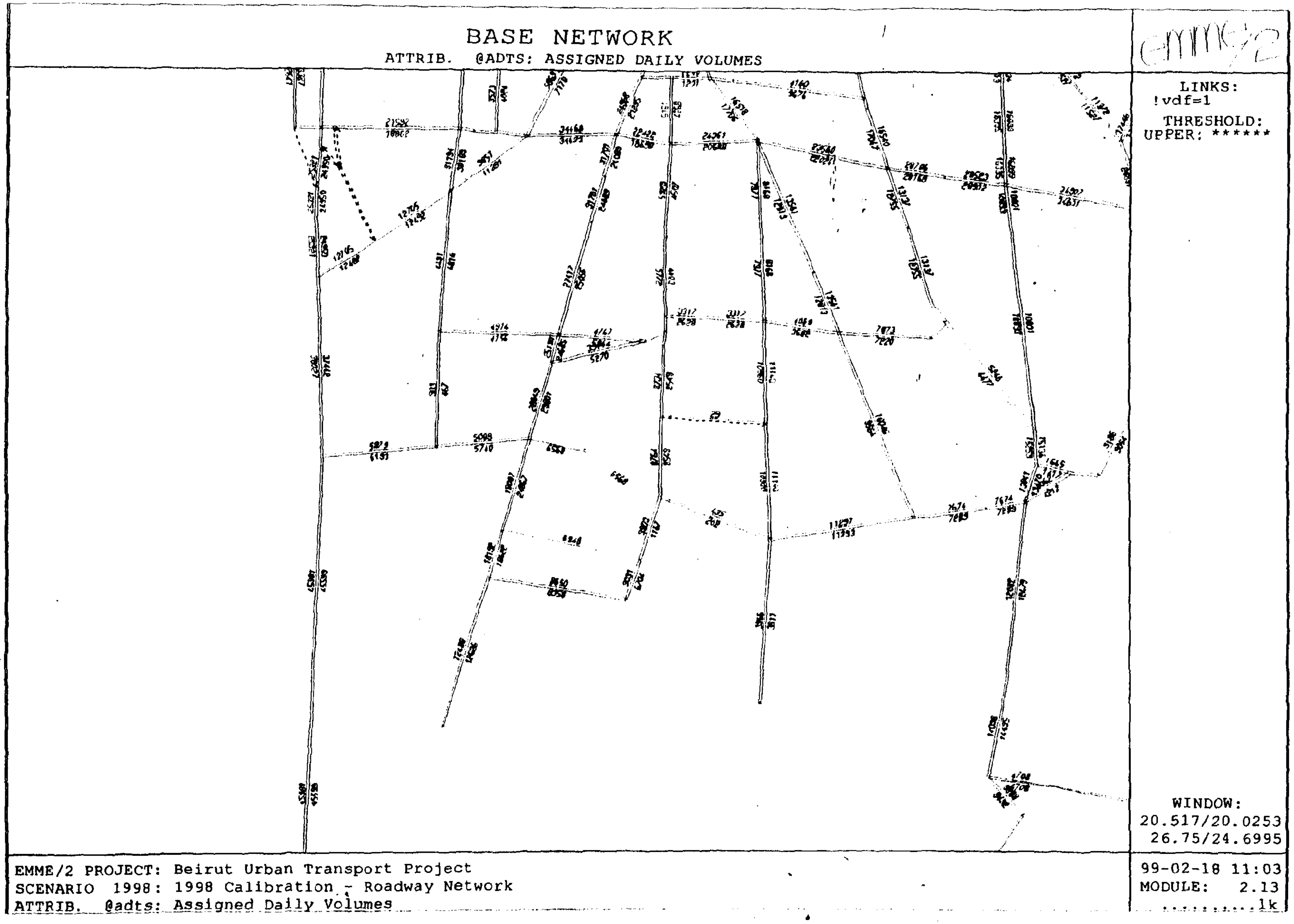

BASE NETWORK
ATTRIB. @ADTS: ASSIGNED DAILY VOLUMES
emme/2
LINKS:
!vdf=1
THRESHOLD:
UPPER: ******
WINDOW:
20.517/20.0253
26.75/24.6995
EMME/2 PROJECT: Beirut Urban Transport Project
SCENARIO 1998: 1998 Calibration - Roadway Network
ATTRIB. @adts: Assigned Daily Volumes
99-02-18 11:03
MODULE: 2.13
..........1k

FIGURE A. 6 - 4

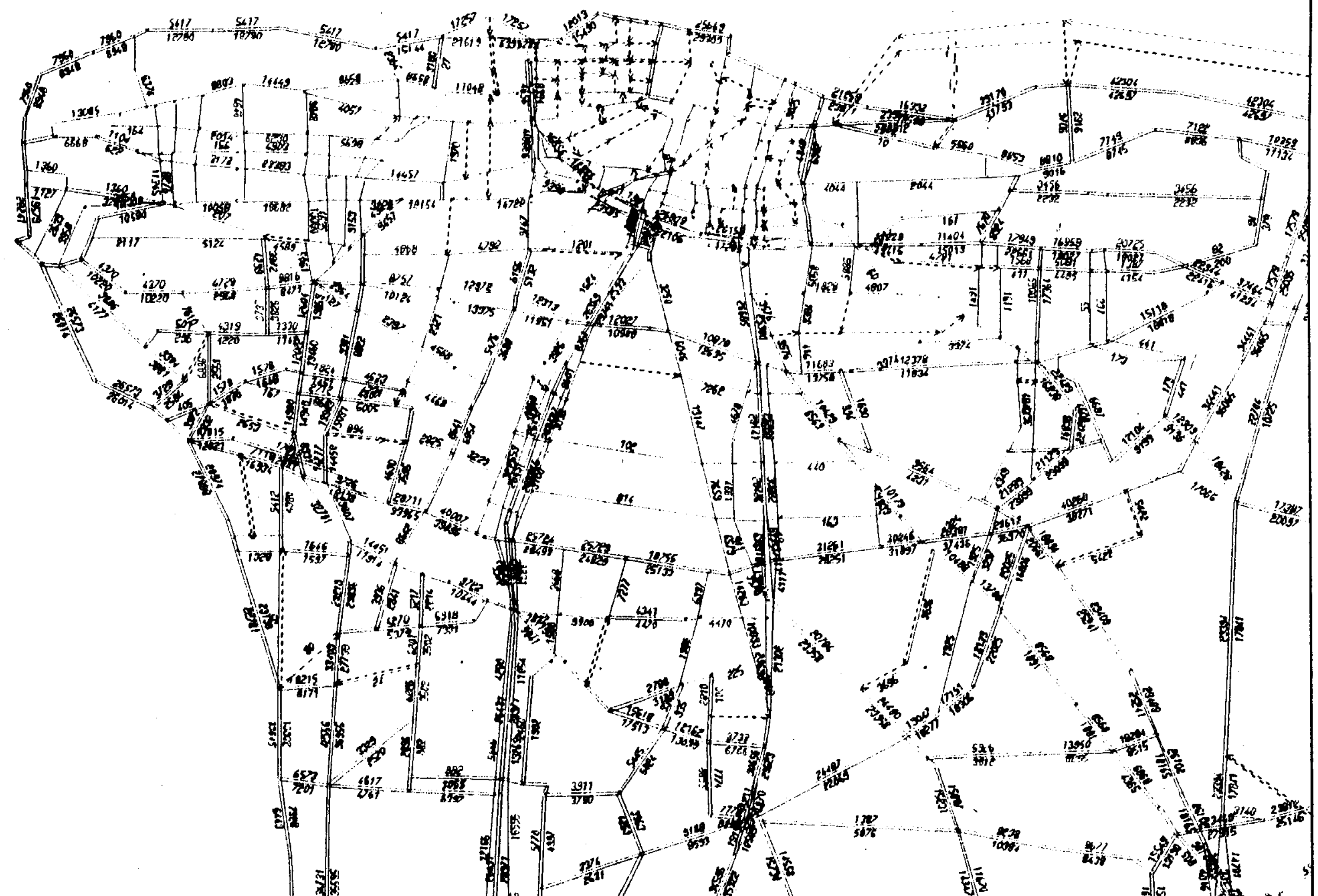
BASE NETWORK

ATTRIB. @ADTS: ASSIGNED DAILY VOLUMES

emme/2

LINKS:
!vdf=1

THRESHOLD:
UPPER: ******



WINDOW:
20.517/24.6995
26.75/29.3737

EMME/2 PROJECT: Beirut Urban Transport Project
SCENARIO 2905: Year 2005 Roadway Network (With Tolls)
ATTRIB. @adts: Assigned Daily Volumes

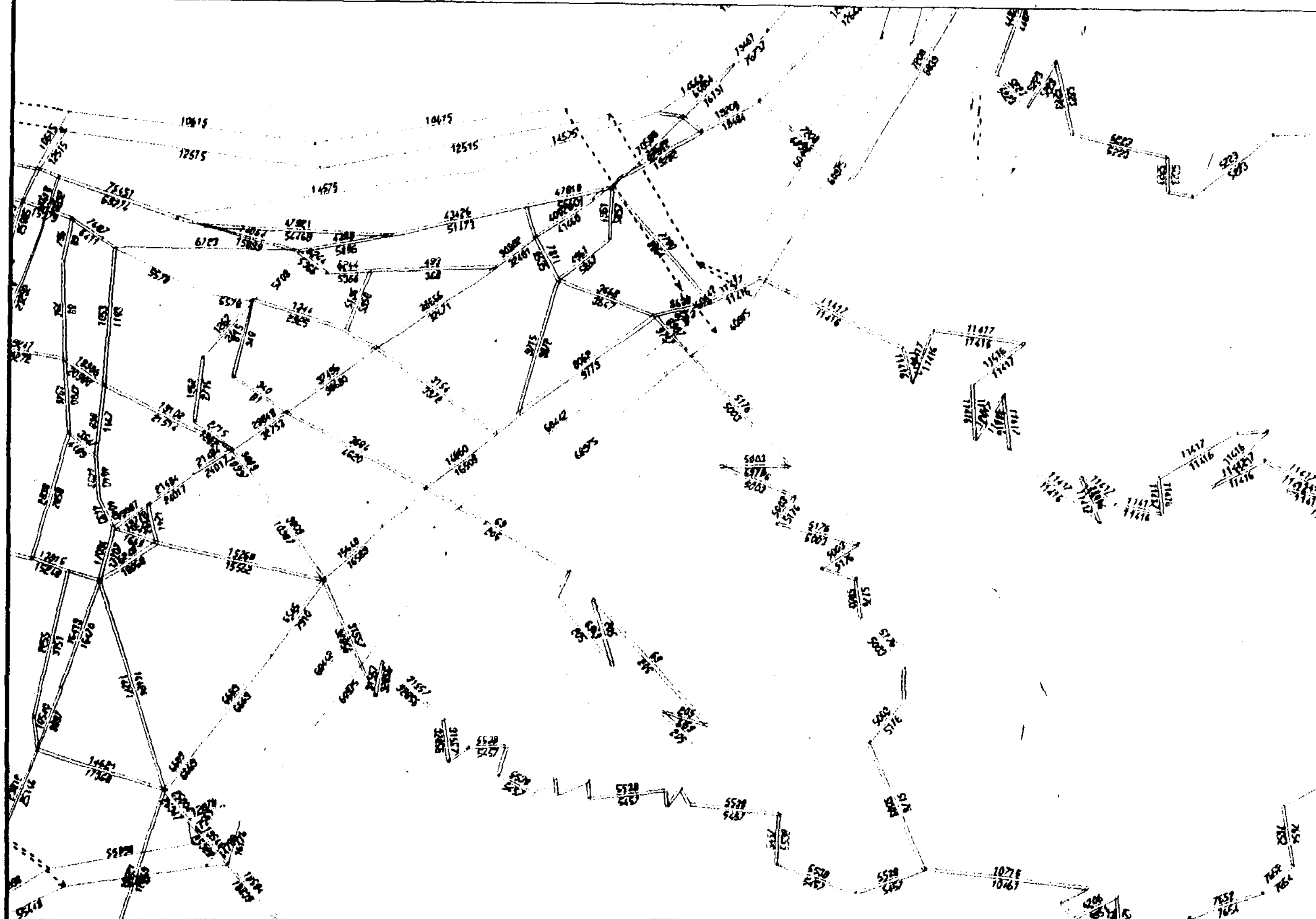
99-02-18 13:04
MODULE: 2.13
..........1k

FIGURE A. 6 - 5

BASE NETWORK

ATTRIB. @ADTS: ASSIGNED DAILY VOLUMES

emme/2



LINKS:
!vdf=1

THRESHOLD:
UPPER: ******

WINDOW:
26.75/24.6995
32.982/29.3737

EMME/2 PROJECT: Beirut Urban Transport Project
SCENARIO 2905: Year 2005 Roadway Network (With Tolls)
ATTRIB. @adts: Assigned Daily Volumes

99-02-18 12:55
MODULE: 2.13
...........lk

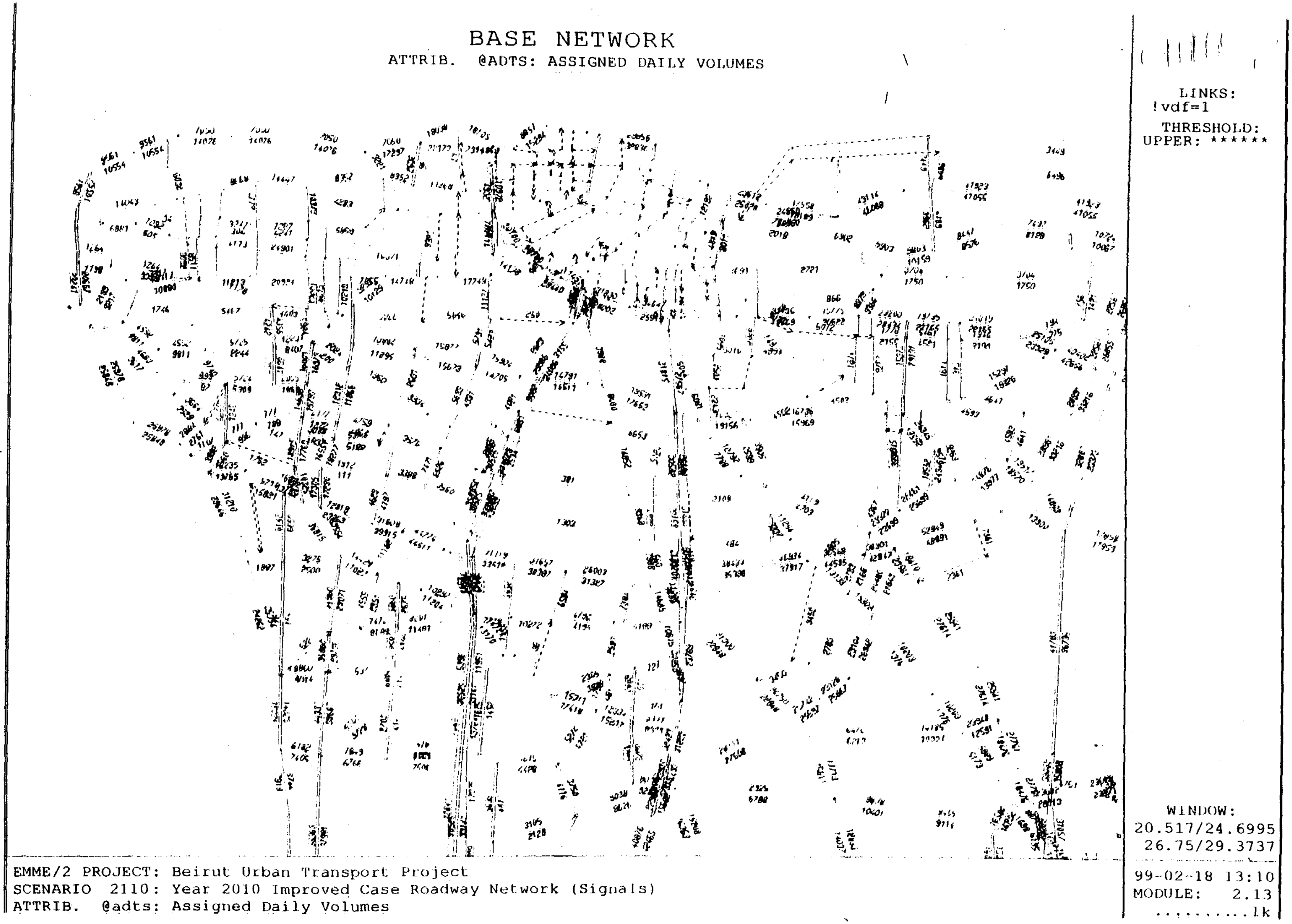

BASE NETWORK
ATTRIB. @ADTS: ASSIGNED DAILY VOLUMES
LINKS:
!vdf=1
THRESHOLD:
UPPER: ******
WINDOW:
20.517/24.6995
26.75/29.3737
EMME/2 PROJECT: Beirut Urban Transport Project
SCENARIO 2110: Year 2010 Improved Case Roadway Network (Signals)
ATTRIB. @adts: Assigned Daily Volumes
99-02-18 13:10
MODULE: 2.13
..........lk

