No.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

COUNCIL FOR DEVELOPMENT AND RECONSTRUCTION (CDR)
REPUBLIC OF LEBANON

THE STUDY OF ENVIRONMENTAL FRIENDLY INTEGRATED TRANSPORTATION PLAN FOR GREATER TRIPOLI

FINAL REPORT

Technical Report - 5

ENVIRONMENTAL ASSESSMENT

DECEMBER 2001

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REPORT COMPOSITION

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

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

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

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

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

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

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

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

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

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

APPENDIX

TECHNICAL REPORT - 5
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LIST OF ABBREVIATIONS

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

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

CHAPTER 1

ENVIRONMENTAL CONDITIONS

CHAPTER 1

ENVIRONMENTAL CONDITIONS

1.1 LEGISLATION AND LAW ON ENVIRONMENT

1.1.1 Environmental Legislation

Lebanon has a large body of environmental laws with some dating back to the 1930s. However, these laws are characterized by:

1. Obsolescence and the need for update.
2. Lack of clarity regarding accountability for implementation.
3. Lack of provisions of mechanism for implementations.
4. General weakness of law enforcement due to lack of clarity in responsibilities and coordination and insufficient deterrent value.

Lebanon's institutional framework is now integrated. The fact that line ministries (transport, agriculture, hydraulics, and electrical resources, public health, public works, industry and petroleum and CDR) still keep control over environmental management issue, means that the environmental management system itself remains fragmented. Under these circumstances, there are some constraints on the ability of the Ministry of Environment (MOE) to have a real impact on the coordination of various sector initiatives, and on facilitating the integration of environmental policy into general development initiatives.

The state Ministry of Environment was first established in May 1981 aiming at controlling all forms of pollution, the use of pesticides deforestation and forest fires, solid waste disposal, protection of fauna and flora and urbanization. There was no global environmental law, but specific uses were addressed in sector laws and regulations. These laws included the protection of natural sites forestry, archeological and tourists sites, drinking water, sewage, marine pollution, air pollution, industry, hunting, fishing, urban development, mining food control, housing and toxic waste disposal.

In April 1993, the Ministry of Environment issued the Law 216, marking a significant step forward in the management of environmental affairs. It has the power to: 1- formulate general environmental policy and propose measures for its implementation in coordination with other concerned agencies. 2- protect the natural and man-made environment in the interest of public health and welfare. 3- controls and prevents pollution irrespective of the source. Although the monitoring function is given to the MOE, enforcement powers lie within the prerogatives of the ministry of the interior. In addition the resources budgetary expenditures and staffing levels provided are such that the MOE's capacity for environment management is very limited.

Moreover, the same Ministry of Environment has suggested, in 22 September 2000, an Environmental Impact Assessment outline, which is still a draft decree under revision by a committee composed of representatives from related ministries and agencies. The contents of this draft decree are presented in Appendix 7.1.

The main goal of this decree is to specify the obligatory requirements for public and private projects concerning the evaluation of its impact on the environment. The framework of the projects under this decree provides the following conditions:

(1) It is not allowed to divide the project and offer it in stages so as to prevent the ability to precisely classify said project. In such a case, the initial environmental examination or the environmental impact assessment study is considered inadmissible.

(2) The ruling of this decree is applicable to any changes, additions, expansions or rehabilitation to a project, already existing, or licensed if private project, or approved if public project, which may lead to important effects on the environment.

1.1.2 Environment Related Agencies

A number of other government organizations have responsibilities for environmental management, in particular the CDR, which is leading the recovery and reconstruction program. The key overlaps in responsibility on the national level are summarized as presented in Table 1.1-1.

Table 1.1-1 Environment Related Agencies

Wastewater:	MOE, CDR, Ministry of Housing, Hydraulics and Electric Resources, Health and Public Works
Solid/Hazard Waste:	MOE, CDR, Ministry of Health, Urban Affairs, and Public Works
Water Resources:	MOE, CDR, Ministry of Health, and Public Works
Land Use:	MOE, CDR, Ministry of Transport, Agriculture, Tourism, Housing and Health
Forest and Agriculture:	MOE and Ministry of Agriculture
Pollution:	MOE, Ministry of Transport, Industry and Petroleum
Cultural Heritage:	MOE, Ministry of Antiquities Department

1.2 PHYSICAL ENVIRONMENT

1.2.1 Meteorology

- Temperature and Humidity:

Like the rest of the Lebanese coast, the Greater Tripoli area is characterized by a mediterranean climate, with the rainy season ranging from October through April and virtually rainless summers from May to October. Summers are hot and humid, with average temperature of 28°C and high temperature of 40°C. Winters are characterized by tempered weather with an average temperature of 10°C. Greater Tripoli rarely knows freezing temperature.

- Wind Pattern:

The sea and the mountains, locally by the river Abou Ali determine wind and breeze conditions. Prevailing winds are from the west and southwest (85% of the time). The wind blows from the east and northeast the rest of the time (15%).

Although there is very little information on the nature and extent of air pollution in Lebanon (this is potentially serious problem), there are no direct measurements of air quality or pollutant concentrations in Lebanon. Estimates made by the Environmental Resources Management (“ERM”) supplemented by personal observations indicate that overall air pollution is likely to be a major public health hazard. At present vehicles in Greater Tripoli are the major sources of air pollution.

The poor air quality resulting from vehicular emissions may cause significant health problems. Vehicles dominate the emission of NOx. The total volume of NOx emitted by vehicles contributes to overall air quality deterioration; estimate maximum hourly carbon monoxide (CO) concentrations in the immediate vicinity of heavily trafficked roads are likely approach or exceed WHO guidelines for health. ERM estimates that total vehicles lead emissions in heavily trafficked areas in Tripoli represent significant quantities in the atmosphere.

Management of urban air quality arising mostly from traffic which poses serious health problems and is the only major environmental issue that has not yet received the attention of the Lebanese Government. There is a need for a multi faceted policy that includes Traffic Management, incentive pricing for unleaded gasoline and for imports of new fuel-efficient vehicles straitening and strengthening and enforcement of emissions standards, and a scrappage program for very old vehicles.

1.2.2 Water Quality

Water supply in Greater Tripoli today is in a very precarious situation and causes major public health concern for population and municipal authorities.

Water quality of Greater Tripoli is being impaired by uncontrolled discharges of industrial wastes, uncontrolled discharges of solid waste, sewage and waste oils, exposure of the water distribution systems to waste water infiltration, and the absence of adequate water treatment. According to some national survey, about 70% of all natural waters sources and piped water are exposed to bacteriological contamination; 66% of town network were microbial contaminated.

Inadequate water supply and sanitation are major causes of health problems and water pollution. The water supply is usually only available during limited periods and suffers extensive losses due to leaky water distribution facilities. The conditions of existing wastewater facilities are even worse than those for water supply. Wastewater collection systems are non-existent. Wastewater is directly discharged to the sea.

1.2.3 Water Sources

Water is currently supplied to the Greater Tripoli area from three main sources:

a. Racheine springs
b. Hab source
c. Vundobonian limestone aquifer

It is assumed that these three water resources currently provide Greater Tripoli a combined flow of 50,000 m^2/day.

- Hab Treatment Woks

In the past water from Hab source was treated at the Hab water treatment works (WTW) located in the Wadi Bahasass “Valley” on the southern limit of municipality of Tripoli. Because the Hab WTW is currently non-operational, poor and uncontrolled quality raw water is supplied directly to the system.

- Distribution system and water quality

The major part of the network is very old and a high percentage of water is wasted through leaks and careless practices. Moreover, very little maintenance has been carried out in the past twenty years. Overall losses due to leakage, illegal connections and losses at households are estimated to be at least 60% of the flowing into the system.