FIGURE A. 6 - 7

BASE NETWORK

ATTRIB. @ADTS: ASSIGNED DAILY VOLUMES

LINKS:
!vdf=1

THRESHOLD:
UPPER: ******

WINDOW:
26.75/24.6995
32.982/29.3737

EMME/2 PROJECT: Beirut Urban Transport Project
SCENARIO 2110: Year 2010 Improved Case Roadway Network (Signals)
ATTRIB. @adts: Assigned Daily Volumes

99-02-18 13:11
MODULE: 2.13
..........1k

FIGURE A. 6 - 8

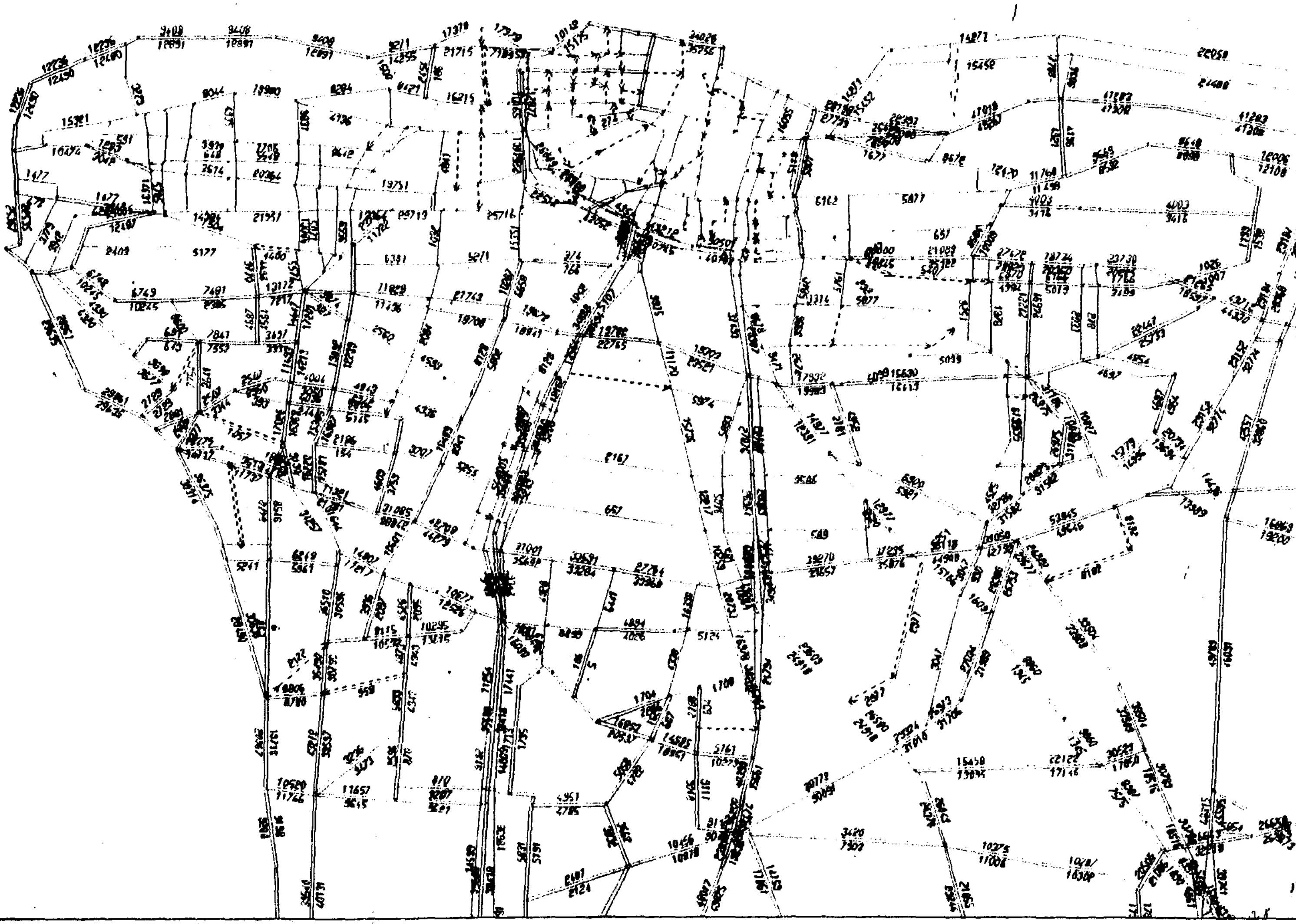
BASE NETWORK

ATTRIB. @ADTS: ASSIGNED DAILY VOLUMES

emme/2

LINKS:
!vdf=1

THRESHOLD:
UPPER: ******



WINDOW:
20.517/24.6995
26.75/29.3737

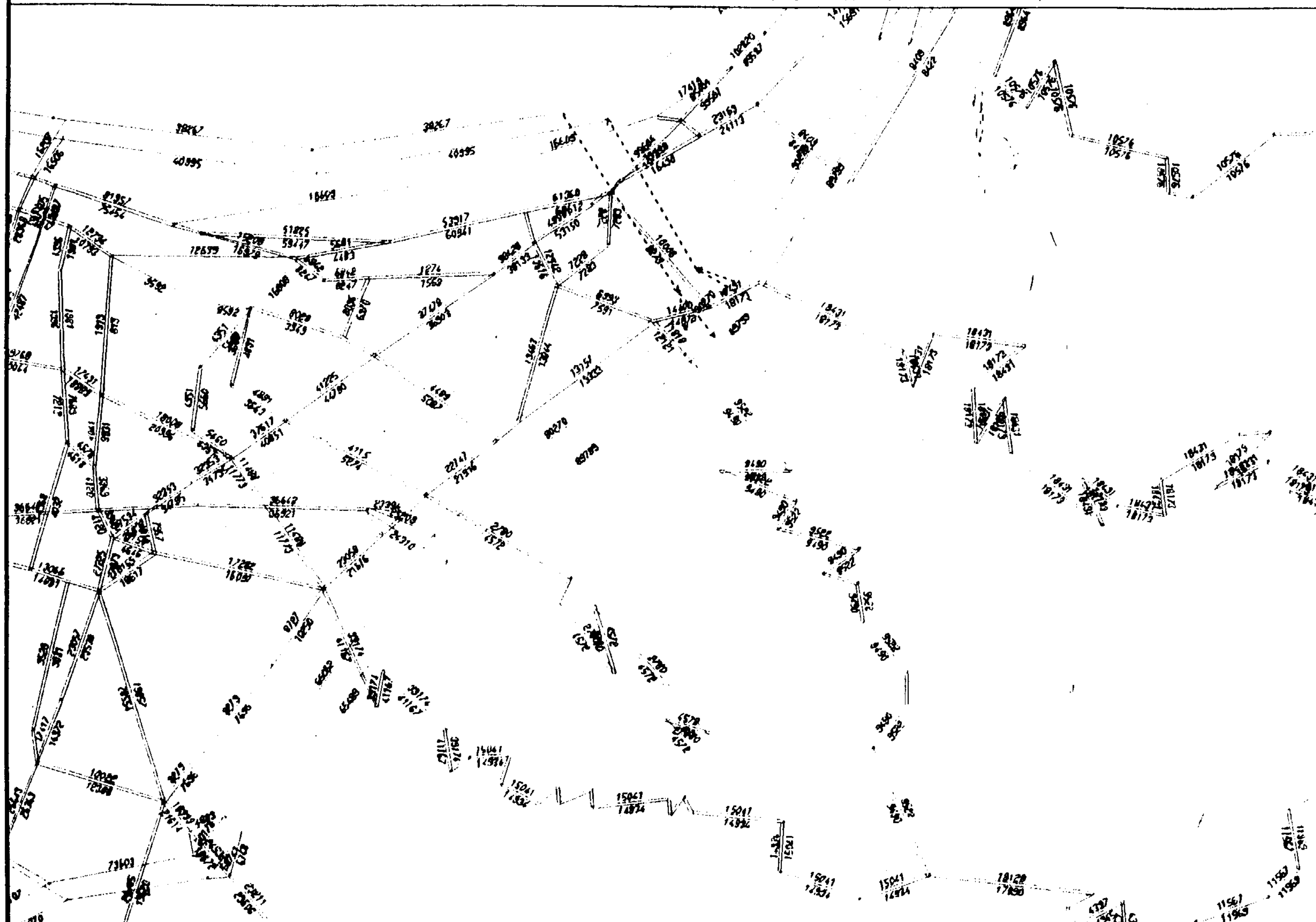
EMME/2 PROJECT: Beirut Urban Transport Project
SCENARIO 2215: Year 2015 Improved Case 2 (Parking)
ATTRIB. @adts: Assigned Daily Volumes

99-02-18 13:31
MODULE: 2.13
..........1k

FIGURE A. 6 - 9

BASE NETWORK

ATTRIB. @ADTS: ASSIGNED DAILY VOLUMES



LINKS:
!vdf=1

THRESHOLD:
UPPER: ******

WINDOW:
26.75/24.6995
32.982/29.3737

EMME/2 PROJECT: Beirut Urban Transport Project
SCENARIO 2215: Year 2015 Improved Case 2 (Parking)
ATTRIB. @adts: Assigned Daily Volumes

99-02-18 13:31
MODULE: 2.13
..........lk

FIGURE A. 6 - 10

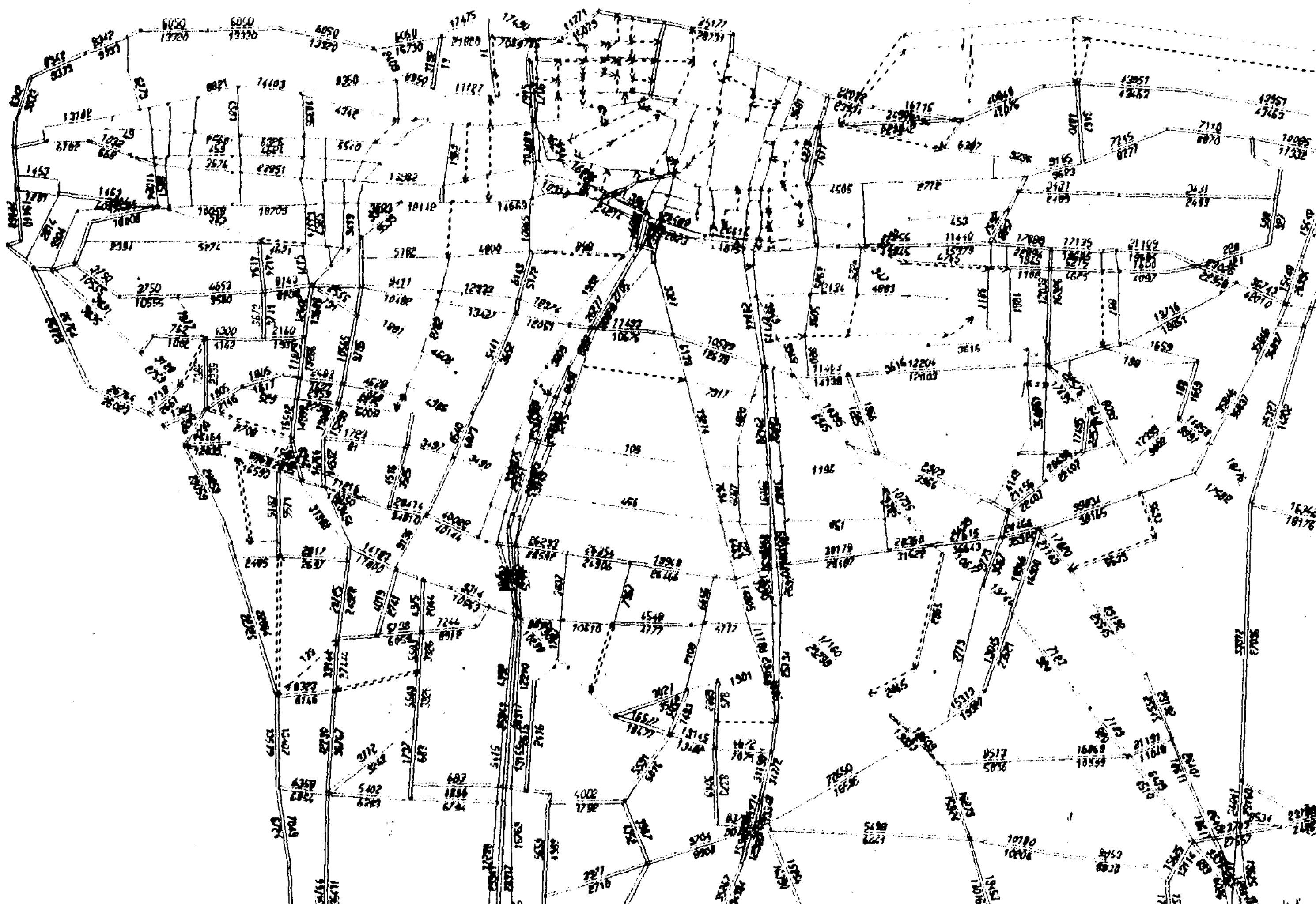
BASE NETWORK

ATTRIB. @ADTS: ASSIGNED DAILY VOLUMES

emme/2

LINKS:
!vdf=1

THRESHOLD:
UPPER: ******



WINDOW:
20.517/24.6995
26.75/29.3737

EMME/2 PROJECT: Beirut Urban Transport Project
SCENARIO 2305: Year 2005 Improved Case 3 (GS I)
ATTRIB. @adts: Assigned Daily Volumes

99-02-18 13:35
MODULE: 2.13
..........1k

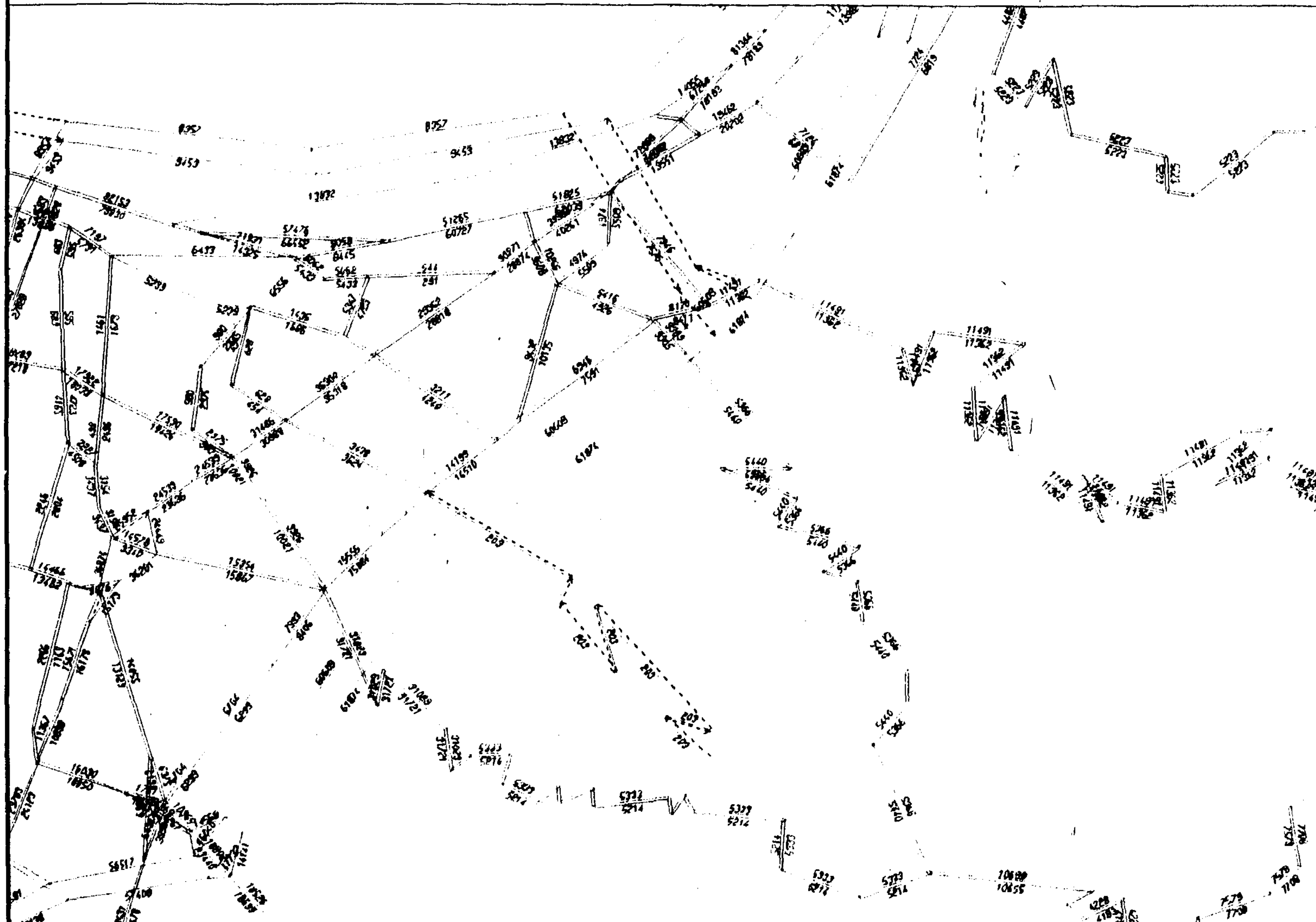
FIGURE A. 6 - 11

BASE NETWORK

ATTRIB. @ADTS: ASSIGNED DAILY VOLUMES

LINKS:
!vdf=1

THRESHOLD:
UPPER: ******



WINDOW:
26.75/24.6995
32.982/29.3737

EMME/2 PROJECT: Beirut Urban Transport Project
SCENARIO 2305: Year 2005 Improved Case 3 (GS I)
ATTRIB. @adts: Assigned Daily Volumes

99-02-18 13:35
MODULE: 2.13
..........:lk

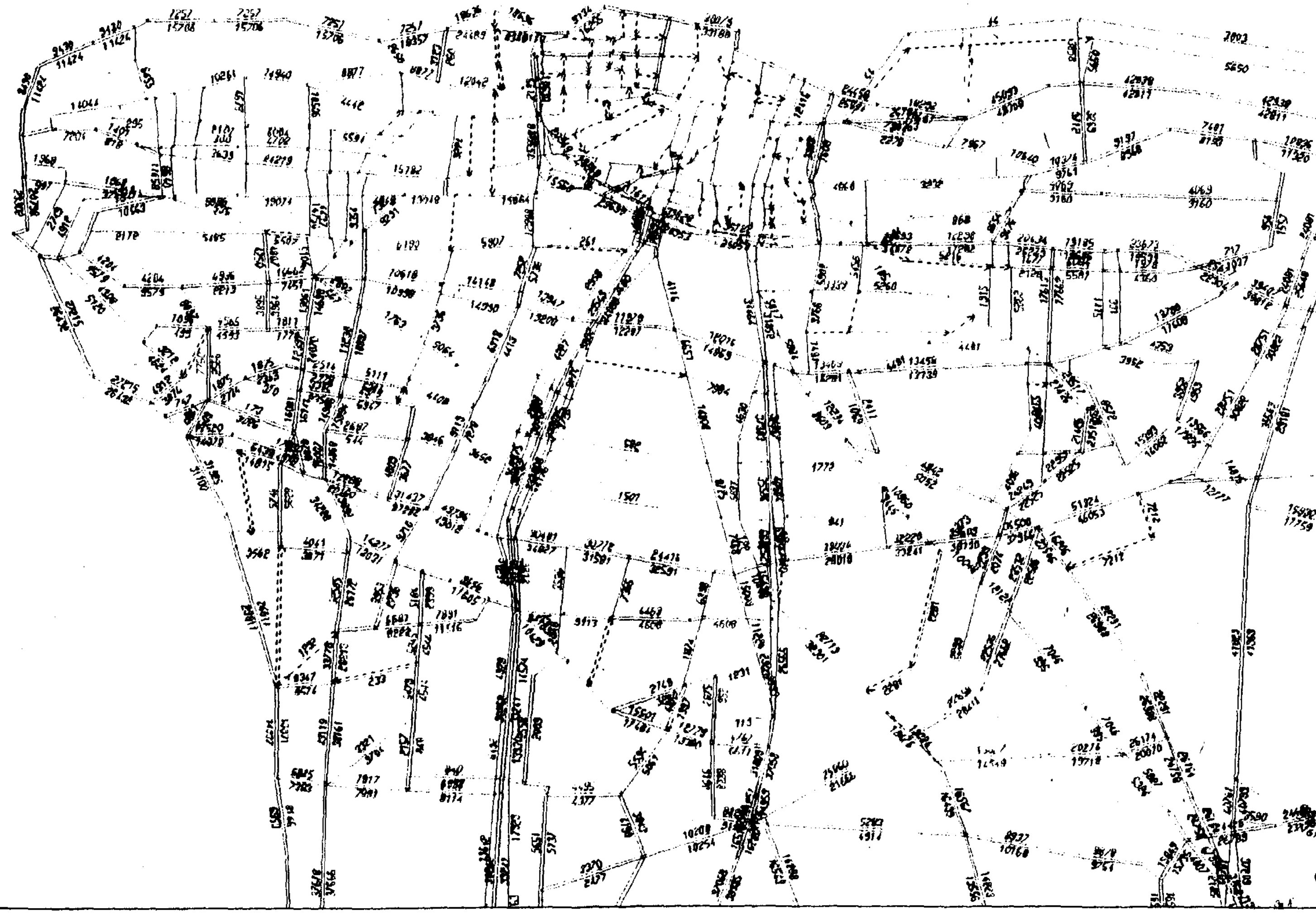
FIGURE A. 6 - 12

BASE NETWORK

ATTRIB. @ADTS: ASSIGNED DAILY VOLUMES

LINKS:
!vdf=1

THRESHOLD:
UPPER: ******



WINDOW:
20.517/24.6995
26.75/29.3737

EMME/2 PROJECT: Beirut Urban Transport Project
SCENARIO 2410: Year 2010 Improved Case 4 (GS II)
ATTRIB. @adts: Assigned Daily Volumes

99-02-18 13:44
MODULE: 2.13
..........lk

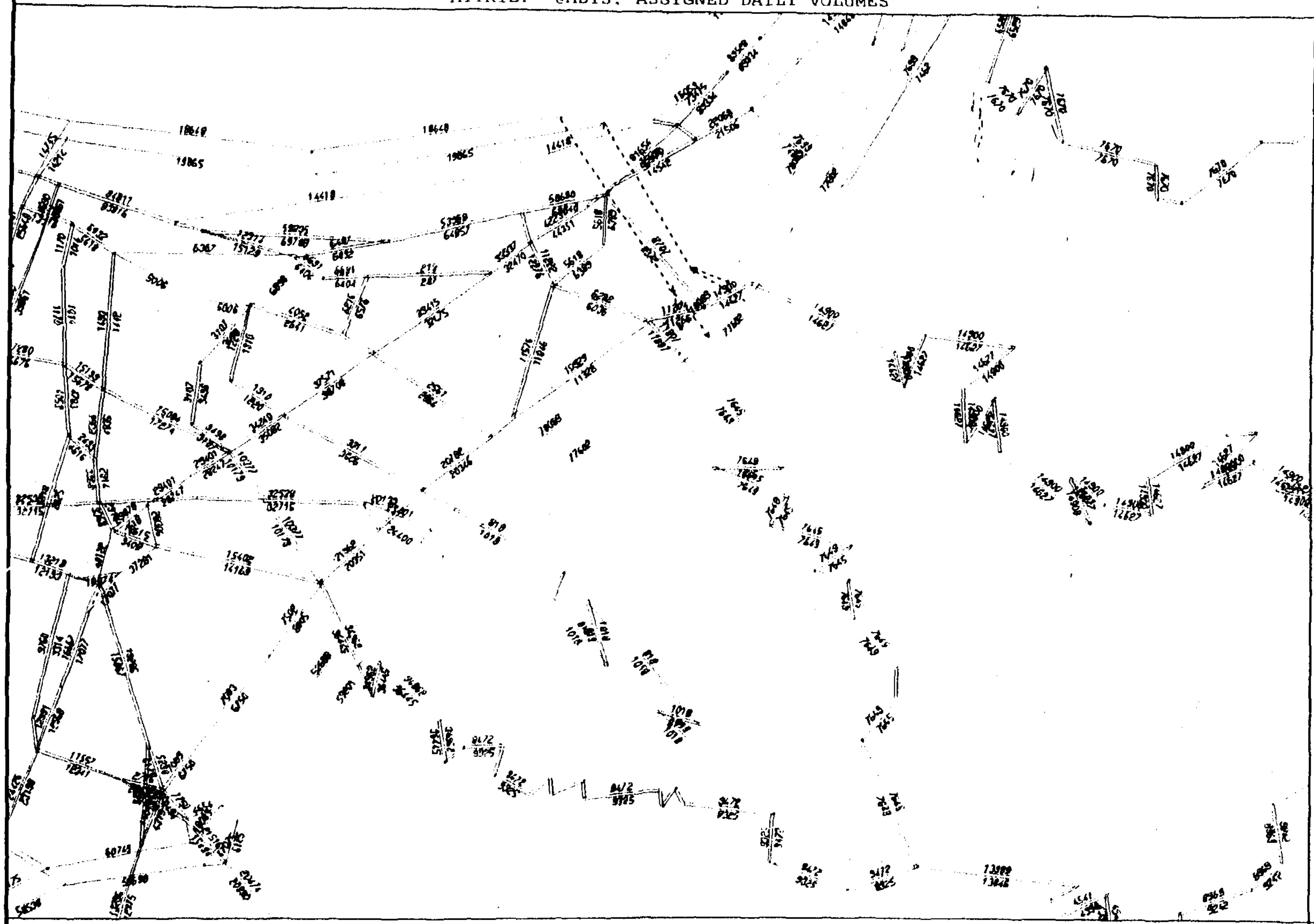
FIGURE A. 6 - 13

BASE NETWORK

ATTRIB. @ADTS: ASSIGNED DAILY VOLUMES

LINKS:
!vdf=1

THRESHOLD:
UPPER: ******



WINDOW:
26.75/24.6995
32.982/29.3737

EMME/2 PROJECT: Beirut Urban Transport Project
SCENARIO 2410: Year 2010 Improved Case 4 (GS II)
ATTRIB. @adts: Assigned Daily Volumes

99-02-18 13:42
MODULE: 2.13
..........lk

FIGURE A. 6 - 14

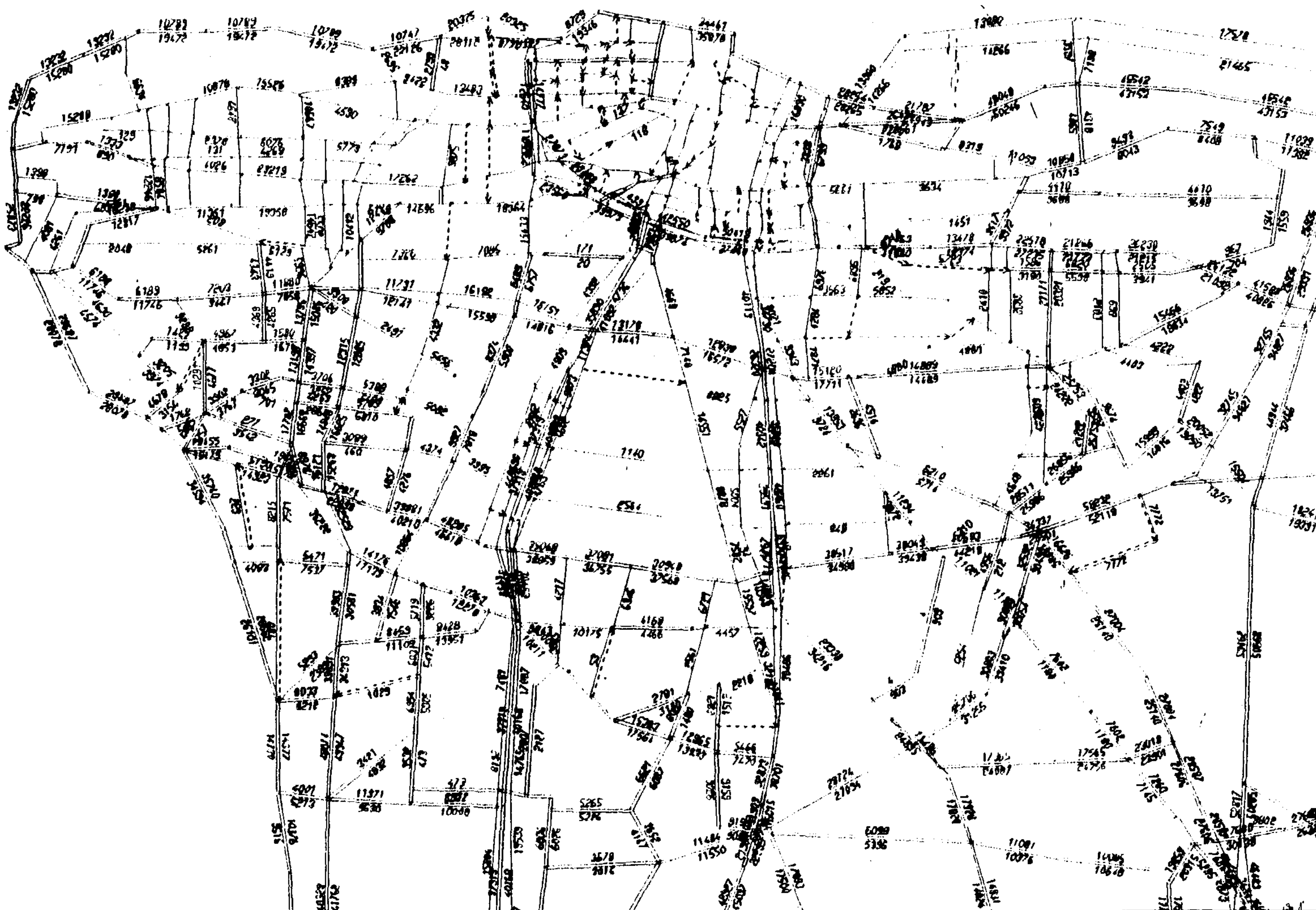
BASE NETWORK

ATTRIB. @ADTS: ASSIGNED DAILY VOLUMES

emme/2

LINKS:
!vdf=1

THRESHOLD:
UPPER: ******



WINDOW:
20.517/24.6995
26.75/29.3737

EMME/2 PROJECT: Beirut Urban Transport Project
SCENARIO 2515: Year 2015 Improved Case 5 (GS III)
ATTRIB. @adts: Assigned Daily Volumes

99-02-18 13:54
MODULE: 2.13
..........lk

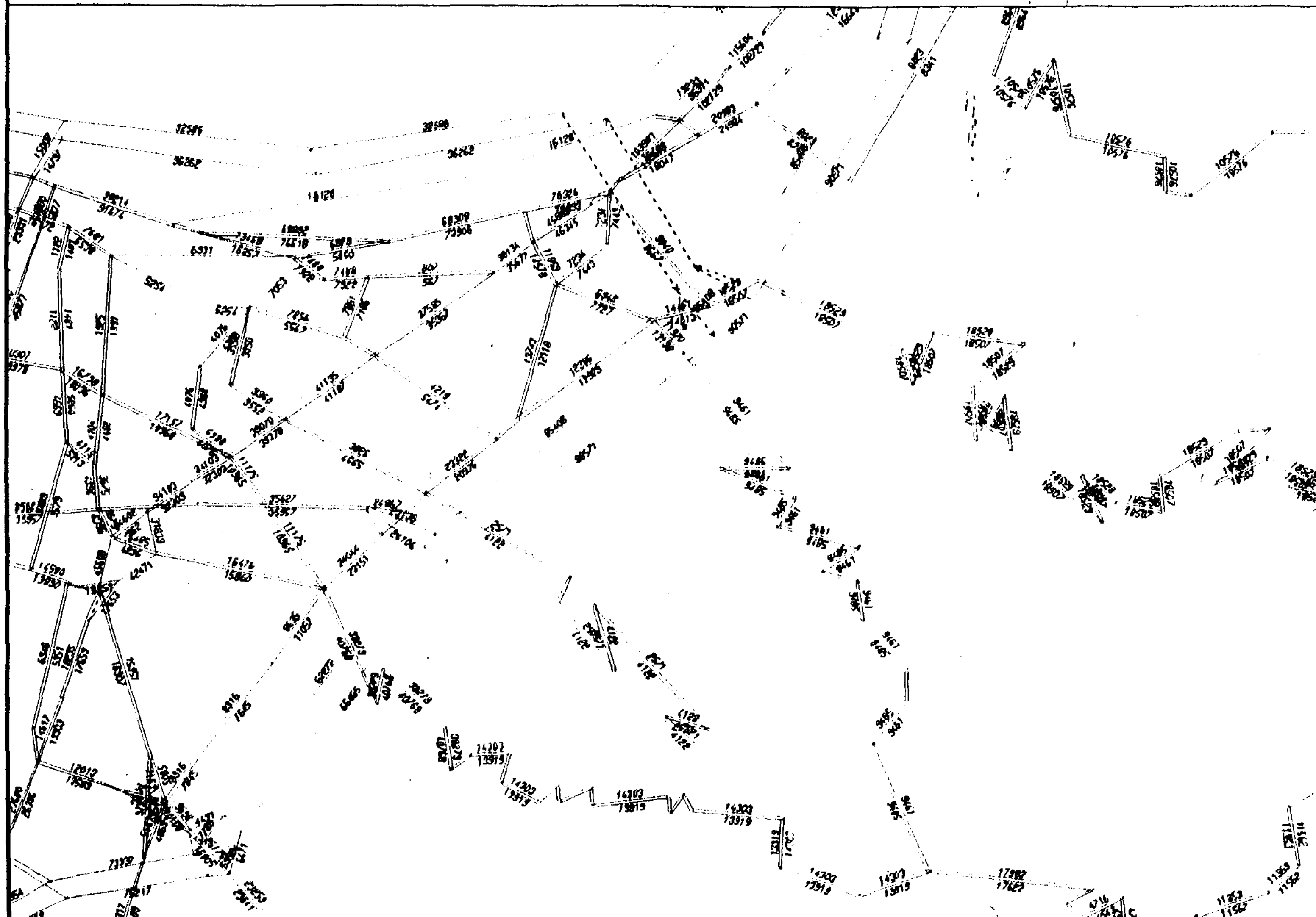
FIGURE A. 6 - 15

BASE NETWORK

ATTRIB. @ADTS: ASSIGNED DAILY VOLUMES

LINKS:
!vdf=1

THRESHOLD:
UPPER: ******



WINDOW:
26.75/24.6995
32.982/29.3737

EMME/2 PROJECT: Beirut Urban Transport Project
SCENARIO 2515: Year 2015 Improved Case 5 (GS III)
ATTRIB. @adts: Assigned Daily Volumes