Lebanon has no regulation on the quality of raw water used for drinking water supply. Therefore it is practically uncontrolled at this time. Several current sources of water are reported to be contaminated with the exception the Rachine Springs; all water sources show the presence of Bacteria. Leaking sewers and improperly designed septic tanks causes bacteriological pollution. A large number of residents do not use tap water for drinking, however poor or low-income populations cannot afford the regular consumption of bottled mineral water. This population is permanently exposed to the threat of infections from drinking contaminated water such as typhoid fever, hepatitis, and gastroenteritis.

The Tripoli water board is an institution that belongs to the ministry of hydraulic and electrical resources. It is responsible for operating and maintaining the water supply system for the Greater Tripoli area.

The Tripoli water board is severely handicapped due to the absence of capital investment for replacement and extension, inadequate operation and maintenance, equipment deterioration, understaffed, and weak labor force.

1.2.4 Coastal Area

Poorly managed urban growth and deteriorating environmental conditions resulting from war-damaged infrastructure are posing critical threats to health and productivity. The most intense pressure on land use and natural resources are from urban encroachment on the coastal zone. The seacoast of Greater Tripoli has become densely populated settlements, haphazardly built and lacking in services.

Another problem is dredging sand from the seabed, which has a significant impact on marine ecology, coastal morphology, beaches and fisheries. Furthermore the seabed might have become a pollution sink as a result of long-term contamination of coastal water and any major disturbance of the seabed such as dredging for sand, could release many contaminants into the marine environment.

The sea shoreline and coastal waters of Greater Tripoli are affected by pollution. Many studies have identified positive concentration of mercury, copper, cadmium, PCBs, all of which are likely to be associated with discharge of untreated industrial affluent. In addition there is evidence of bacteriological contamination of coastal waters resulting from the discharge of sewage and solid waste.

1.2.5 River and Wadis “Valley”

Nahr Abou Ali “River Abou Ali” is an important landmark of the geomorphology and urban development patterns of Greater Tripoli. The river has flooded twice in recent history, once in 1942 and more seriously in 1955 causing extensive property damage and loss of life. Nahr Abou Ali was later rebuilt in late1968.

Populations living in adjacent streets use the flood channel literally as a dumpsite so that important quantities of refuse are accumulated on both sides of the channel. The situation is unsustainable from the environmental point of view. In addition to Nahr Abou Ali the study area has several other wadis including:

1. Wadi El-Behsass on the southern edge of Tripoli
2. Wadi Khennak-Hemarou
3. Wadi El-Nehle in El-Bedaoui

All of these dry water course beds became open-air sewers and refuse dump sites. Even relatively short but intense storms provoke serious flooding and solid wastes, including large numbers of tires, block culverts and under-bridge passages at road intersections. Serious floods paralyzing traffic occur at the intersections between Wadi El-Behsass and the Beirut-Tripoli road and between the road and Wadi El-Nahel in El-Bedaoui.

Most parts of Tripoli and EL-Mina are located on a relatively flat coastal land with elevations ranging from two to fifteen meters above sea level. The quarters of Abou Samra and El-Qoubbe occupy a steep hillside and an elevated plateau between sixty and eighty meters above sea level. In these two hills there is no storm water drainage system at all. Storm water causes quite a lot of annoyance: on the plateau it accumulates in the streets and on the hillside it runs down along steep streets and exacerbates flooding problems in lower areas.

During heavy rains persistent flooding is reported to occur all along the old Beirut-Tripoli road because the system is incapable of absorbing storm water run off discharged by steep streets draining Abou Samra and El-Qoubbe. Persistent flooding also occurs between the Beirut-Tripoli road and the motorway leading from El- Behsass to El-Mina, especially near the International Fairgrounds.

Municipal sewerage departments are responsible for sewerage, sewage disposal and storm water drainage. Their institutional capacity is very low due to understaffing, under equipment, and the lack of municipal taxes and government taxes provisions for rehabilitation, maintenance and extension works.

1.2.6 Sanitation and Storm Water Drainage

Sewerage, and sewage disposal and Storm Water drainage are in an extremely degraded situation in Greater Tripoli at the present time, and cause major public health and environmental concern for both population, and municipal authorities. The present situation can be summarized as follows:

- The separate sewer system constructed some thirty seven years ago is inoperable in large portions, due to the destruction of crucial facilities such as, the El-Mina pumping station and sea outfall during the civil war as well as clogging and silting of numerous sewer lines in the lower parts of Tripoli, and practically the entire surface of El-Mina.

- Where the separate system inoperable or does not exist yet, dwellings are now connected to an old network of irrigation canals originally used also as a storm water drainage system. As a result, row sewage is discharged directly to land, rivers and sea at more than thirty different points. The now combined old system is itself in very bad conditions. Leakage from drains and channels in developed areas constitute a potential hazard for contamination of wells and water supply pipelines. Permanent discharge of sewage to land creating swampy areas in the flat part of the study area causes considerable environmental harassment.

- Severe pollution and eutrophication all along the Greater Tripoli coastline constitute a serious threat to public health. The most polluted sections are near the temporary sewage outlet at the tip of El-Mina and the mouth of Wadi Bahasass on the southern edge of Tripoli.

- Storm water drainage is not done by a properly designed and constructed Storm.

- Water drainage system. Moreover the existing system of canals and channels is old and precarious. The system need to be upgraded overall, as well as extended to the upper areas of Abou Samra and El-Qoubbe Hills.

- Large portions of the old Storm Water drainage systems are undersized and subjected to blockage causing flooding problems in flat lands down gradient between the motorway and the built-up areas, especially near the Tripoli International Fairgrounds.

- El-Bedaoui has no proper sewer system. Sewers covering less than 30% of its surface area. Raw sewage is discharged into open sewers and irrigation canals.

1.2.7 Solid and Hazardous Waste

In 1997 Tripoli Municipal Union with the World Bank furnished a solid waste site. Located at the sea by the end of Abou Ali River. But solid waste collection equipment is either not enough by number or has deteriorated due to aging and lack of maintenance. Consequently the authorities are unable to collect the refuse generated by the population sufficiently.

Outside the jurisdiction of Greater Tripoli, solid waste is dumped indiscriminately in rivers along roadsides, in vacant lots, in rivers causing water pollution problems. Industrial solid wastes and medical wastes are mixed with municipal refuse. In addition waste-lubricating oil is disposed at waste dumps or directly into the sewers.

1.3 SOCIAL ENVIRONMENT

1.3.1 History and Heritage

The city of Tripoli was more or less clustered on two hills (Abou Samra and El-Qoubbe) around a central core (the old city) with Abou Ali River flowing between them. El-Mina was concentrated on the peninsula north west of Tripoli. El-Bedaoui was a small town concentrated along the main road connecting it to Tripoli, except for the Palestinian camp of El-Bedaoui located up on the hill overlooking the Tripoli-El-Bedaoui main route.

The 1971 master plan allocated the areas separating Tripoli, El-Mina and El-Bedaoui for future development, principally residential.

The master plan envisaged an integration of the three Cities to form one urban conglomeration. High and middle-income residential buildings have been erected around and along the three main boulevards (Riad El-Solh, Azmi, and Abdellatif El-Bissare road) linking Tripoli and EL-Mina. This development has all but decimated the famous orange orchards of Tripoli. The historic city center of Tripoli is cuddled at the foot of Abou Samra Hills dominated by St. Gilles Fortress. This old center comes second only to Cairo with its rich heritage of religious and secular buildings from the Mamlouk period.

The many Mosques, Madrasas (Schools), Khans (Caravansaries), and Hammams (Baths) are all intertwined with the dense structure of the city center, still very lively with craftsmen, shopping streets or open markets which most of these buildings or monuments suffer from neglect.

There are also important monuments outside the center of Tripoli, including the Lions tower, and Caravansaries in El-Mina and the Old Mosque of El-Bedaoui.

Slightly over a hundred and sixty historical monuments are listed in national decree for conservation. Authorities declare that at least there are thirty-five other monuments that could be added to this list.