99-02-18 13:54
MODULE: 2.13
..........lk

FIGURE A. 6 - 16

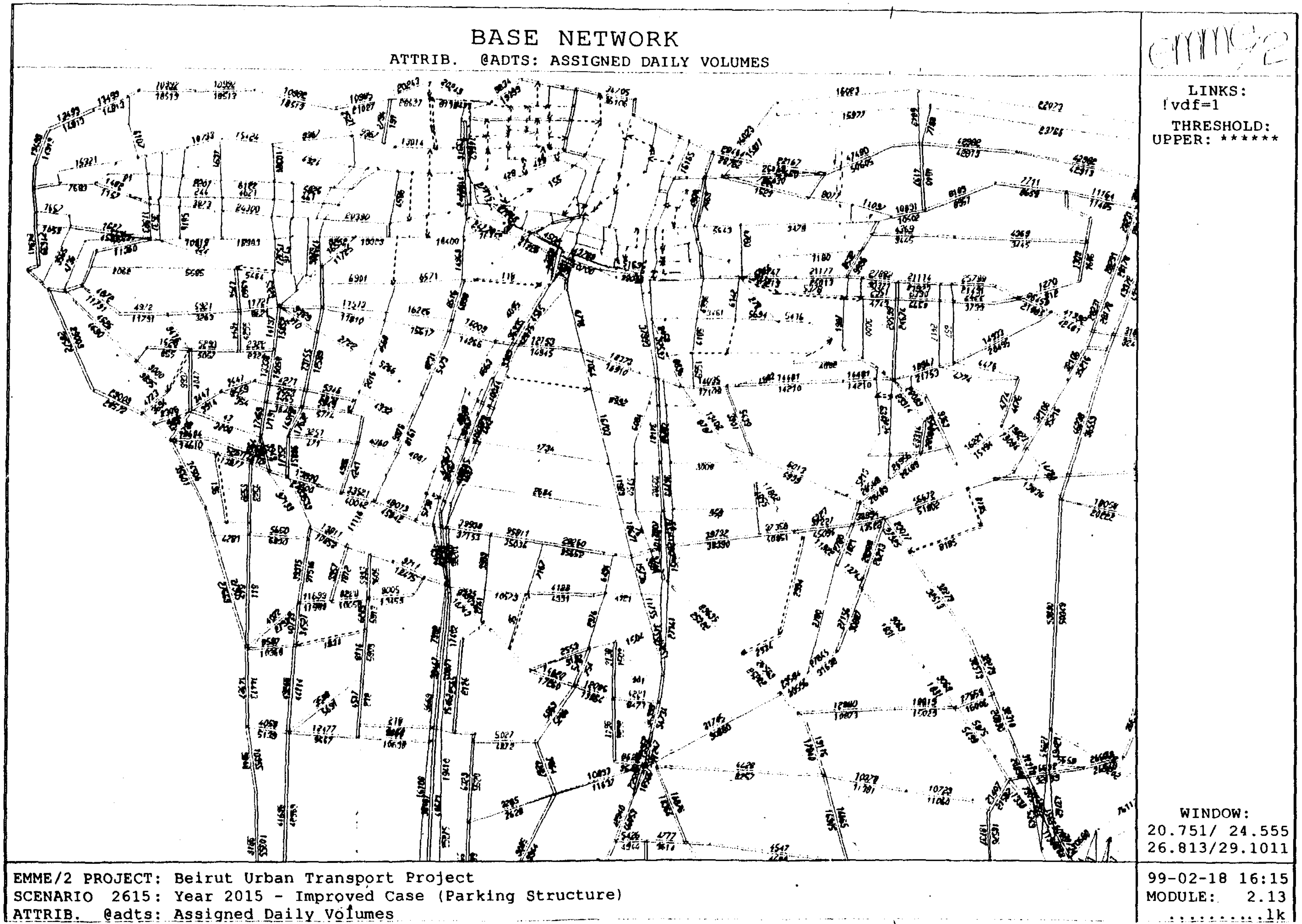

BASE NETWORK
ATTRIB. @ADTS: ASSIGNED DAILY VOLUMES
emme/2
LINKS:
!vdf=1
THRESHOLD:
UPPER: ******
WINDOW:
20.751/ 24.555
26.813/29.1011
EMME/2 PROJECT: Beirut Urban Transport Project
SCENARIO 2615: Year 2015 - Improved Case (Parking Structure)
ATTRIB. @adts: Assigned Daily Volumes
99-02-18 16:15
MODULE: 2.13
.........lk

FIGURE A. 6 - 17

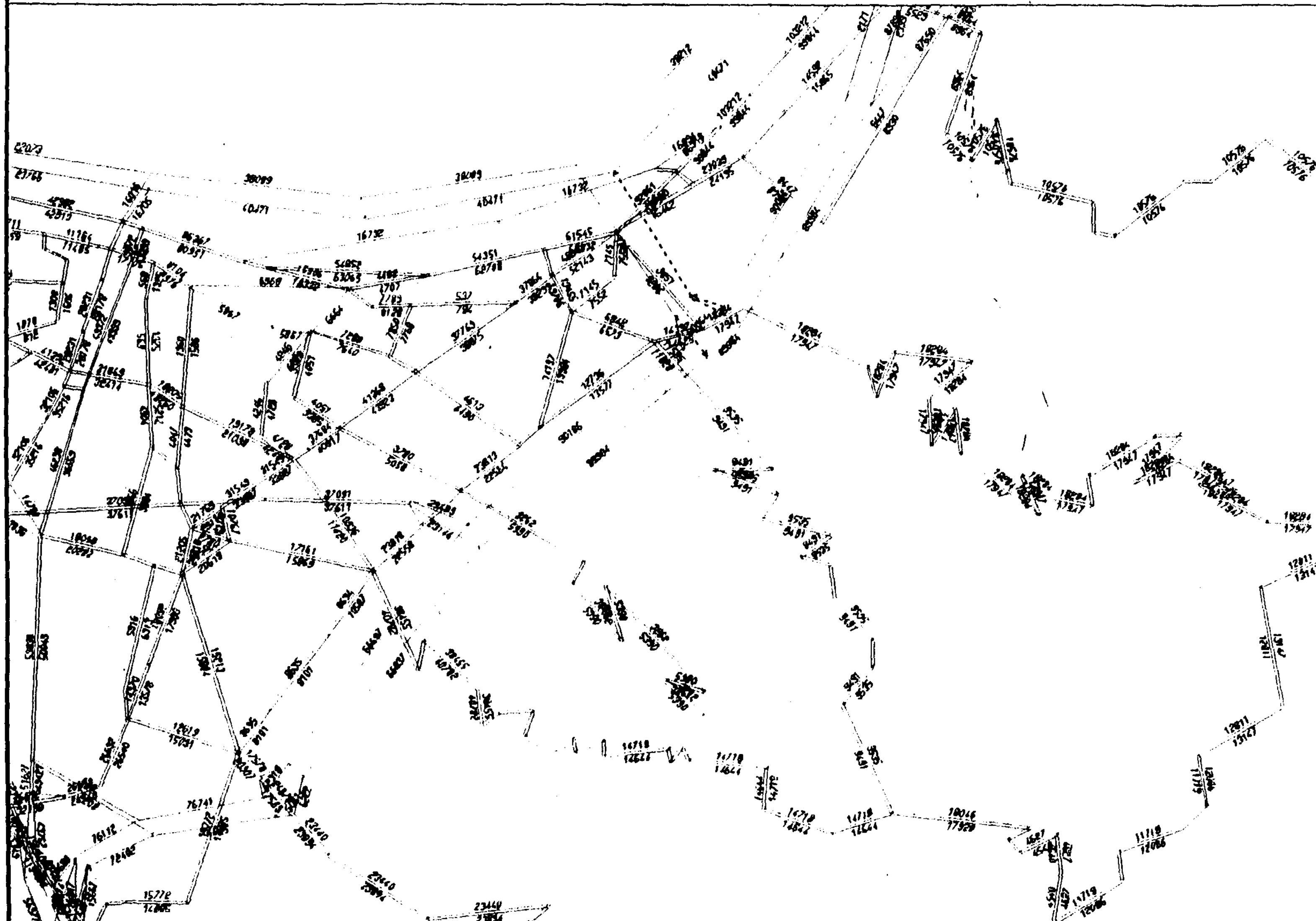
BASE NETWORK

ATTRIB. @ADTS: ASSIGNED DAILY VOLUMES

emme/2

LINKS:
!vdf=1

THRESHOLD:
UPPER: ******

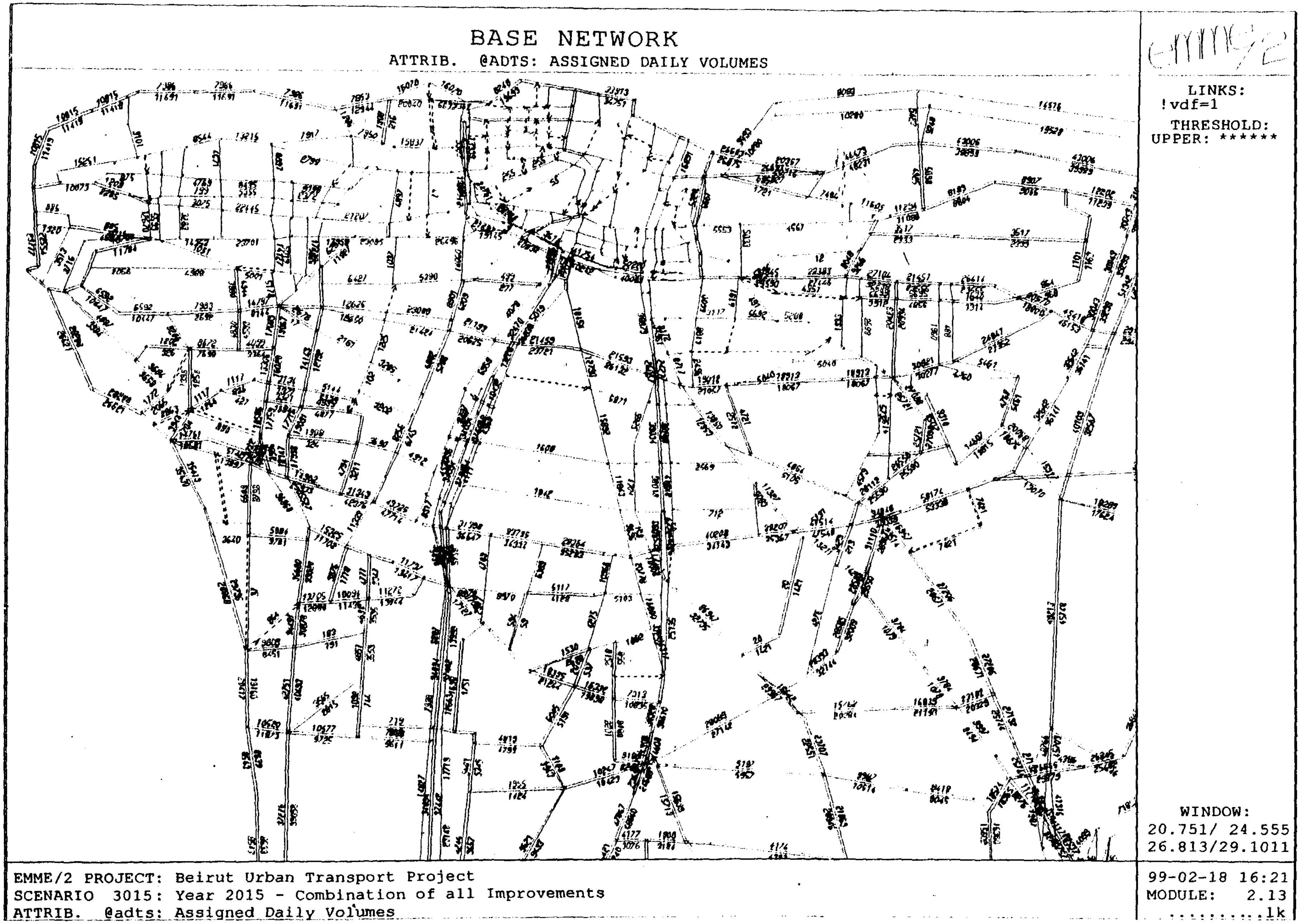


WINDOW:
26.214/24.2978
33.517/29.7754

EMME/2 PROJECT: Beirut Urban Transport Project
SCENARIO 2615: Year 2015 - Improved Case (Parking Structure)
ATTRIB. @adts: Assigned Daily Volumes

99-02-18 16:13
MODULE: 2.13
..........lk

FIGURE A. 6 - 18

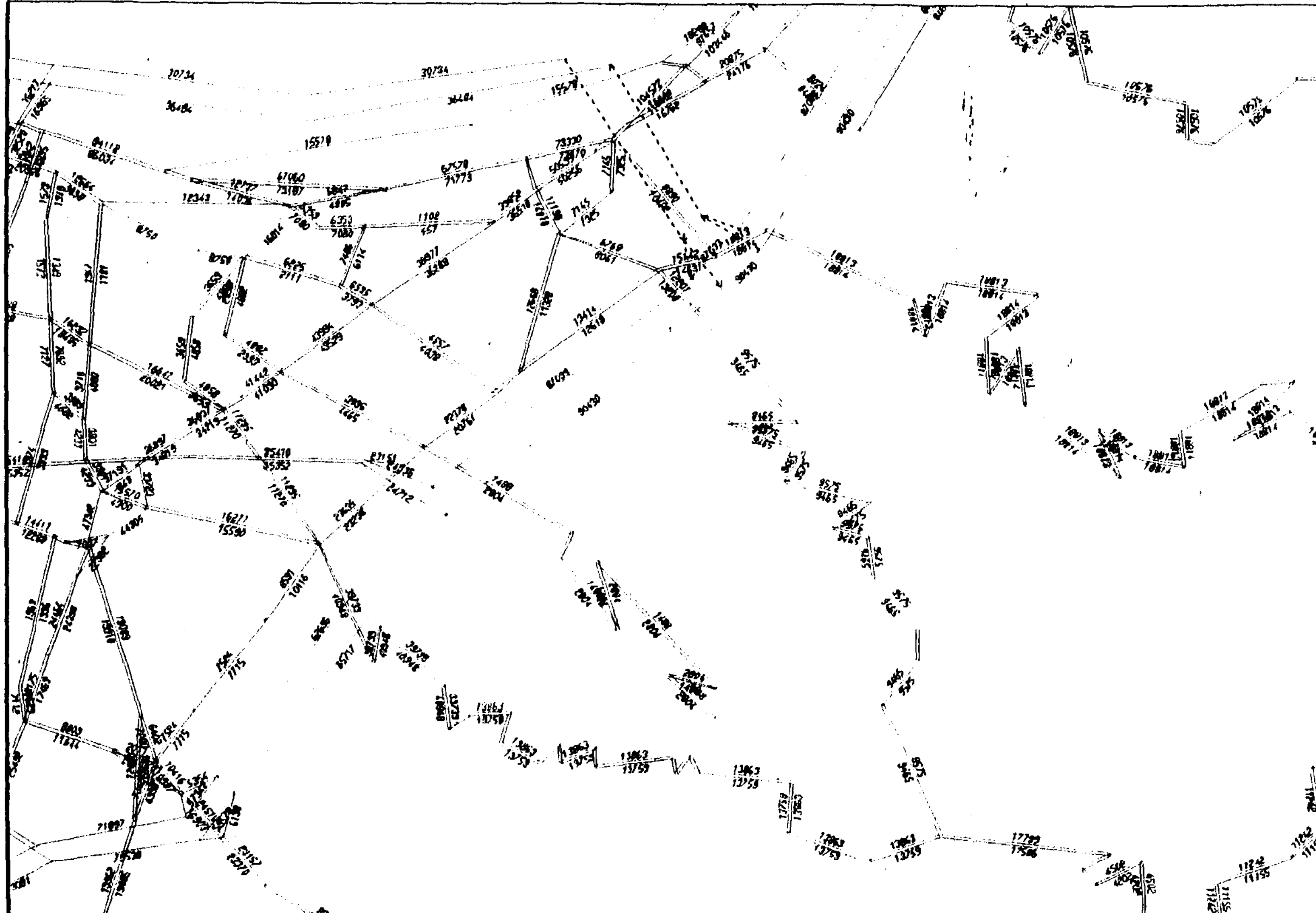


BASE NETWORK
ATTRIB. @ADTS: ASSIGNED DAILY VOLUMES
emme/2
LINKS:
!vdf=1
THRESHOLD:
UPPER: ******
WINDOW:
20.751/ 24.555
26.813/29.1011
EMME/2 PROJECT: Beirut Urban Transport Project
SCENARIO 3015: Year 2015 - Combination of all Improvements
ATTRIB. @adts: Assigned Daily Volumes
99-02-18 16:21
MODULE: 2.13
..........lk

FIGURE A. 6 - 19

BASE NETWORK

ATTRIB. @ADTS: ASSIGNED DAILY VOLUMES



LINKS:
!vdf=1
THRESHOLD:
UPPER: ******

WINDOW:
26.813/ 24.555
32.874/29.1011

EMME/2 PROJECT: Beirut Urban Transport Project
SCENARIO 3015: Year 2015 - Combination of all Improvements
ATTRIB. @adts: Assigned Daily Volumes

99-02-18 16:21
MODULE: 2.13
..........1k

FIGURE A. 6 - 20

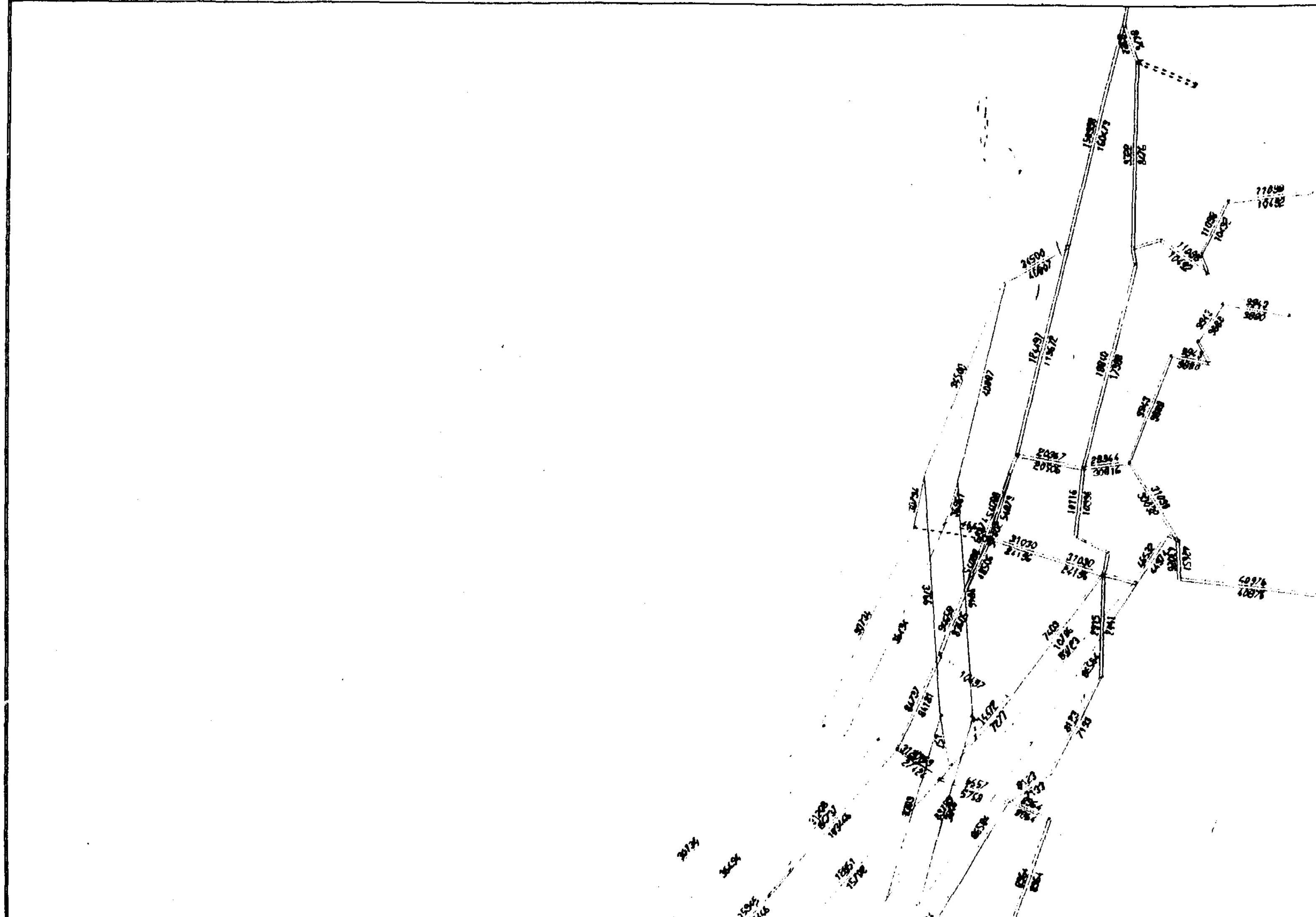
BASE NETWORK

ATTRIB. @ADTS: ASSIGNED DAILY VOLUMES

emme/2

LINKS:
!vdf=1

THRESHOLD:
UPPER: ******



WINDOW:
26.813/29.1011
32.874/33.6473

EMME/2 PROJECT: Beirut Urban Transport Project
SCENARIO 3015: Year 2015 - Combination of all Improvements
ATTRIB. @adts: Assigned Daily Volumes

99-02-18 16:22
MODULE: 2.13
..........1k

FIGURE A. 6 - 21

BASE NETWORK

ATTRIB. @ADTS: ASSIGNED DAILY VOLUMES

LINKS:
!vdf=1

THRESHOLD:
UPPER: ******

WINDOW:
20.751/20.0089
26.813/ 24.555

EMME/2 PROJECT: Beirut Urban Transport Project
SCENARIO 3015: Year 2015 - Combination of all Improvements
ATTRIB. @adts: Assigned Daily Volumes

99-02-18 16:22
MODULE: 2.13
..........1k

FIGURE A. 6 - 22

APPENDIX 5

SOCIAL ASSESSMENT

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SOCIAL ASSESSMENT

1. Introduction

1.1 Background

Beirut is the core of the service-based economy of Lebanon with one-third of the population, and contributes in excess of two-thirds of the total value added in the economy. The city and its metropolitan area, however, suffer severe traffic congestion, a result of a deficient transportation system. This causes economic losses and deteriorating air quality. As sustained growth of the service-oriented economy required an by efficient infrastructure, Beirut needs to improve the operational and economic efficiency of its urban transport system.

In its heyday, Beirut had an extensive urban transport system including a well-developed bus system and even a trolley-bus system. Due to the prolonged period of conflict this infrastructure deteriorated. Also, over the last two decades major changes have occurred in Lebanon's demography owing to urbanization and displacement of residents from the South and relocation of businesses from Beirut to other situations along the coast. These have resulted in important changes in traffic patterns throughout the Greater Beirut Area (GBA), which, in turn, generates severe congestion both in and around Beirut and particularly at the connections with the coastal highway to the north and south. The problem of congestion is exacerbated by a heavy reliance on private cars—there are about 300,000 cars for a population of some 1.2 million in the Greater Beirut Area(GBA) (about 250 cars per 1000 inhabitants). Over 70 percent of total motorized person trips, more than half of which are home-to-work, are made by private car. Shared taxis account for nearly 20 percent of all trips, while just 10 percent of the population is served by privately and publicly operated bus services. In addition, latent travel demand is high and would materialize with improved transport capacity.

Beirut's future development as a competitive regional center for finance, trade, services and tourism requires an efficient transport system. To this end, the Government prepared a comprehensive Greater Beirut Area Transportation Plan (GBATP) which addresses the most serious urban transport issues, analyzes needed investments through the year 2015, and recommends a large phased investment program. The prioritization and phasing of this program, which will be the largest single investment in Lebanon over the next ten years, will require a significant planning, consensus building, and resource mobilization. The proposed Beirut Urban Transport Project (BUTP) would provide the fundamental urban transport apparatus needed to address the extremely diverse and complex transport issues the city faces, and support selected immediate actions of the GBATP.

Several key issues must be immediately addressed to improve the operational and economic efficiency of the GBA urban transport system. These include:

(a) traffic management;
(b) network capacity;
(c) parking provision and controls;
(d) public transport; and

(e) transport emissions.

This particular project would focus on three key strategic issues: traffic management, network capacity deficiencies, and parking. This would serve as a foundation for one or more subsequent projects that would address transport planning, public transport, and emissions.

1.2 BUTP Components

Specifically, BUTP would comprise of the following physical components:

1. **Traffic Management Improvement Program**:

   (i) traffic signals and layout improvements for all significant intersections in GBA (about 215); and

   (ii) equipping a Traffic Control Center (TCC) to be operated by the GBA Traffic Management Organization (TMO).

2. **Parking Improvement Program**: to control parking along all main arteries and in selected zones and increase off-street parking capacity in those zones by developing appropriate strategy, regulations, pricing and institutional arrangements for parking controls enforcement and parking facilities operation; and

3. **Corridor Improvement Program** for Beirut Entrances to improve traffic flow along major corridors and Beirut entrances by financing the construction of grade separations at 16 congested intersections (see location of proposed grade separations in the Appendix).

1.3 Scope of Social Impact Assessment

The topics to be covered by the Social Assessment comprised two components See Annex 1, Terms of Reference). The first component related to the impacts of the expropriation of land and buildings occasioned by the grade separation facility component of the BUTP. These impacts may be categorized as those, (a) on the resettlement of families; (b) the resettlement of businesses; (c) other impacts on businesses; and (d) impacts on landowners who would lose land only. The nature and extent of these impacts, together with the social characteristics of those affected, were determined through a study which verified the number of people affected, identified some key characteristics, particularly in relation to socio-economic status and mobility, which would affect the adequacy and determination of resettlement and compensation issues. The SA findings in these respects were incorporated directly into the Resettlement Action Plan, a separate document.

The topics covered in this report relate to the local socio-economic aspects of the project: at the neighborhood level, since the economic analysis has taken the larger benefits into account.

The key issues presented in this report are in response to four key questions:

- Who are the key local stakeholders?
- How would local residents be impacted by parking reforms, especially the introduction of paid parking?
- How would parking reforms impact on local formal and informal commercial activities?
- What are the attitudes and expectations of local population in the areas affected differentiated by different types of stakeholders.

2. Identification of Local Stakeholders

The BUTP stakeholders include all Greater Beirut residents and businesses and visitors, since the project aims at an area wide improvement of traffic conditions. The targeted improvement in traffic conditions results in direct economic and environmental benefits, that were identified and quantified in the Economic Assessment and Environmental Assessment reports. The indirect benefits are of a much larger magnitude. The implementation of the BUTP provides the ground and prerequisite for restructuring urban transport function. It is the prelude for wider use of public transport and for the metamorphosis of a sustainable urban transport system.

At the local level the stakeholders are limited mainly to persons directly affected by the grade-separation component and to a smaller extent by the organization of on-street parking in selected business zones.

Project preparation benefited from an extensive consultation process in relation to the environmental assessment, which was the first ever of its kind in Lebanon. Very early during the project preparation a national consultation was conducted. It was followed by extensive consultations with members of the newly elected municipal councils. Eventually, consultation meetings ,were held with local stakeholders. Local stakeholders, living or working in the vicinity of the proposed grade-separations were consulted. A second national consultation meeting was held while preparing the final Environmental Assessment Report. The consultation process is fully documented in a separate Annex to the EA report.

Additional contact with the local stakeholders was undertaken during the preparation of this Social Assessment, in order to elicit attitudes toward the planned grade-separations and paid on-street parking.

In general, formal local organizations were limited to the municipal councils, federations of local merchants, and few members of environmentally motivated local NGO's. All were previously identified and involved in the consultation process.

In general, the BUTP is likely to have substantial impacts on local residents and pedestrians, including the following:

1. The introduction of traffic signals at intersections will improve safety for crossing pedestrians. At present the absence of signaling means that there are few gaps . Currently vehicles do not move in platoons and no gaps are available for pedestrians to cross at intersections nor at mid-block.
2. Grade-separations will take through traffic away from the at-grade intersection, thus providing safer pedestrian crossing as part of the signal cycle.
3. Organizing parking will result in clearing sidewalks from parked vehicles, leaving them from their intended use by pedestrians.

The only "convenience" which risks being threatened by the BUTP is that of violating the traffic code, the improper and irresponsible use of the private vehicle, and its intrusion on the urban living space. Should law enforcement of the traffic code for the sake of safety and efficiency be considered as an "inconvenience" to the violators?

3. Impact of the Parking Component on Local Residents

3.1 Salient Features of Beirut Parking Conditions

The chaotic parking conditions in Greater Beirut are the main reasons for traffic congestion and the resulting inadequate operation of public transport, increased pollution due to vehicular emissions, and the general deterioration of quality of urban life. Studies done for the GBATP and Beirut Urban Transport Project BUTP have fully investigated the parking conditions. Highlights of the finding of these two studies are presented below.

The average car ownership is 250 per 1000 population in Greater Beirut Area. In Municipal Beirut, car ownership is higher, at about 278. Residential parking, overnight, is 57 percent on the public domain (streets right-of-way) and reaches 60 percent in municipal Beirut.

Parking conditions in most parts of GBA, and especially Municipal Beirut, are highly congested. Illegal and improper parking is systematically practiced. Parking enforcement is less than adequate, leaving grave parking violations unchecked. Public parking lots are, in general, not well laid out, with poor surfaces and without markings. In spite of this congested parking conditions, off-street lot parking is offered at only LL1500 (US$ 1.00) for unlimited time during the day, by municipal decision. Low parking fees are not attractive to customers, since illegally parked cars are not systematically fined. Cars parked on sidewalks right outside parking lots with plenty of vacant spaces, are a common scene.

The current parking problem cannot be controlled through increasing the parking supply. The demand for parking must also be controlled. Turning streets to free parking lots is a bad allocation of public money.

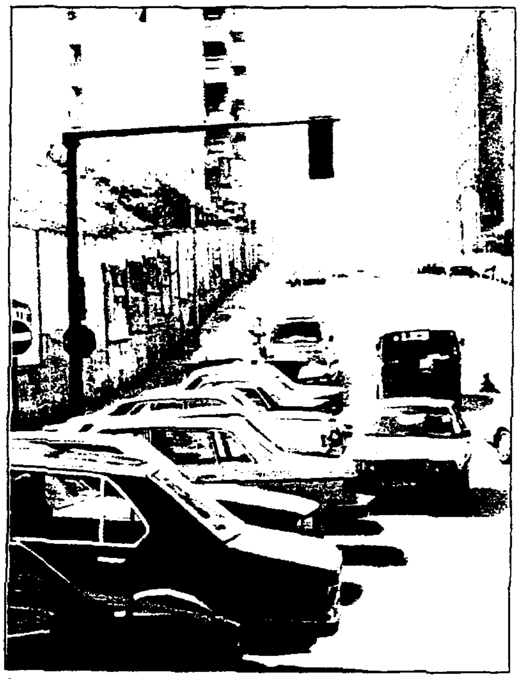
Exhibits 1 and 2 present a photographic documentation of the chaotic parking conditions in Beirut.

3.2 Background: Objectives and Rationale of the BUTP Parking Component

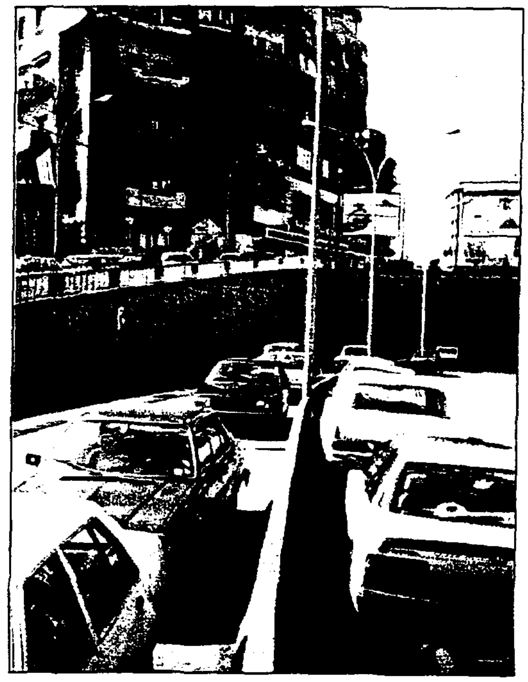
The three components of the BUTP are, to various degrees, parking-related. The proposed Traffic Management Component can only produce its intended benefits if illegally parked cars no longer occupy sidewalks, intersection corners, or are double parked. The Corridor Improvement Component, which includes construction of grade-separations also requires strict parking regulation. Parking on ramps and along the main-lines of major corridors cannot be permitted.

The Parking Component includes provision that on-street parking in selected zones, will be metered and paid, and is a basic requirement for the success of the entire BUTP. The interventions do not require additional parking regulations, but only the enforcement of existing ones. Removal of double parking will improve public transport operation, which has positive impacts on low income groups and on environmental conditions. Removal of vehicles occupying the sidewalks should encourage walking as a mode of transport and increase pedestrian safety.

The introduction of paid parking in business areas is not driven by the objective of realizing revenues. Paid timed on-street parking will increase parking turnover, with clear benefits to shoppers and visitors. Commuters would go to off-street parking facilities. And since timed paid on-street parking would be enforced only during working hours (mostly from 9:00 AM to 6:00 PM) free parking would be available overnight for residents.