Most of Greater Tripoli cultural sites are badly neglected and urgent need for protection, conservation and rehabilitation; such of this rapid process of decay is due to the destructive practice of the local population. During the war there was physical damage to these historical buildings and urban encroachment of resettled migrants on many of Tripoli’s Heritage sites. The major existing facilities are as follows:

- Tripoli Port: Second after Beirut Port.
- International Fairgrounds
- Administrative Buildings (i.e. Municipality, governors office, ministry of finance, central bank)
- Social Building (i.e. Hospital, schools, universities and orphanage)
- Recreational Areas (i.e. National and Municipal stadiums, public gardens)
- Municipal functions (i.e. Slaughter house, Solid waste land fill)
- Existing industry (i.e. Refinery – IPC, Olive extractions)
- Inner and Inter-city Roads.

As in other countries the urbanization came as a direct result of population migration from surrounding towns and villages. Population migration was exacerbated during the war.

1.3.2 Socio-Cultural Activities

Greater Tripoli has suffered significant infrastructure and property damage and loss of human lives during the Lebanese war (1975-1990). Despite the war, the inhabitants like their compatriots elsewhere in Lebanon, have managed to go about their daily lives.

Most large industries, located in El-Behsass at the southern entrance of Tripoli, have closed down during the war (Steel mill, Compressed wood mill, Seed oil, and Sugar refinery) and may not open again. The Government owned oil refinery in El-Bedaoui stopped operating, and its future is uncertain. Scattered throughout Greater Tripoli residential neighborhoods, small industries include a large proportion of car mechanics and body shops (~1200, in Tabbane, Khannk and Muharram districts) food processing establishments (~900), and furniture and wood crafts (~800), and different commercial shops (~13,000).

Tripoli suffers from insufficient cultural and recreational facilities such as theaters, public libraries, recreational areas, and parks. Not withstanding this general lack of facilities, a few organizations have managed to promote socio-cultural activities on sustainable bases. The Lebanese cultural Alliance (Al Rabita Al Thakafia) organizes numerous socio-cultural activities including conferences, art exhibitions, annual book fair, and an important public library. Various NGO's and the Municipalities organize several cultural activities, such as music concerts.

1.3.3 Land Features

Following many inactive years due to scarcity of resources, the municipalities of Greater Tripoli have seized the initiative in revitalizing the future development areas that envisaged in the 1971 master plan. Development planning efforts are concentrated in the four locations as follows:

(1) The orange orchards at the southern entrance to Tripoli and El-Mina: They are comprises of 1,000,000 m^2 privately owned and extends from Beirut-Tripoli Highway to the Behsass El-Mina motorway. They inhibit approximately 75,000 residents. An operation of "demembrement-remembrement" was carried out. 1,100 private owners of the land pulled their lots and redistributed the land accordingly to a new development plan. These lots turned to a conventional grid system and were granted for building permits in the late 1998 mainly for residential areas.

(2) The orange orchards at the northwestern area between Tripoli and El-Bedaoui: This land is under study for future land development since 1997. An operation of "demembrement-remembrement" will be carried out mainly for industrial, commercial, residential and tourism.

(3) The olive groves of Al Manar of Abou Samra Hill are privately owned lands. An operation of "demembrement-remembrement" was carried out. They were redistributed according to a new development plan. These lands turned to a conventional grid system and were granted for residential and commercial building and university areas. They were permitted in early 1992.

(4) The olive groves of Abou Samra Hill, 750,000 m^2 are under study for future land use since 1996. An operation of "demembrement-remembrement" will be carried out mainly for residential and commercial buildings. Future development was planned for the construction of a Beltway around Greater Tripoli, and an Arab Motorway connecting Lebanon and Europe through Syria. The plan was not executed due to the economy in Lebanon.

CHAPTER 2

INITIAL ENVIRONMENTAL EXAMINATION

CHAPTER 2

INITIAL ENVIRONMENTAL EXAMINATION

2.1 PROJECTS IN THE MASTER PLAN

The Initial Environmental Examination (IEE) was carried out for the urban transport master plan of Greater Tripoli in order to make a preliminary identification of negative and diverse environmental impacts. The master plan includes various types of transport improvement projects that comprise not only physical environment but also institutional improvement, especially parking control. The project types are as follows:

- Road Improvement and Construction
- Interchange Construction
- Intersection Improvement
- Bus System
- Signal Installation
- Parking Control and Facility Improvement

2.2 SCREENING AND SCOPING OF PROPOSED PLANS

Screening and scoping were carried out using existing data and information in order to identify items that should be examined in more details in the coming stages of further environmental impact analysis.

The interactions between all activities that may produce negative impact on either the physical or social environments during the main three stages of pre-construction, construction and operation for the Master Plan projects are presented in the impact identification flow in Figure 2.2-1.

2.3 SCREENING AND SCOPING

As a result of Screening, further environmental examination is required. Details of each factor are shown in Table 2.3-1. Based on examination of screening as presented and discussed in Table 2.3-1, a scoping procedure for further examination was carried out and the results are presented in Table 2.3-2. Under this process, the evaluation categories are as follows:

A: Serious impact is predicted.
B: Some impact is predicted.
C: Extent of impact is unknown. (Examination is needed. Impact may become clear as study progresses)
D: No impact is predicted. EIA is not necessary.

2.4 OVERALL EVALUATION AND POSSIBLE COUNTERMEASURES

As a result of screening and scoping examination for the master plan, major negative impacts are predicted. Resettlement may suffer major negative impact in pre-construction stage on roads and intersection projects. In addition waste may cause major negative impact in both construction and operation stages. Other minor negative impacts are on economic activities, traffic and public facilities, public health condition, topography and geology, soil erosion, landscape, air pollution and vibration in both construction and operation stages. A summary of the scoping process for project packages is presented in Table 2.4-1.

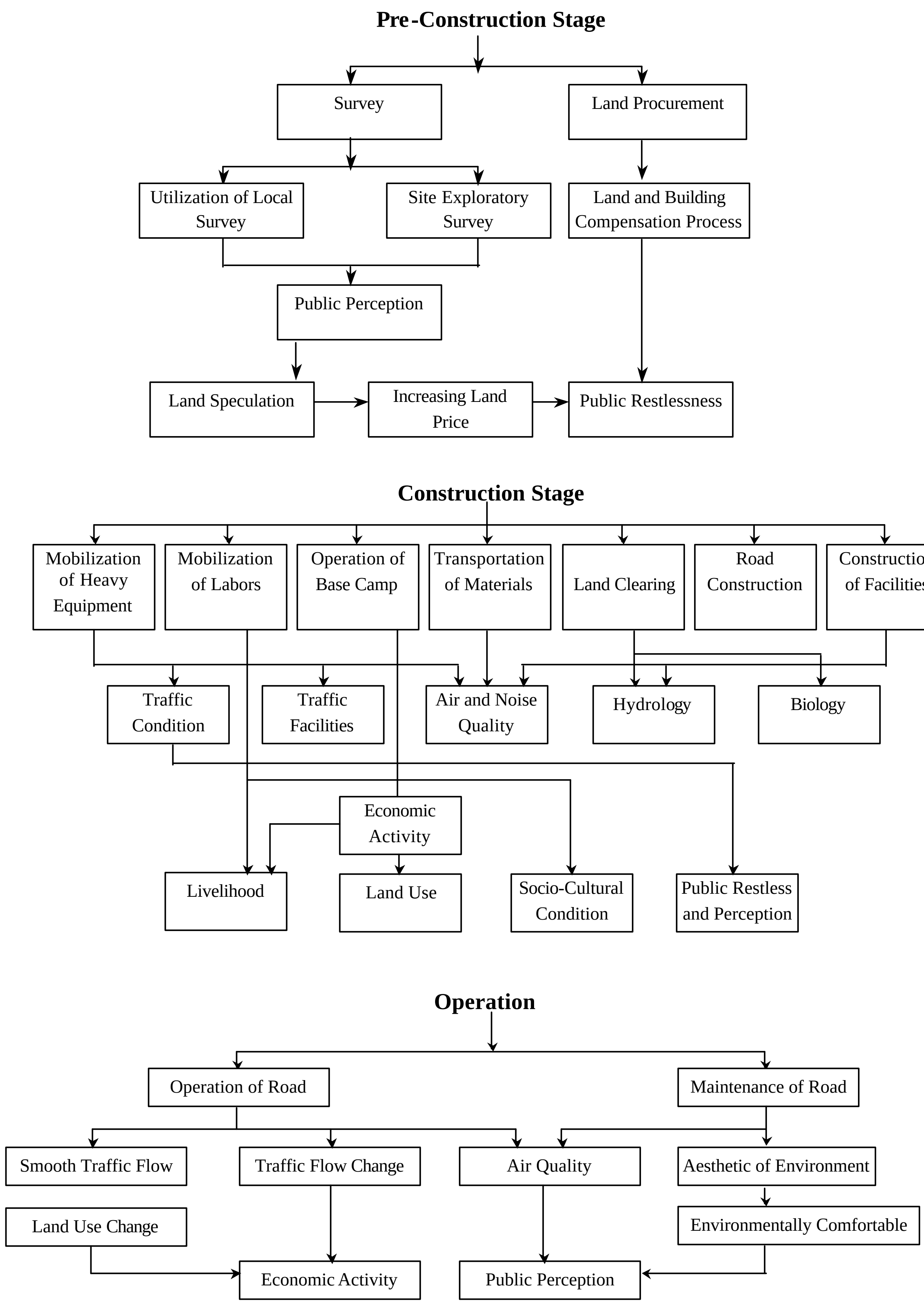


Figure 2.2-1 Impact Identification Flow

Table 2.3-1 Screening of Master Plan Projects

Item	Description	Evaluation	Notes
SOCIAL ENVIRONMENT			
Resettlement	Resettlement by occupancy of proposed land	Yes	Residence are living in project areas
Economic Activities	Loss of productive opportunity such as Land	Yes	Various economic activities exists
Traffic and Public Facilities	Influence of existing traffic such as congestion	Yes	Public facilities exist in the project area
Split of Communities	Split of Communities by obstruction of traffic	Yes	Some access controlled roads may create split
Cultural Property	Loss of cultural property and falling of values	No	Cultural heritage buildings do not exist in all areas.
Water Rights and Rights of Common	Obstruction of fishing rights, water rights, and common rights of forest	Unknown	Rivers and canals for agriculture exist
Public Health Condition	Deterioration of Waste dumps and solid waste	Yes	Large refuse amount will be produced
Waste	Occurrence of Waste dumps and solid waste	Yes	Some construction waste of dumps will be produced
Hazards (Risks)	Increase of possibility of danger of landslide and accident	No	Low possibility
NATURAL ENVIRONMENT			
Topography and Geology	Change of valuable topography and geology by excavation or filling works	Yes	Large scale structure or earth work
Soil Erosion	Surface soil erosion by rainwater after land development (vegetation removal)	Yes	Subjected area is not developed
Ground Water	Change of distribution of ground water by large scale excavation	Unknown	Main work is construction and filling
Hydrological Situation	Change of river discharge and riverbed condition due to landfill and drainage	No	No structure will be built on the rivers
Coastal Zone	Coastal erosion and sedimentation due to landfill or change in marine condition	No	Project area is on Land
Flora and Fauna	Obstruction of breeding and extinction of spices due to change of habitat condition	No	Urbanized and developed area
Meteorology	Change of temperature, precipitation, wind, etc., due to large-scaled development.	No	There are no large scale development
Landscape	Change of topography and vegetation by land development and harmonious obstruction by structural objects	Yes	Landscape will be changed
POLLUTION			
Air Pollution	Pollution caused by exhaust gas or toxic gas from vehicles and factories	Yes	Impact by exhaust gas from increasing traffic
Water Pollution	Pollution by inflow of silt, and effluent into rivers and ground water	Unknown	Less impact by road facilities
Soil Contamination	Contamination of soil by dust and chemicals	No	No chemical activities for soil
Noise and Vibration	Noise and vibration generated by vehicles	Yes	During construction and operation
Land Subsidence	Deformation of land and land subsidence due to the lowering of ground water	No	Sensitive land do not exist in the subject area
Offensive Odor	Generation of exhaust gas and offensive odor by facilities and operation	No	No Factor
Overall Evaluation	Environmental Impact Assessment (EIA) is required or not	From the results of the evaluation, EIA is required	

Table 2.3-2 Scoping of Master Plan

ENVIRONMENTAL ITEMS	EVALUATION OF ROAD BY NUMBER								
ROAD NUMBER *	A01	A02	A03	A04	A05	A06	A07	A08	A09
SOCIAL ENVIRONMENT									
Resettlement	A	B	B	C	C	B	A	A	A
Economic Activities	B	B	C	B	B	B	B	B	B
Traffic and Public Facilities	B	B	C	B	B	B	B	B	B
Split of Communities	C	D	C	D	D	D	D	C	C
Cultural Property	D	D	D	D	D	D	D	C	C
Water Rights and Rights of Common	C	C	C	D	D	D	D	C	C
Public Health Condition	B	B	C	D	D	B	B	B	B
Waste	A	A	A	B	B	A	A	B	B
Hazards (Risks)	D	D	D	D	D	D	D	D	D
NATURAL ENVIRONMENT									
Topography and Geology	B	B	C	D	D	D	B	B	B
Soil Erosion	B	B	C	D	D	D	B	B	B
Ground Water	D	D	D	D	D	D	D	C	C
Hydrological Situation	C	C	C	D	D	D	B	C	C
Coastal Zone	D	D	D	D	D	D	D	D	D
Flora and Fauna	D	D	D	D	D	D	D	D	D
Meteorology	D	D	D	D	D	D	D	D	D
Landscape	B	B	B	D	D	D	B	B	B
POLLUTION									
Air Pollution	B	B	B	D	D	B	B	B	B
Water Pollution	D	D	D	D	D	D	D	D	D
Soil Contamination	C	C	C	D	D	D	D	C	C
Noise and Vibration	B	B	B	B	B	B	B	B	B
Land Subsidence	C	C	C	D	D	D	D	C	C
Offensive Odor	D	D	D	D	D	D	D	D	D
Overall Evaluation	A	B	B	C	C	B	A	A	A

* Road Numbers: Refer to Technical Report - 2, Figure 4.3-1 of the Road Projects

Evaluation categories are:

A: Serious impact is predicted
B: Some impact is predicted
C: Extent of impact is unknown (Examination is needed. Impact may become clear as study progresses)
D: No impact is predicted. EIA is not necessary

(1) Road Improvement

Major negative impact, which is resettlement, is identified. Especially some proposed projects located in existing urbanized area, which include informal housing area and mixed land use: residential and commercial, before the construction stage, so that resettlement is necessary for project implementation. In addition waste is identified as a major negative impact, which is identified for construction and operation stages. Other negative impact before construction stage effect traffic is landscape. In addition, air pollution and noise and vibration are also identified for operation stage due to increase in traffic volume.

For the smooth implementation of the projects, countermeasures such as resettlement system including compensation based on current value of housing, compensation housing in suitable locations and speedy implementation shall be considered.