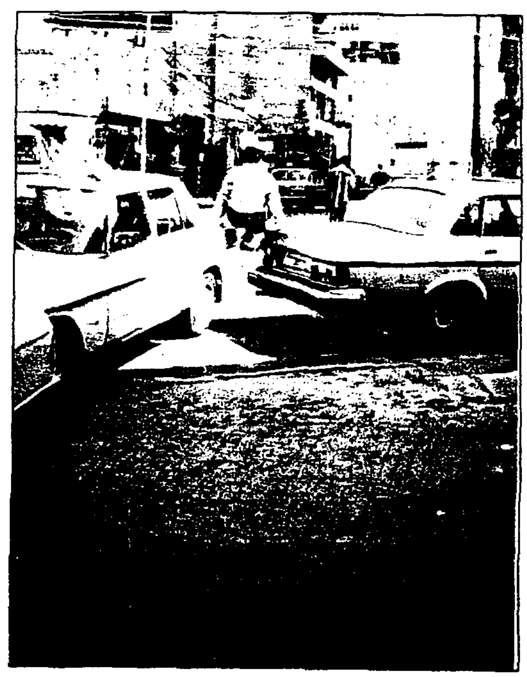


Angle and double parking at a signalized intersection



Parking on the left side at the entrance and exit of a tunnel

Parking on the sidewalk forcing pedestrians to the street



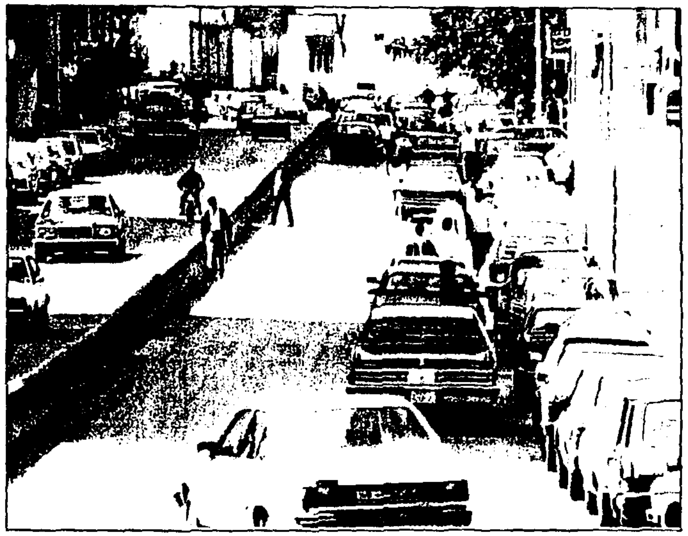
Parked cars block sidewalks leaving no room for pedestrians

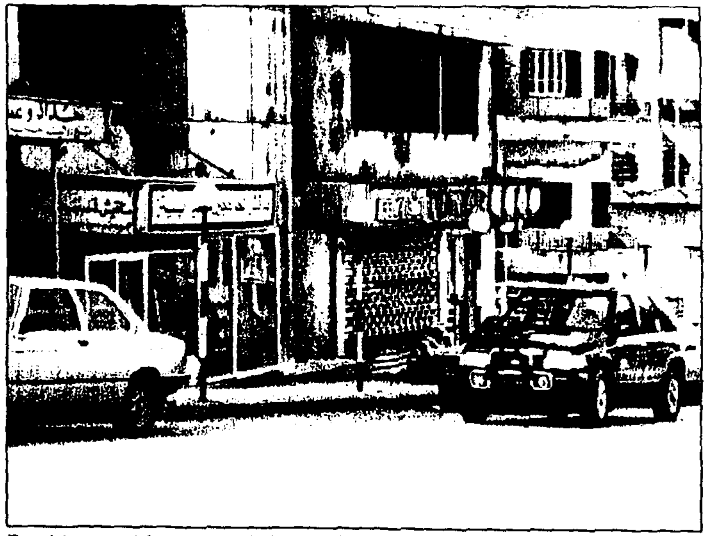
Exhibit 1

Exhibit 2


Parking partly on side walk and partly over pedestrian crossing


Parking over the planted median


Double parking leaving hardly one travelled lane for moving vehicles


Double parking could have been avoided, since a curb parking space is available

The introduction of timed paid curb parking will not negatively impact low income groups. The zones for adopting these measures are mixed land use business areas with moderate to high level housing. Timing curb parking and making it for a fee in these areas will force shop owners to use off-street parking for their cars leaving the curbs for their customers. The increase in potential business far outweighs the inconvenience caused to shop owners. Merchants' organizations are in favor of introducing parking meters because they know it makes their areas more attractive to shoppers.

The parking measures proposed by the BUTP will not greatly impact residential parking, since it will be limited to areas that are business dominated (Figure 1). Still these areas have residential uses, but since paid parking is enforced during work hours, overnight parking will be available free for residents. Still there will be some shift of residential parking from the curb to parking lots. Monthly fees for lot parking averages LL 60,000 (US$45) in the targeted area, which is a reasonable burden. Parking outside work hours on work days (week-end and holidays excluded) will continue to be free at the curb. Parking enforcement during night hours is expected to continue to be lax, especially on side streets.

The new parking arrangements will make access to the areas much easier. It will also decrease cruising in search of a parking space, which will reduce vehicular emissions. Clearing the sidewalks of parked vehicles will improve the quality of life in these areas. The impacts on businesses will be more prominent than on residents. It is positive, since it will encourage shoppers to come, due to the availability of curb parking, which was occupied before by commuters.

3.3 On-Street 24-hour Parking Survey

A limited 24-hour survey of on-street parking was conducted on Makdessi Street on January 24 and 25, 2000 for the purpose of this Social Assessment. Makdessi is a one-way street (West-bound) north of and parallel to Hamra Street, running between Sadat Street to the West and Rome Street to the East. It is characterized by mixed abutting land uses: shopping at the ground floor, with mostly residential and some offices on the upper floors.

Parking is currently permitted only on one side of the street. There is no good reason to prohibit parking along the second curb. Cars park anyway on both sides, and may double park.

The purpose of the limited license-plate survey was to differentiate between parking characteristics of:

- residents
- commuters
- visitors and shoppers.

License plates of parked vehicles were checked at various times as follows:

- 6:00 AM - only residents are expected to be parked that early in the day;
- 9:00 AM - residents who drive to work should have left, commuters should have replaced them. No visitors and shoppers are expected yet, as most businesses (especially shops) are not yet opened;
- Noon time - to confirm the visitors and commuters;
- 3:00 PM - to check any movement due to school trips; and
- 7:30 PM - commuters and shoppers must have left and the residents are back home.

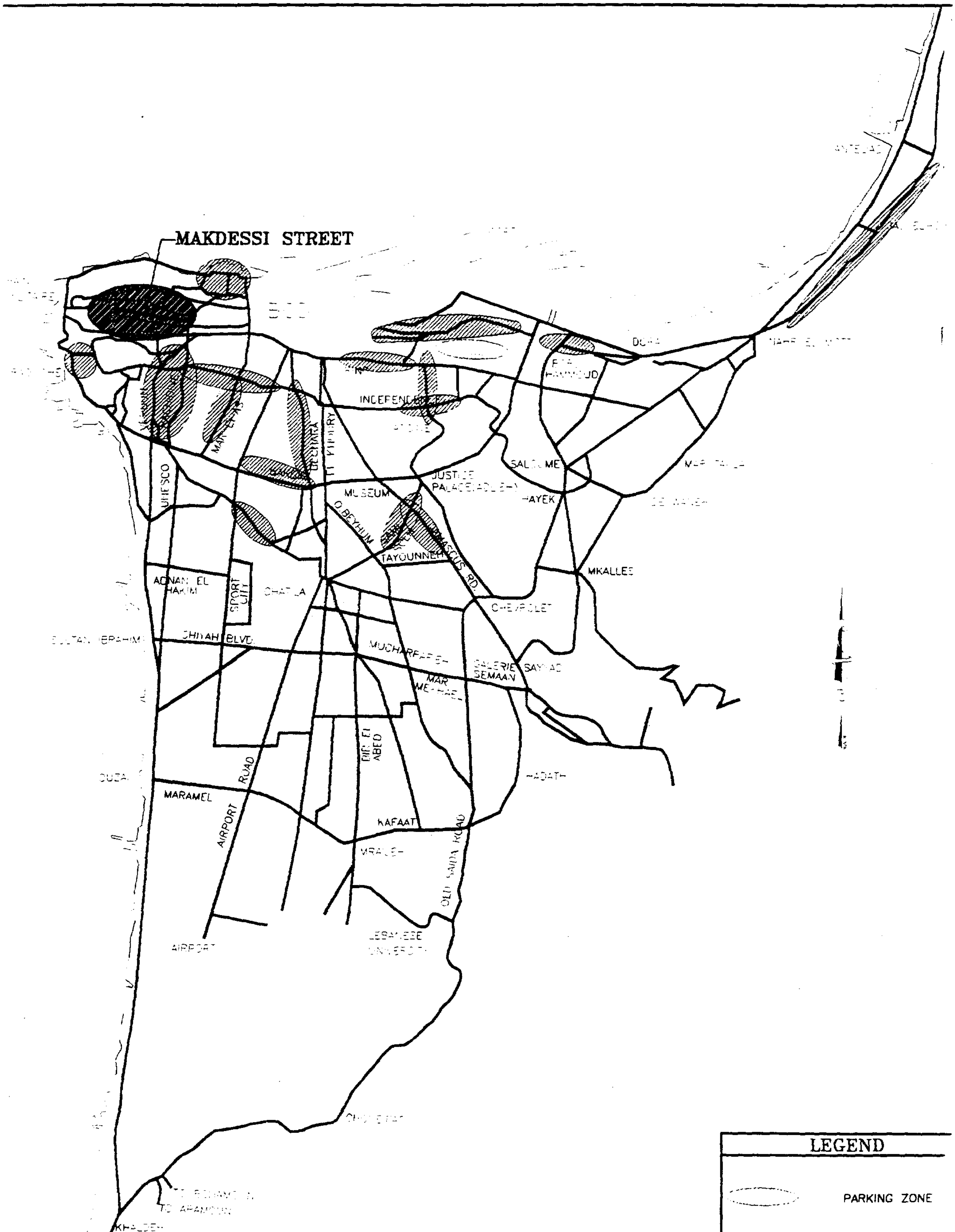


FIGURE 1 ON-STREET PARKING ZONES

On Makdessi Street, which is typical of the areas where timed paid on-street parking will be introduced, the present dynamics of on-street parking are as follows (Table 1 and Figure 2):

Residents who park overnight along the street curb are about 215. It is to be noted that 72 vacant spaces 30 percent of total proper[1] spaces, were available overnight. This indicates that residents have already satisfied a substantial portion of their parking needs by renting spaces in parking lots.

As the day breaks, some residents take their cars and drive away to their work. By 9:00 AM, commuters have started to arrive and to occupy available spaces. Some visitors start arriving as early as 9:00 AM, but shoppers do not appear before 10:00 AM. The demand for parking is high during working hours, from 9:00 AM to 7:00 PM, as is demonstrated by the number of improperly parked vehicles, which represented to 42 percent of all parked vehicles at noon.

Different types of business end their working day at that range from 3:00 PM. to 7:00 PM for shops. During this time a total of 83 parked commuters occupied curb spaces. After that time, the curb is available to residents and visitors. On Makdessi Street, night entertainment is not a significant land use.

Between 6:00 AM and 7:30 PM and probably beyond that, 57 vehicles were parked at the same curb space. These belong to local residents who own more than one vehicle, or do not use their vehicles for work trips. This preemptive use of expensive curbside space denies their use to clients and customers of local businesses. This leads shoppers and visitors, benefiting from lax enforcement, to park their vehicle improperly, causing congestion of vehicular traffic and hazardous conditions to pedestrians.

The above analysis demonstrates that Makdessi and similar streets would be best served by introducing paid timed on-street parking. Introducing paid on-street parking would benefit more commuters than penalize residents (83 to 57 in this case). It would make available curb space for more users because of the higher turnover, and would encourage investment in off-street parking facilities to serve commuters and residents. This would rectify the perception of the cost of the private car ownership, and help the shift towards a more socially and environmentally responsible attitude towards the satisfaction of transport needs.

3.4 Attitudes Towards Paid On-Street Parking

Attitudes towards planned paid on-street parking were investigated through an open-ended questionnaire. The selected location is also Makdessi Street due to its characteristics described earlier.

The survey covered 19 establishments of various sizes and types of activity, classified in the Table 2.

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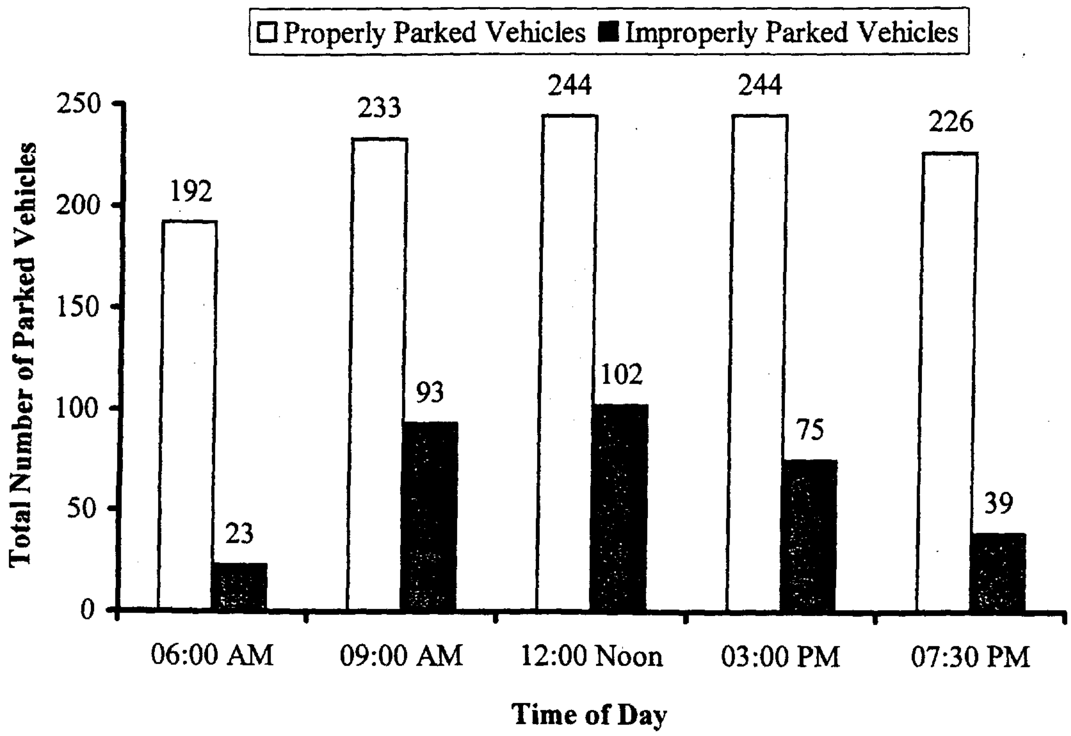
[1] A "proper" parking space is defined as that where a vehicle can park, irrespective of whether there is a NO PARKING sign or not, in a manner which does not cause a blockage to pedestrians nor vehicular traffic. Accordingly, improperly parked vehicles include, but are not limited to double parking, parking on street corners, over the sidewalk, angle parking (where it is supposed to be parallel parking).

TABLE 1
CURB OCCUPANCY BY PARKED VEHICLES AT VARIOUS TIMES OF THE DAY
MAKDESSI STREET

	06:00 AM			09:00 AM			12:00 noon			03:00 PM			07:30 PM		
	N	S	Total	N	S	Total	N	S	Total	N	S	Total	N	S	Total
Total No. of Parked Vehicles	101	114	215	155	171	326	167	179	346	153	166	319	131	134	265
No. of Vacant Spaces	40	32	72	6	5	11	3	7	10	3	5	8	27	23	50
No. of Vehicles Double Parked	0	2	2	7	14	21	16	21	37	6	10	16	1	5	6
No. of Vehicles Parked @ Street Corners	8	12	20	15	24	39	16	25	41	13	24	37	14	16	30
No. of Parked Vehicles Blocking Driveways (some are double parked)	1	0	1	4	2	6	3	4	7	4	1	5	3	1	4

	N	S	Total
Vehicles did not move bet. 6:00AM & 9:00AM	64	67	131
Vehicles did not move bet. 6:00AM & 12:00noon	50	54	104
Vehicles did not move bet. 6:00AM & 3:00PM	44	51	95
Vehicles did not move bet. 6:00AM & 7:30PM	25	32	57
Vehicles did not move bet. 9:00AM & 12:00noon	123	113	236
Vehicles did not move bet. 9:00AM & 3:00PM	91	87	178
Vehicles did not move bet. 9:00AM & 7:30PM	33	37	70
Vehicles did not move bet. 12:00noon & 3:00PM	106	102	208
Vehicles did not move bet. 12:00noon & 7:30PM	32	37	69
Vehicles did not move bet. 3:00PM & 7:30PM	44	55	99
Vehicles did not move bet. 7:30PM & 6:00AM	47	60	107

PARKING ACCUMULATION



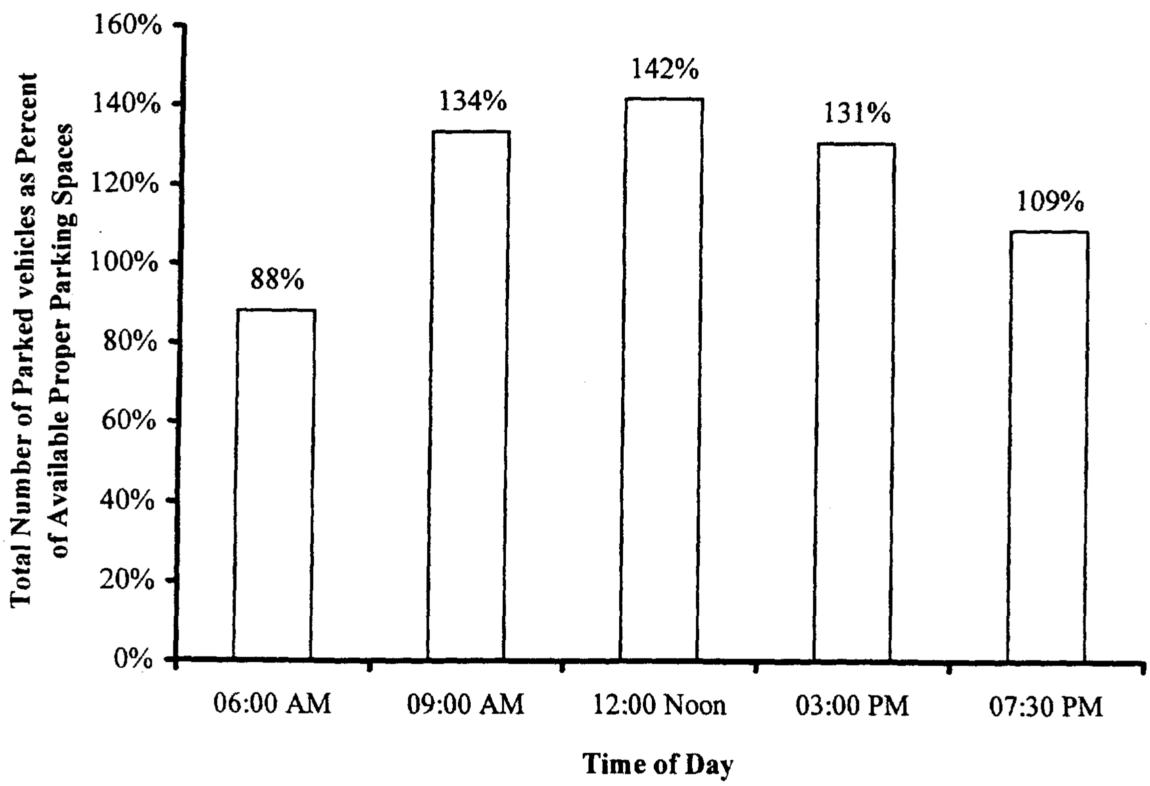


Figure 2 Parking Accumulation - Makdessi Street

Table 2: Classification of Interviewed Establishments According to Type and Size

Type \ Size	Large	Medium and Small
Retail	- Apparel Grand Store - Supermarket - Stationer - Roasted Nuts - Toy Shop	- Corner drugstore - Flower Shop - Apparel boutiques - Leather shop - Novelties shop - Electric appliances
Services	- Bank - Medical Laboratory - Post office	- Doctor's clinic - Dry cleaners - Travel agent - Restaurant

The interviewed included 18 owners or managers, 9 employees, 11 customers, and 8 residents.

The introduction of paid timed on-street parking was unanimously welcomed by the owners and managers, and to a lesser degree by employees and residents.

The residents accepted the idea, especially given the proposition that overnight parking would be free. Residents who had reservations were those who owned more than one car, who expressed concern about where they would park their second car during the day when they drove the other car to work, confirming that at present they leave one car parked on-street all day.

Some comments related to the project are presented below under several headings.

Parking Fees: A fee of LL 1,000 per hour was acceptable. Females and employees would like it to be no higher than to LL 500 per hour.

Enforcement: There was an expressed concern that without enforcement such a program would not succeed. Respondents were concerned that enforcement should be uniform and consistent. Interviewees favored a scale of fees that would rise for periods exceeding 2 hours, in lieu of a prohibition against parking in a place for a period exceeding two hours.

Information Campaign: The need for informational and educational campaigns was stressed.

Public Transport: Some respondents indicated that they would be willing to shift to public transport if it were reliable and scheduled.

Off-Street Parking Rates: Commuters feared that parking lots might raise their fees after paid on-street parking was introduced, and felt that some municipal control of parking lot charges would be desirable.

4. Attitudes Towards the Project

The real impact of a project on its surrounding can only be measured after the project is implemented. What is attempted now is to identify the attitudes towards the project and the perception of its impacts by residents in the area surrounding the project site.

4.1 Rapid Appraisal Method

It was neither possible nor desirable to undertake an exhaustive survey of the persons affected by the project. A rapid appraisal was performed through interviewing a small group of persons selected from the vicinity of each site. This group included the following concerned categories:

- owners and renters of residences and shops in the vicinity,
- residents in buildings in the vicinity of the project,
- businesses in the vicinity of the project (large and small merchants), professionals, artisans, managers of bank branches,
- members of local non-governmental organizations; and
- local engineers and architects, for their background which allows a good understanding of the project.

The interviews were undertaken with persons belonging to the above described groups selected from the vicinity of four of the grade separation projects. The four sites were selected to cover the variability in the site characteristics and the proposed design for the grade separation. The selected sites are all characterized by their mixed land uses. Business and commerce on the ground floor, with offices, clinics, and residential uses on the upper floors.

The selected sites were those surrounding the following proposed grade separations (Figure 3):

- Hayek, an area just to the East of River Beirut where a fork of two overpasses is proposed to relieve a heavily congested 5-leg intersection. The land uses on the various streets intersecting at this location include a variety of residential and business uses, that also vary within the same use as to quality and status.
- Ghobeyri, an immediate southern suburbs of Beirut, where two busy intersections of Chiyah Blvd. at Musharrafieh and at Airport Road are proposed for grade separations. An overpass at the first and an overpass and underpass (3-level) at the latter. The area includes mixed commercial / residential uses.
- Dora area, also across River Beirut to the East along the highway going North, where a narrow one-way steel grade separation is proposed to be replaced by a bridge, 3-lanes in each direction. The area is a commercial and business area, and at the edge of crowded residential and commercial areas.

The proportion of residential uses is not the same among all the four sites. More residential uses are present in the vicinity of Hayek and less in the vicinity of Dora.

These areas are among the most congested (vehicles and pedestrians) in the close suburbs of Beirut. This selection provides a wide spectrum of representation in terms of grade separation design and land use. Due to specific characteristics of these sites, there are overpasses proposed at each one of them. Moreover, due to the site characteristics they are the more likely to attract objection by the neighbors. Accordingly the most negative attitudes towards the proposed grade separations are expected to be reflected by neighbors of the proposed grade separations selected for the social assessment survey.

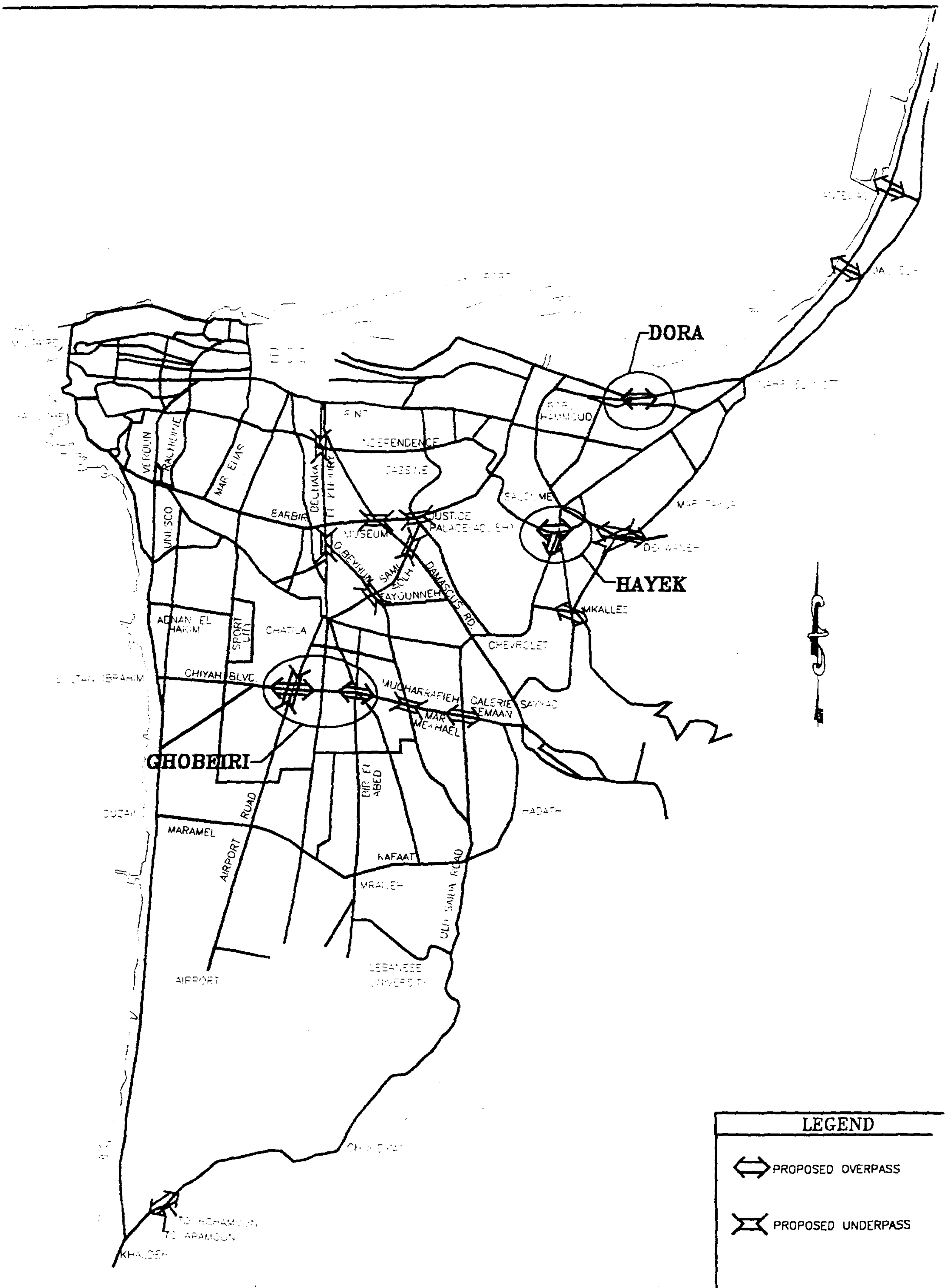


FIGURE 3 PROPOSED GRADE SEPARATIONS

4.2 The Interviewees

The interviewees were chosen from among residents or workers in the immediate vicinity of the proposed grade separation. Sixty percent were owners and the rest renters. They were distributed as follows:

- six merchants,
- seven shopkeepers,
- four branch bank officials,
- six members of NGO, residing in the vicinity,
- eight employees and operatives; and
- five architects & civil engineers.

Some of the interviewees were among those who participated earlier in the previous consultation meetings. The opinions of the interviewees are likely to be representative of those who live or work in the vicinity.

The interviews revealed that the information about the project that each of the interviewee had, was either from what he heard during the consultation meetings, or from the topographical surveyors during survey. The information they had about the project was not complete, precise, or clear.

All the interviewees knew about the project prior to the interview, 22 out of 36 knew about it from their local municipality and from the consultation meetings.

4.3 An Exposé of the Declared Attitudes

The majority of the interviewees expressed their satisfaction with the proposed project (25 out of 36). Most of the disapproval was concentrated in Hayek, or came from persons whose residence was close to a proposed overpass.

Most of the opposition is associated with overpasses. Business owners worry that an overpass prevents people on one side of the overpass from seeing shops on the other side. Moreover, the loss of potential business of the through traffic, which will take the overpass (or underpass).

Residents of buildings along the overpass, especially those in first floors object to the visual intrusion of the bridge, possible loss of privacy, and the increased noise and emissions at the level of their apartments, and the reduced use of balconies facing the proposed overpass.

The people objecting to Hayek grade separations worry about the visual intrusion a grade separation may cause and the barrier such a structure may create between areas lying on either side of which. Their proposed alternative is to replace the overpass by an underpass. This alternative was fully discussed during the consultation meetings. The more enlightened members of the community were then convinced that an underpass is not a feasible alternative due to the topography.

The other alternative they were proposing is to forget doing anything at Hayek, hoping that projects planned at other locations will reduce the level of congestion at Hayek. Again the do-nothing alternative was not proven to be a serious solution to traffic jamming. Traffic simulations show the need for grade separation at Hayek even if all the other projects in Beirut are executed. The need for Hayek grade separation increases more due to the delay expected in implementation of the Périphérique.

4.4 Analysis of Attitudes

The engineering design for the proposed grade separations were carefully reviewed, and it is clear that nothing can be done, through geometric design, to keep the grade separations farther from the abutting buildings. Noise and emission simulations (presented in the EA Report) have shown that the level of noise and emission will be higher for the do-nothing alternative; and the expected level of noise does not warrant installing noise barriers.

At the locations where grade separations are proposed, that are mainly intersections of heavily traveled corridors, the phenomena of "invasion-and-succession" [2] will eventually take place. That is residential uses will go to quieter areas while commercial and business uses will move in. This will mean better value for land owners, especially if the grade separations provide better fluidity for traffic. The change towards business - commercial uses will provide better compensation (through the market mechanism) for residential uses to move out and be replaced by business - commercial uses.

The worries expressed by merchants due to diverting the through traffic to an overpass or an underpass away from their doorstep reveal their conviction that every passer-by is a potential client. Thus every diversion of traffic away may cause loss of business. The other side of the picture is rarely seen by the merchants. Congestion is conceived by shop owners as a sign of increased potential business not realizing that fluidity of traffic is a better indication, because it entails higher flows and encourages more people to come to the area. Therefore, the better fluidity will encourage the one who is specifically coming to the area to shop or on-business to come, while through traffic will be diverted to the grade separation and thus will cause less congestion.

It should be noted that Hayek residents' complaints convey a distorted understanding which dos not realize that it is a junction of 5 major roads and thus serves through traffic to a much larger extent than serving the area itself.

While Hayek residents expressed an interest to see that junction as a large roundabout. But it is difficult to understand their objections to the proposed project, which aims at reducing the congestion and that includes an extensive beautification and landscaping of the islands and medians.

Some of the negative attitudes towards Hayek grade separations can be attributed to a group dynamics that encourages negative attitudes and refusal, which although is rationally unsupported, yet it can claim caring for environmental issues. This refusal can also partly be explained by the fact that the topic was discussed right after the last municipal elections, and everybody was keen to present himself as a proponent of the people's interest. It is also understandable that locals' interests be in conflict with that of the general public.

At locations other than Hayek, the opposition to the project - if any - seemed more rational. It was apparent that citizens were more understanding of the fact that in such projects there is a balance to be drawn between the interests of the immediate locals and that of the larger area. This attitude is probably a reflection of the obvious need for the project, which far outweighs any of its negative features.

The contrast in attitude between those interviewed in Hayek compared to those interviewed at Ghobeyri and Dora is worthwhile to try to explain. In the case of Hayek, even small possible negative impacts were blown out of scale and used a pretext for almost a complete refusal of the project, without presenting any feasible alternative. At the other two locations,

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[2] Chapin, F. Stuart Jr. Urban Land Use Planning. 2nd ed., University of Illinois Press, Urbana, 1965.

still some negative aspects were identified, but the merits of the project were not denied. A possible explanation for Hayek residents attitude towards the project was more an expression of disapproval of a political era and all that it represented. This explanation of their attitude is supported by the fact that the consultations and interviews took place right after a change in government. And the project under discussion as taken as a product of the past government and its modus operandi.

Most of the interviewees (31 out of 36) were afraid the grade separations may result in a lowering of property in the vicinity of the project, due to visual intrusion. It should be noted, however, that experience does not support this fear. Because the reduction of congestion and the resultant lowering of the level of pollution will have positive effects. Moreover, these areas will undergo the gradual change in land use, referred to earlier, and explained by the "invasion and succession" phenomenon. In these cases, the change will be from residential to commercial uses, thus it should entail an improvement in value of real estate and not a reduction.

Looking more closely at the attitudes and fears expressed by the interviewees, it becomes evident that they reflect the imbalance between their perception of their immediate interests and how much they are related to wider public interests.

The interviewees at other than Hayek were in favor of the project and expressed their confidence in their Municipal Council as the proper channel to convey their interests.

The interviewees found the projects to be beneficial first to through traffic and then to the neighborhood, but with little benefits to their immediate neighbors.

No social negative impacts are perceived by any of the interviewees, except those of Hayek. This attitude is shared by local residents and with business owners who are not residents of the area.

A great number of the interviewees expressed the importance of integrating the projects with their milieu, such that the benefits of the project for the through traffic is also realized by that of local traffic.

What distinguishes the interviewees of Hayek from those at the other sites is that the latters insisted on replacing the proposed project at Hayek by other projects somewhere else, hoping through traffic will stay away from their area.