Table 2.4-1 Summary of Scoping for Proposed Projects

Environmental Items	Road Improvement	Intersection Improvement	Bus System	Signalization	Parking Control and Facility
SOCIAL ENVIRONMENT					
Resettlement	A	C	C	D	D
Economic Activities	B	B	D	D	D
Traffic and Public Facilities	B	B	C	D	D
Split of Communities	C	D	D	D	D
Cultural Property	C	B	C	D	D
Water Rights and Rights of Common	D	D	D	D	D
Public Health Condition	B	D	D	D	D
Waste	A	B	B	D	D
Hazards (Risks)	D	D	D	D	D
NATURAL ENVIRONMENT					
Topography and Geology	B	D	D	D	D
Soil Erosion	C	D	D	D	D
Ground Water	D	D	D	D	D
Hydrological Situation	D	D	D	D	D
Coastal Zone	D	D	D	D	D
Flora and Fauna	D	D	D	D	D
Meteorology	D	D	D	D	D
Landscape	B	B	B	D	D
POLLUTION					
Air Pollution	B	B	C	D	D
Water Pollution	C	C	D	D	D
Soil Contamination	D	D	D	D	D
Noise and Vibration	B	B	C	D	D
Land Subsidence	D	D	D	D	D
Offensive Odor	D	D	D	D	D
Overall Evaluation	A	B	C	D	D

Evaluation Categories:

A: Serious impact is predicted

B: Some impact is predicted

C: Extent of impact is unknown (Examination is needed. Impact may become clear as study progresses)

D: No impact is predicted. EIA is not necessary

In addition, conservation system for cultural heritage properties in the city that are registered by the Antiquities Department, as well as for new sites to be identified in the future. Furthermore, in general, from the natural viewpoint in this region, ratio of green open spaces and roadside trees shall be conserved.

(2) Intersection Improvement

As in the case of road projects, resettlement may suffer major negative impact in the pre- construction stage. Those intersections have busy traffic so that some affects to traffic are identified during construction stage. Moreover, other negative impacts are identified such as waste, landscape, air pollution, noise and vibration.

(3) Bus System

There is no major negative impact on this project because the proposed project utilizes existing roads. However, minor impact such as traffic is identified on construction and operation stages. In order to enhance the bus system, avoiding interruption from other traffic, shall be considered in operation stages.

(4) Signalization

There is no major negative impact from this project. Component of the project is signalization facility and central control center installation. Only a minor impact during the installation in intersections is traffic. Appropriate traffic control is required during the installation.

(5) Parking Control and Facilities Improvement

Here is no major negative impact on both parking control and facility improvement in all stages of implementation. Enhanced parking control will improve traffic conditions and have hardly and negative aspects. Some of proposed parking facility areas are already used for the same function while others are open space or squares. Proposed improvement calls for constructing multi stories parking garages, and thus it is not necessary to acquire land.

Appropriate announcement shall be required when the new parking control system is introduced. Traffic management system shall be required for surrounding area of new parking facilities in order to provide smooth access to parking facilities. General mitigating measures for major physical environmental impacts are proposed as shown in Table 2.4-2.

Table 2.4-2 General Mitigating Measures for Physical Environmental Impact

Environmental Item	Mitigating Measures
Air Pollution	Construction Regulations - Plantation – Buffer Zones
Water Pollution	Management System – Urban Planning
Noise and Vibration	Regulations – Noise Barriers – Plantation
Soil Contamination	Waste Disposal Plan
Land Subsidence	Soft Ground Treatment
Soil Erosion	Vegetation – Drainage
Traffic Build-up and Safety	Management Plan – Detouring – Safety Measures

2.5 STUDY ITEMS DURING THE ENVIRONMENTAL IMPACT ASSESSMENT (EIA) STUDY

Based on the IEE evaluation, for some projects it is necessary to conduct further detail environmental examination such as road improvement, intersection improvement. While the other projects such as public transport signalization and parking control and facility do not require detail environmental examination due to less impact generated by these projects. The study items for road and intersection improvement includes, as shown in Table 2.5-1, are as follows:

Category A;

- Resettlement
- Waste

Category B;

- Economic Activities
- Traffic and Public Facilities
- Public Health Condition
- Topography and Geology

- Landscape
- Air Pollution
- Noise and Vibration

Table 2.5-1 Study Items to be emphasized for EIA Study by Project Category

Environmental Items	Roads and Intersections	Public Transport	Parking Facility
SOCIAL ENVIRONMENT			
Resettlement	A	D	D
Economic Activities	B	D	C
Traffic and Public Facilities	B	C	C
Split of Communities	C	D	D
Cultural Property	C	C	C
Water Rights and Rights of Common	C	C	C
Public Health Condition	B	D	D
Waste	A	C	C
Hazards (Risks)	D	D	D
NATURAL ENVIRONMENT			
Topography and Geology	B	D	D
Soil Erosion	C	D	D
Ground Water	D	D	D
Hydrological Situation	D	D	D
Coastal Zone	D	D	D
Flora and Fauna	D	D	D
Meteorology	D	D	D
Landscape	B	B	B
POLLUTION			
Air Pollution	B	C	C
Water Pollution	C	D	C
Soil Contamination	D	D	D
Noise and Vibration	B	C	C
Land Subsidence	D	D	D
Offensive Odor	D	D	D
Overall Evaluation	A	D	D

Evaluation Categories:

A: Serious impact is predicted
B: Some impact is predicted
C: Extent of impact is unknown (Examination is needed. Impact may become clear as study progresses)
D: No impact is predicted. EIA is not necessary

CHAPTER 3

ENVIRONMENTAL IMPACT

CHAPTER 3

ENVIRONMENTAL IMPACT

This environmental assessment (EA) aims at evaluating the impacts of the Master Plan on air quality and noise levels within the Greater Tripoli Area. In a later stage, a more comprehensive environmental impact assessment (EIA) may be conducted for each specific project.

A filed monitoring campaign was designed and conducted to obtain baseline air quality and noise data that are useful for future comparison as well as for the calibration of mathematical models. Meteorological parameters (wind speed, wind direction, and ambient temperature), particularly matter, CO, SO_2, NO_2 and noise levels were monitored.

3.1 SAMPLING LOCATIONS AND DURATION

Ten (10) sampling locations were selected and denominated from S1 to S10. Table 3.1-1 describes each location, which are depicted in Figure 3.1-1. Air quality and meteorological parameters were measured continuously using the EMS for a period of 24 hours at each location. Particulate matter concentrations were measured at different times of the day to obtain a daily average at each location. Noise measurements were also conducted for fifteen-minute periods at different times of the day. The noise level meter indicates the maximum (Lmax), minimum (Lmin), and average sound level (Leq) recorded during the fifteen-minute sampling period.

Table 3.1-1 Description of the Sampling Locations

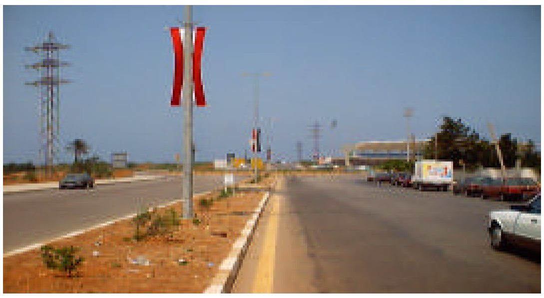
Sampling Location	Description
S1	Located at the main entry of Tripoli, near to “Al Nour” roundabout
S2	Located at the main boulevard next to a bus and taxi stop station in a crowded area due to the presence of food and beverage places, offices and banks
S3	Located at the main boulevard in a business area within an agglomeration of offices and other establishments
S4	Located on a main road to Syria. The road characterized with a relatively high traveling speed and recognizable share of truck
S5	Located next to the watch known as the “Big Ban” of Tripoli; the site is near to public gardens
S6	Located in a highly commuted area next to the main entry to two major regions in Tripoli (Abou Samra and Qoubbe)
S7	Located next to a main roundabout in Abou Samra near residential buildings and some commercial stores
S8	Located next to the Lebanese University and a military base; excavation activities were taking place during monitoring activities
S9	Located near the main road that leads to Beirut; the area is characterized by a relatively large number of truck trips, especially during the morning
S10	Located on the El Mina road at the main access in and out of the Mina, which is usually congested


S1 S2


S3 S4


S5 S6


S7 S8




S9 S10

Figure 3.1-1 Photographic Illustration of the Sampling Locations

3.2 RESULTS OF METEOROLOGICAL ASSESSMENT

Meteorological data include wind direction, wind speed and ambient temperatures. The most common wind directions are towards the northwest and the north, with a combined frequency of occurrence of over 20 percent. Table 3.2-1 summarizes the average wind speeds measured at each sampling location as well as average day and night temperatures. Daytime was taken from 6 AM to 6 PM. Average wind speeds varied from a low of 0.7 m/s to a high of 3.8 m/s. Average daytime temperatures varied between 29.8 and 33.4 ^{0}C, and average night-time temperatures varied between 25.7 and 27.6 ^{0}C.