Last but not least, a majority of the interviewees (25 out of 36) criticized the lack of comprehensive planning. They also have a very positive view of the Social Impact Study and with the new interest in consulting the people, and they consider this method of work a positive initiative which should be generalized.

It was clear that there is the need for more public information, in order that people have a better understanding of the larger picture and how the project proposed at one location is, in fact, part of a larger integrated scheme.

This Social Impact Study of BUTP and the entire consultation process revealed the need for a better coordination of physical development between central and municipal organizations, especially with the very recent reactivation of the municipal function. The relationship between "consultation" and "participation" needs to be better defined and clarified.

5. Poverty Aspects in BUTP

The poverty aspects of transport reform will be more evident in the follow up project than in the present one which, as explained in the first section, must deal with fundamental underlying conditions. In the longer run, public transport improvement, as well as improved service taxi circulation, would benefit lower income groups disproportionately. The greater propensity of the poor to use public transport is illustrated by the contrast between legal residents and squatters in three sites.

Despite its small numbers, Table 3 from the Resettlement Action Plan shows vividly that legal residents were far more likely to own cars and to use them than squatters. For example, a legal resident was six times as likely to take a car to work than to use the bus (12 compared with 2), whereas a squatter was more than three times as likely to take the bus than to drive (17 compared to 5).

In order to integrate poverty alleviation issues into public transportation, which should be a concern of the next urban transport project, a more systematic and detailed study of the transportation needs and practices of the urban poor should be undertaken. This would identify the areas of the city occupied predominantly by lower income people, and would disaggregate their current transportation practices by mode purpose, gender and destination. It would estimate the costs of current transportation in relation to household budgets, and in terms of time; and the costs and implications of private car ownership for the poor. It would seek to understand the factors in their transportation decisions and behavior, and determine what would be their key needs and expectations in public transportation.

In the longer run, the BUTP would help to rectify the distortions and externalities in the perceived costs of owning and operating a private car. A high rate of private car use and ownership in Beirut is not in the public interest. BUTP provides the initial measures required to escape from the current vicious circle. Lower income groups in Greater Beirut in particular are "captive" owners of the private car which generally suffer from poor maintenance (and are therefore unsafe and highly polluting). Rather than subsidizing low income owners through overlooking parking violations and providing provide gasoline at a relatively low pump-price, their long term interests would be better served by moving towards a system where their transport needs are more reliably served, and at lower costs, by efficient, reliable, and reasonably priced public transport. Efficient, reliable and reasonably priced public transport cannot be made available under the current conditions of congestion and laxity of law enforcement.

Table 3: Mobility of Legal and Illegal Residents at Three Sites

Serial No.	Grade Separation Junction	No. of Residents	No. of Residents	No. of Working Residents	Distance from Residence to Current Workplace (km)			Mode of Transport to Work				Preferred Distance Residence Relocation (km)			No. of Children in Schools & Universities	Distance from Residence to Schools (km)			Mode of School Trip			
					< 1	> 1 < 3	> 3	Own Car	Taxi	Bus	Walk	< 1	> 1 < 3	> 3		< 1	> 1 < 3	> 3	School Bus	Private Car	Bus	Walk
	A. Legal Residents																					
1	Beit Al Atfal	11	53	17[1]	1	8	8	10	2	2	1	6[2]	3	2	14	1	4	9	10		2	2
3	Airport	2	9	7	6		1	1			6		1	1	3	1	1	1			2	1
4	Musharrafieh	2	9	2		1		1	1			2			4		4			4		
12	Bchamoun / Aramoun	2	10	4	4						4	2[3]			5			5		5		
	Total	**17**	**81**	**30**	**11**	**9**	**9**	**12**	**3**	**2**	**11**	**10**	**4**	**3**	**26**	**2**	**9**	**15**	**10**	**9**	**4**	**3**
					37%	**30%**	**30%**	**40%**	**10%**	**7%**	**37%**	**59%**	**24%**	**18%**		**8%**	**35%**	**58%**	**38%**	**35%**	**15%**	**12%**
	B. Illegal Residents																					
4	Musharrafieh	3	18	5			5		3	2			1	2	5	5						5
5	Mar Mekael	22	82	25	1	6	18	5		15	5	14		8	27		21	6	10	4	5	8
	Total	**25**	**100**	**30**	**1**	**6**	**23**	**5**	**3**	**17**	**5**	**14**[3]	**1**	**10**	**32**	**5**	**21**	**6**	**10**	**4**	**5**	**13**
					3%	**20%**	**77%**	**17%**	**10%**	**57%**	**17%**	**56%**	**4%**	**40%**		**16%**	**66%**	**19%**	**31%**	**13%**	**16%**	**41%**
	C. All Groups																					
	Total	**42**	**181**	**60**	**12**	**15**	**32**	**17**	**6**	**19**	**16**	**24**	**5**	**13**	**58**	**7**	**30**	**21**	**20**	**13**	**9**	**16**
					0.2	0.25	0.53	0.28	0.1	0.32	0.27	0.57	0.12	0.31		0.12	0.52	0.36	0.34	0.22	0.16	0.28

Note:
(1) Two heads of families work abroad
(2) Four owners unwilling to relocate
(3) Two families unwilling to relocate

6. Summary and Conclusions

The social assessment has verified the potential inconvenience to locals due to the implementation of the BUTP.

The negative impacts on formal and informal businesses, if any, are minimal. Businesses that must be relocated will receive adequate compensation to allow them to move to comparable locations in the same area. Very few informal businesses will be affected. In all such cases relocating on the same site is feasible.

The proposed parking component involving introducing paid on-street parking in selected business areas is fully supported by businesses. Parking spaces occupied by residents for the whole day are only part of the total residential parking demand. Moreover, curb parking space is abundantly available overnight. This indicates that most of the residential parking demand is currently being satisfied off-street. The survey has shown that curb space is being used more by commuters than by residents.

The attitudes of the neighbors of the grade-separation projects realize that the benefits go mainly to through traffic, then to the corridor and neighborhood and to a lesser extent to the immediate abutting land. In most of the cases the attitude towards the project are favorable in general, reflecting a high sense of public responsibility. The attitudes displayed by the Hayek area residents, which were characterized by inflexibility, reflects more a politically motivated stand which overshadows any other consideration.

ANNEX 1

Beirut Urban Transport Project

Social Assessment Terms of Reference

Background

1. The proposed Beirut Urban Transport Project would involve land acquisition in a number of sites to improve traffic flows and provide parking. It also proposes to eliminate free and unregulated on-street parking and to replace it with metered and off-street parking. The 13 sites will be implemented in two or three phases.

2. As a formal condition of appraisal, the borrower should submit to the Bank a resettlement plan that the Bank accepts as conforming to the requirements of its OD 4.30, a copy of which has been supplied to the project preparation team. The implementing agency has extensive experience in resettlement in Central Beirut, and there are developed and established legal procedures for monetary compensation. The magnitude of involuntary resettlement is expected to be modest (64 persons in one apartment building, plus other isolated cases totaling about 100 persons is the current informed estimate). The project would also involve the acquisition of some portions of parcels (up to 25%) for which, under Lebanese law, monetary compensation is not payable, although it would be given in respect of any structures affected. The government appears reluctant to vary its established procedures, fearing costly precedents and a possible influx of compensation-seekers engendered by advance publicity. The central purpose of the resettlement plan will therefore be to ensure in the context of this proposed project that the need for resettlement has been minimized, that resettlement compensation would be adequate and appropriately implemented, and that essential livelihoods would not be adversely affected to a significant degree.

3. The project would be expected to impose some local social and economic costs as a trade-off for a widely shared benefit. These costs include: (a) local impact on residents and pedestrian traffic (b) increased costs to local residents of vehicle ownership; (c) the effect on property owners of uncompensated acquisition of small strips and edges of land; and (d) possible impacts on local formal and informal commercial activities. A rapid Social Assessment (SA) would identify and estimate the magnitude of these effects, the attitudes of the stakeholders (residents, and others) and propose any mitigatory measures that could be taken. This would assist the Bank to appraise the project in the full knowledge of the non-monetary costs and benefits.

Preparation of Resettlement Plan

4. The consultant should prepare, in consultation with the preparation team, a brief resettlement plan which will be submitted in draft to the Bank not later than February 25, 1999. This plan, which should reflect the actions or commitments of the implementing agency, should cover the resettlement procedures, and specific information on the main resettlement site (with 64 persons) and the two to three other sites that will comprise Phase I. A supplementary resettlement plan for the remainder of the sites, is required not later than the end of March 25, 1999. The plan will contain the following elements:

(a) A complete inventory of the proposed sites affected by land acquisition, together with a descriptive note in respect of each parcel to be acquired detailing its location, area and all the current uses of the land affected for residential, formal or informal commercial purposes. Photographic illustrations would be desirable. Any sites whose designation is not yet finalized should be included, with an explanatory note. A brief review of efforts to minimize involuntary resettlement should be given here.

(b) An estimate (a nominative census would be better) of the number of households and persons who would be involuntarily displaced under the proposed project. Information as precise as possible within prevailing circumstances should be supplied on their socio-economic profile: what kind of people they are, how long they have lived their, their circumstances i.e. whether they are owner-residents or tenants, whether they are citizens or not (if this is will be a material fact), whether there is any economic activity, whether there are any illegal residents, and their sources of income and places of employment.

(c) An estimate of the magnitude of the socio-economic impacts on displaced persons. This should comprise a realistic estimate or projection of the costs of displacement and reinstallation in a new location, and any significant variation in essential livelihood costs that would be incurred thereby (e.g. costs of transportation to place of employment, effect on pupil enrollment in school etc.). Good judgment should be used here to distinguish significant effects on the level of livelihood from minor inconveniences.

(Four) A systematic, step-by-step description of the procedures by which persons to be displaced are to be identified, informed and compensated. This description should include a clear statement of the legal basis, the instruments and procedures to be applied, the basis on which eligibility is determined, the way compensation will be calculated for owners and tenants, how and when it will be paid, and the mechanisms and procedures for appeal, and mechanisms for monitoring to ensure that no undue hardships have been incurred. This description should be accompanied by a timetable for each step.

(Five) An evaluation, based on (c) and (d), of the adequacy of compensation and/or other benefits in relation to the losses suffered, the overall level of compensation envisaged, and an indication of the source and availability of funds. This should be done by category of person as appropriate (e.g. owner, tenant). Careful attention should be given to identifying any persons liable to displacement who risk receiving no or insufficient compensation. This section could also include a brief justification of the methods and procedures used.

(Six) An estimate, of the nature and severity of impacts of land acquisition on those resident in the immediate area who will not be displaced, but who will be directly affected by land acquisition. This should be done category by category, and should include property owners whose lots will be reduced in size, vendors or other beneficial users of space, and any other effects on livelihood earnings.

(Seven) A description, if any, of mitigatory measures that could be undertaken in respect of the effects in (f), or of any project-related side-benefits that might be incurred to persons so affected. If none of these is possible, a brief justification should be presented.

(Eight) A brief indication of any variations or alternatives in project design envisaged by the preparation team, that could have significant impacts on the scale and location of land acquisition or on the numbers of people affected.

5. Having studied the technical plans, the consultant should visit each of the sites to verify the socio-economic characteristics in person. The methods of collecting other information are left to the discretion of the consultant, according to the specificities and sensitivities of the local situation.

6. In all investigations and field work, the consultant should take the greatest care to work in harmony with the expropriation procedures and operations established by CDR in order that these should not be compromised.

7. A concise, tabular presentation with maximum clarity is recommended, with figures and enumerations preferred over qualitative description. The source of information, how, when and by whom obtained should be indicated as appropriate. Where specific (e.g. census) information is not available, or decisions have not been made, this should be noted and the report should specify how, when and by whom this information will be collected and made available to the Bank. Information provided in the Environment Action Plan need not be reproduced.

8. A well-written plan could be presented in 5-10 pages.

Social Assessment

9. The scope of this study should be informed by common sense and good judgment. The project appears to involve some local inconveniences and socio-economic costs to be traded off against a wider benefit to a much larger number of people. Since the economic analysis will take the larger benefits into account, the SA should concentrate on the local impacts and, to the extent possible, contribute positively to project design and implementation. The purpose of the SA is to indicate the extent to which the physical planners have listened to, and taken appropriately into account, the needs of the local stakeholders.

10. The SA should start by identifying and profiling the main stakeholder groups and the ways in which they will be affected. One major benefit of the SA would be to identify in advance any possible major sources of stakeholder opposition to the project, and possibly to suggest in recommendations ways in which they might be encouraged to support the project. Who are the people most affected in the different ways described below? How long have they lived there? What sort of organizations exist in which they are involved? What are their different interests? How are they likely to react to the project?

11. The SA should then focus on identifying and describing significant expected socio-economic impacts of the project such as:

(a) local impact on residents and pedestrian traffic
(b) increased costs to local residents of vehicle ownership through the introduction of paid parking
(c) the effect on property owners of uncompensated acquisition of small strips and edges of land
(d) possible impacts on local formal and informal commercial activities
(e) attitudes and expectations of the local population in the areas affected differentiated as necessary by different types of stakeholders
(f) any other significant issue that may arise during the course of investigation.

12. The study should also make realistic and practical recommendations, to be discussed with the project implementation and the preparation team, that could contribute to the better design or implementation of the project from the point of view of local residents. Where this is not possible, the SA study should explain and justify the trade-offs.

13. The scope and scale of the SA should be realistic. It should describe the major current characteristics or situation with regard to each topic, and then attempt a realistic assessment of what the effects or impacts of the project are likely to be. The SA should use informal, rapid assessment and primarily qualitative methods (direct observation, informal consultations, small group interviews) in a selection of sites, and should not attempt comprehensive coverage. The selection of sites (3-5, except for (c) below) should be informed by their different characteristics, with care taken to include those sites that illustrate different features or issues, where the scale of works is greater, or where the resident population will be more intimately affected. Following a stakeholder analysis, the kinds of specific questions the SA should address are illustrated below:

(a) **Local impact on residents and pedestrian traffic.** New road layouts and traffic patterns affect pedestrian movement. What are current pedestrian movements? How major are these effects? What facilities have been provided for pedestrian movement? Are there significant pedestrian safety issues? Is increased pedestrian education advisable (e.g. schoolchildren). Is there any issue of non-motorized traffic (bicycles, hand-carts, animal-drawn transport etc.)?

(b) **Increased costs to local residents of vehicle ownership through the introduction of paid parking.** The introduction of paid parking here and elsewhere through the project will affect costs of parking, and availability. What will the effect be on local residents? How many of them are vehicle owners? Can some realistic quantitative monetary estimate of costs be made? Can this be related to the household budgets and present vehicle ownership costs? What will happen on holidays, non-work days? In what ways might local residents benefit from the new parking arrangements?

(c) **The effect on property owners of uncompensated acquisition of small strips and edges of land.** Recognizing that this is difficult and possibly delicate, the SA should nevertheless attempt an evaluation, in this case of all relevant sites and not just a sample, and preferable based on a set of diagrams, a cadastral survey, and a list of the land take. How will the properties, and the owners, be affected? What changes in land values to owners might result? Are there any affected structures?

(d) **Possible impacts on local formal and informal commercial activities.** The SA should describe current commercial activity where works or land acquisition will be undertaken. What is the present access to shops and use of parking? How would these be affected by new parking arrangements, grade separations etc.? Would there be significant positive or negative impact on commerce (customer access, deliveries?). Are there any street vendors or roadside-based services that would be affected, and how?

(e) **Attitudes and expectations of the local population in the areas affected.** The consultant has attended some of the environmental hearings. Attitudes of local stakeholders could have an important bearing on the implementation of the project. How well have the local residents been informed of the project? What are the reactions? Is any public information activity needed? Are there any good suggestions or proposals from the public that could be incorporated into project design, or strongly held opinions that need to be taken into consideration?

14. The SA report should be presented in such a way that it can convey a vivid, honest and accurate portrait of local "social reality" as it will be affected by the project, using insight and clear analysis. It should not be highly technical or academic. It may use short illustrative biographies or personal sketches, photos, case studies of families or commercial establishments, daily personal schedules (movement, use of transport and parking etc) to make its points. The writer is advised to think of the model of good investigative journalism, rather than a sociological treatise.

15. Recommendations should be clear, concise, and well justified by preceding fact and argument, and should indicate specific actions to be undertaken, by whom and when, in the context of the project.

16. The SA report, exclusive of appendices, should be between 15-20 pages.

ANNEX 2

Resident's Questionaire

(Sample translated from Arabic)

Questionnaire No	First Name	Family Name	Nationality	Family Status								Residence										Work			School		Car				Preferred neighborhoods for resettlement										
				Family members by age groups								Address			Area							Work Addresses						Parking			Neighborhood ranked by preference			Why?			Aspired area / nb of rooms for your family		Main difficulties that may result due to resettlement		
				Male			Female																																		
				<15	15> >65	> 65	<15	15> >65	> 65	Total	Basic sources of income	Bldg.	Street	Neighborhood	m2	no of rooms	Owner since	Tenant since	Other	Value of rent per year	market value of rent	Main Member	Other members	Mode of transport to work	School Address	Mode of transport to school	nb of private cars	On Street	Private Parking	Public Parking	a	b	c	a	b	c	m2	no of Rooms	a	b	c