Table 3.2-1 Average Wind Speeds and Temperatures at the Sampling Locations

Sampling Location	Average Wind Speed (m/s)	Average Day Temperature (^{0}C)	Average Night Temperature (^{0}C)
S1	0.9	31.7	27.0
S2	1.4	31.7	27.2
S3	1.5	29.8	27.6
S4	1.2	31.0	27.5
S5	1.0	32.5	25.7
S6	0.8	33.4	26.8
S7	0.8	31.5	27.4
S8	0.7	30.5	26.2
S9	3.8	31.6	26.2
S10	0.8	31.3	27.5

3.3 RESULTS OF AIR QUALITY ASSESSMENT

3.3.1 CO, NO_2 and SO_2

Table 3.3-1 to 3.3-3 shows the recorded average day-time and night-time concentrations of CO, SO_2 and NO_2. Figure 3.3-1 provides a graphic illustration of these results. The World Health Organization (WHO) standards are indicated for each contaminant. The standards for CO, SO_2, and NO_2 are 9 ppm (8-hour average), 0.134 ppm (1-hour average), and 0.21 ppm (1-hour average), respectively. It can be observed that the CO concentrations exceeded the standard at most locations during daytime, when there is most of the traffic, and decreased significantly during night-time. It is also interesting to notice that the highest daytime concentrations were measured on Mondays (sites S3 and S7), when an increased traffic activity is usually noticed. The SO_2 concentrations were significantly higher than the equivalent WHO standard, and did not vary much from site to site.

Table 3.3-1 Average Day and Night-Time Concentrations of CO, SO_2 and NO_2

Sampling Location	CO 1-hour WHO standard 9 ppm		SO_2 1-hour WHO standard 0.134 ppm		NO_2 1-hour WHO standard 0.21 ppm	
	Day	*Night*	*Day*	*Night*	*Day*	*Night*
S1	10.3	5.1	1.8	1.6	0.17	0.15
S2	8.3	7.0	1.8	1.6	0.4	0.15
S3	16.0	11.9	1.7	1.5	0.2	0.1
S4	12.3	11.0	1.8	1.6	0.37	0.1
S5	8.9	2.3	1.8	1.5	0.5	0.3
S6	13.5	5.0	1.8	1.6	0.4	0.3
S7	16.4	2.6	1.7	1.5	0.4	0.3
S8	13.7	1.2	1.7	1.5	0.4	0.3
S9	11.8	3.4	1.7	1.5	0.4	0.3
S10	11.6	11.0	1.7	1.5	0.3	0.1

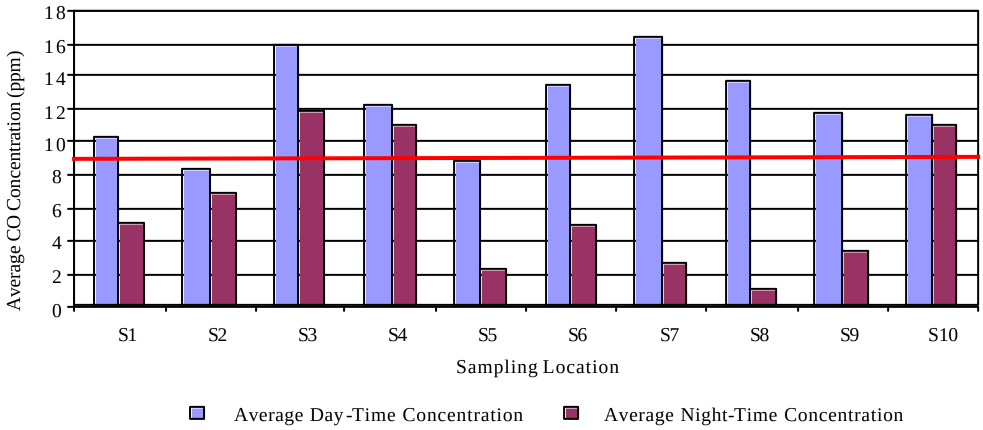


Figure 3.3-1 Average Concentrations of CO

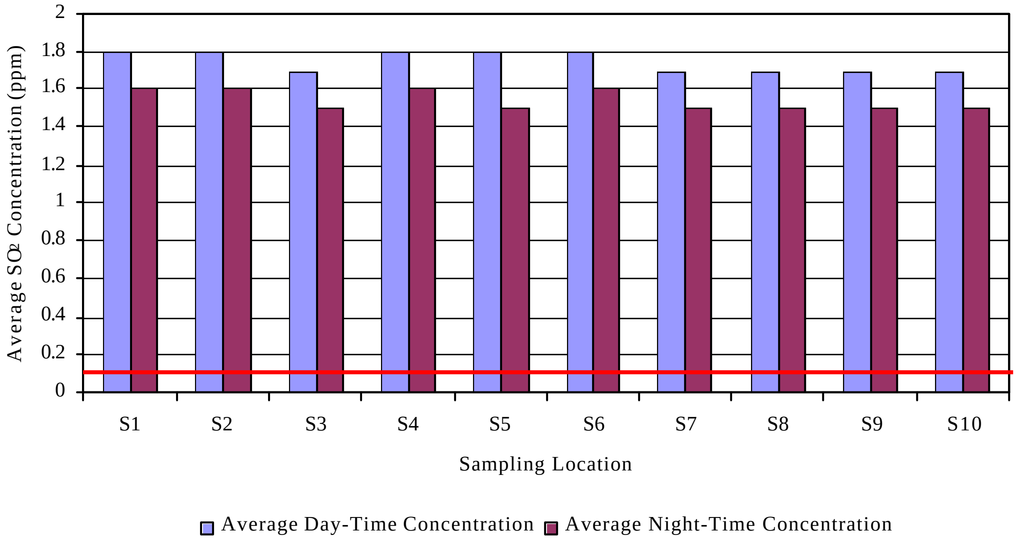


Figure 3.3-2 Average Concentrations of SO_2

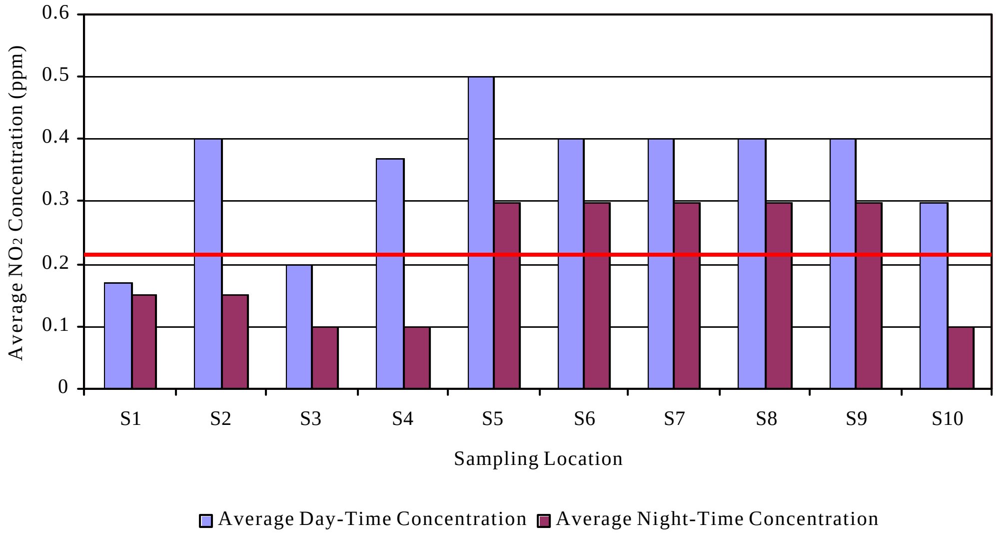


Figure 3.3-3 Average Concentrations of NO_2

3.3.2 Total Suspended Particles (TSP) Assessment

Figure 3.3-4 provides a graphical illustration of daily average TSP concentrations at each site location. The values are based on actual measurements and comparison with the daily variations observed from the municipality data. TSP concentrations exceed WHO standards (150 μg/m^3) at the most congested and busy sampling locations (sites S1, S2, S3, S4, and S9).

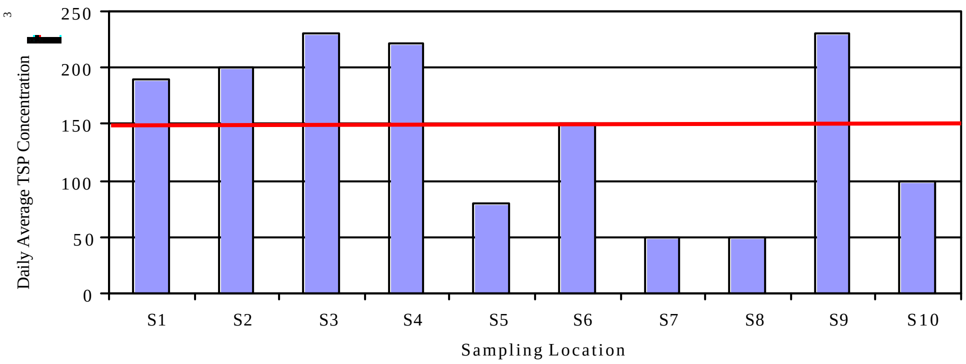


Figure 3.3-4 Daily Average TSP Concentrations

3.4 RESULTS OF NOISE LEVEL ASSESSMENT

Most average noise values (Leq) exceed the Federal Highway Administration (FHWA) noise abatement criteria (NAC) of 72 dBA in developed and urbanized lands such as in Tripoli. Note that noise levels recorded during the night are similar to those recorded during the day, highlighting the intensive nightlife activities in the city. Noise standards are as low as 55 dBA during the night, and are exceeded in all measurements. Figure 3.4-1 shows the result at location S3 as an example of the typical results in the central area.

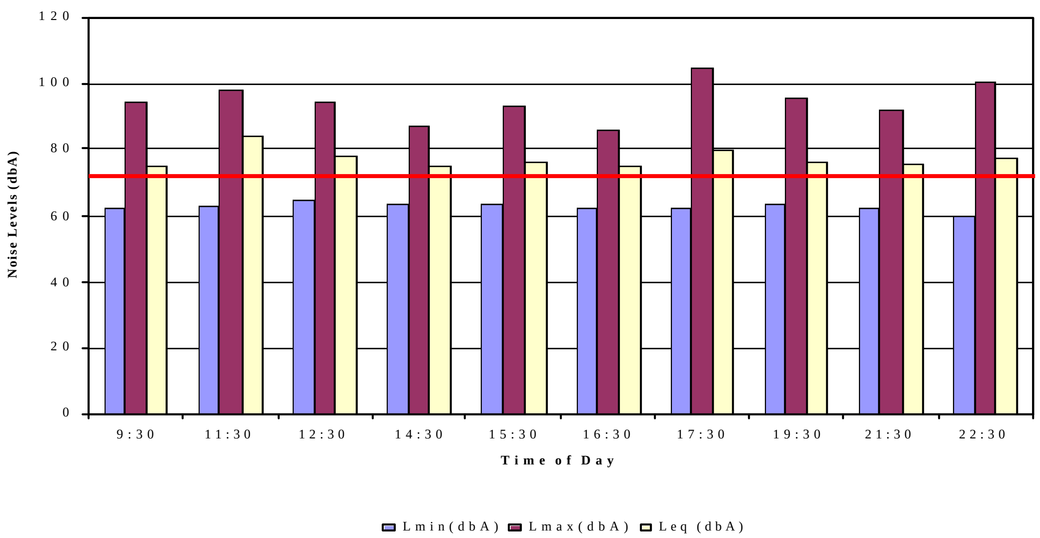


Figure 3.4-1 Noise Level Variations at S3

3.5 OVERALL ASSESSMENT

The monitoring results revealed that air quality and noise levels are significantly high in Greater Tripoli, and mitigation measures are necessary to alleviate the current situation. Seven (7) different were analyzed in this impact assessment study. These are summarized in Table 3.5-1.

Table 3.5-1 Summaries of Simulated Scenarios

Scenario	Year	Master Plan Implementation
1	2000	Without
2	2005	Without
3	2005	With
4	2010	Without
5	2010	With
6	2020	Without
7	2020	With

3.5.1 Air Quality Assessment

Air quality modeling typically involves two major steps. The first step is to build an emissions inventory, which is a compilation of pollutant emission estimates classified according to the different sources of emissions (point, area and line sources). In the case of road traffic, line sources are of most relevance. The second step is to conduct atmospheric dispersion modeling to estimate the concentration of different air pollutants and hence assess exposure levels at different receptor locations. The amount of exposure to air pollution that an area receives consists of pollutants emitted locally into the atmosphere in addition to emissions transported from elsewhere to that area. Road networks are usually simulated as line sources that emit a certain quantity of pollutants that will travel in time and space depending mainly on meteorological and topographic conditions.

1) Air Quality Modeling Methodology

The general methodology to predict current and future concentrations of pollutants with or without project implementation is illustrated in Figure 3.5-1. Part of the methodology relies upon the estimations of traffic volumes and average speeds using JICA STRADA traffic assignment program.

Traffic Model (JICA STRADA) — Estimation of present/future traffic volumes and speed

⇓

Emission Factor Model (MOBILE5) — Estimation of composite emission factors (in g/miles) for vehicle fleet; pollutants include CO, NO_2 and HC

⇓

Dispersion Model (CALINE4) — Estimation of pollutants exposure levels (in ppm) at specified receptor locations

Figure 3.5-1 General Methodology for Air Quality Assessment

The input variables needed to estimate the emission factors using MOBILE5, developed by the United States Environmental Protection Agency (USEPA), include mainly fleet age distribution, activity rates, vehicle mix, modal split, fraction of mileage traveled by each vehicle category, driving pattern, and fuel quality. These variables were obtained from the field measurements and predictions as well as from available data on vehicle characteristics of the Lebanese fleet. MOBILE5 calculates the emission factor for CO, NO_2, and HC. These contaminants, which are among the most representative traffic-related pollutants, were used to assess air quality impacts in the study area.

CALINE, developed by Caltrans (California Department of Transportation), requires the network geometry, meteorological data, receptor locations and activity level at each link to simulation the dispersion process. The Greater Tripoli roadway network was sub-divided to accommodate CALINE's limitation of 20 links. As such, concentrations at receptor locations S1, S2, S3, and S5 were simulated within the same network. The remaining locations (S4, S6, S7, S8, S9 and S10) were simulated independently using their respective surrounding traffic links. The main assumption is that relatively small amounts of pollutants reach other locations as compared to the quantities contributed by local networks. As such, the network was represented by seven (7) sub-networks. The worst-case scenario option for the meteorological conditions was used. Similarly, link activity rates were represented by the peak hour traffic volumes as well as the emission factor corresponding to the average vehicle speed for each roadway link. Under these conditions, the model displays the highest possible concentration of the simulated contaminant at a given hour.

2) Air Quality Modeling Results

Emission factor curves for CO, NO_2, and HC, as a function of average speed, were obtained using MOBILE5 (Figure 3.5-2 to 3.5-4). Note that the emission factors decrease with time for the same average speed. This is attributed to the fact that MOBILE5 updates the vehicle fleet age distribution by assuming that vehicles older than 25 years, which are the most polluting ones, retire. Besides, newer vehicles, which emit less, are assumed to accumulate more mileage than older ones.

Another important observation is that the master plan measures did not affect substantially the emission factors. This is mainly attributed to the types of measures proposed, namely road improvement, enhancement of public transport, and traffic management measures. Among these, only the second measure could directly affect the composite emission factors by promoting the use of buses and discouraging the use of private cars, thus contributing to the reduction of overall emissions, particularly of CO and HC. A recent study showed that increasing the fraction of buses in the vehicle fleet from 10 to 25 percent decreased CO and HC emission factors by about 75 percent in 2015 as compared to year 2000 levels. However, in this case the anticipated increase in the fraction of buses in 2020 is much lower and did not affect the emission factors.

The remaining master plan options do not affect the emission factors. These are mainly affected by traffic-related options that significantly alter the vehicle fleet composition, such as a truck-area ban strategy, promotion of car-pooling, or an intensive mass transit program. Technology-related options can also reduce emission factors such as promotion of inspection and maintenance programs, fuel reformulation, and vehicle retirement programs. These are not included in the master plan. The proposed measures influence mainly the traffic volume and speeds in the network, which in turn may affect ultimate exposure levels.

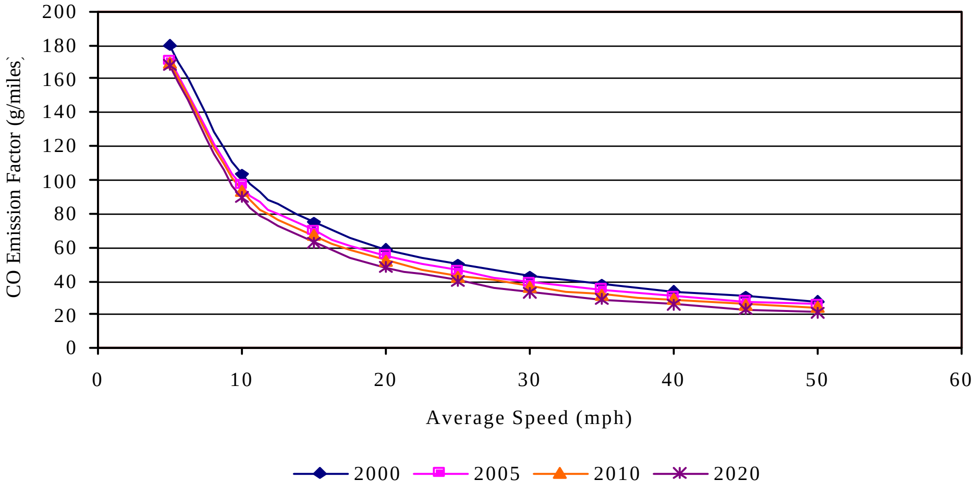


Figure 3.5-2 CO Emission Factor Variations with Average Speed

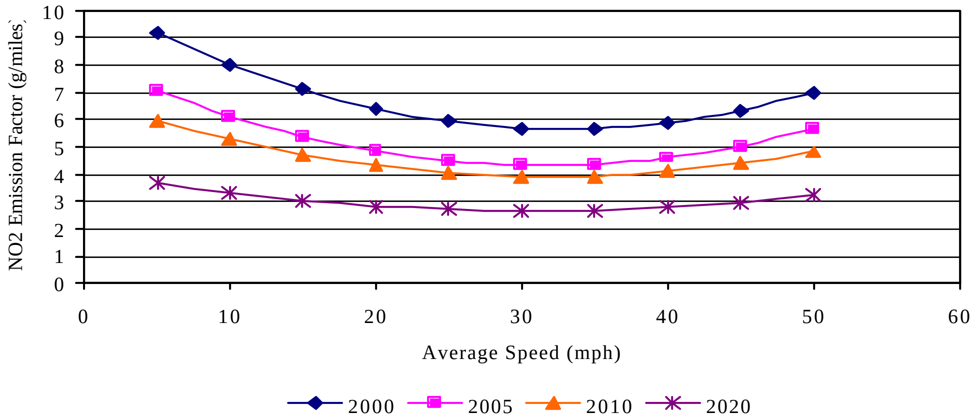


Figure 3.5-3 NO_2 Emission Factor Variations with Average Speed

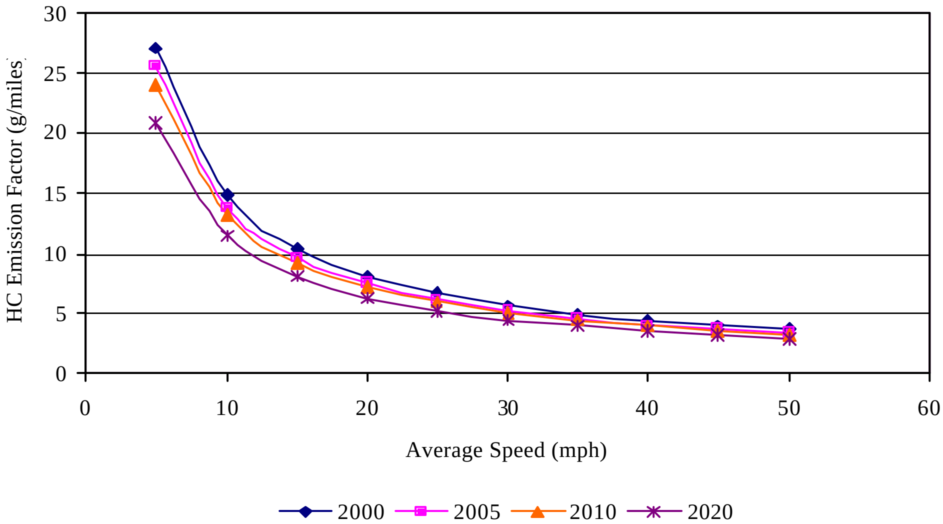


Figure 3.5-4 HC Emission Factor Variations with Average Speed

CO and HC emissions behave similarly with varying average speeds by decreasing with speed. On the other hand, while NO_2 emissions initially decrease with speed, they start increasing again at an average speed of about 40 mph. Figure 3.5-3 indicates the percent improvement in CO concentrations observed in 2010 (Medium Term) and in 2020 (Long Term) at each location with Master Plan implementation as compared to the without implementation scenario for the same year. CO simulations were the most significant in assessing air quality impacts. This can be attributed to two main reasons: 1) CO is the most potent gas among the three, and 2) the variations of NO_2 emission factors with speed is relatively small. Besides, HC behaves similarly to CO, and the same observations are generally applicable to both contaminants.

The simulated concentrations represent those during the busiest traffic hour coupled with the worst-case meteorological conditions, yielding maximum possible contaminant concentrations. This explains the reason why predicted concentrations are higher than the measured ones reported in section, which do not necessarily reflect worst-case conditions. However, simulated values remained within the same order of magnitude than the measured ones.

The locations where the highest pollutant concentrations were predicted are S1, S2, S3, S5 (located along and near the Tripoli Boulevard, which is very congested), S4, and S9 (located along major roadways that attract significant amounts of traffic). CO concentrations at these locations exceeded WHO standards for most of the predicted values. Locations S6, S7 and S8 exhibited lower pollutant concentrations. S10 was not attached at all.

Site S4 is the only that exhibited negative impacts in the long term (2020), with an increase in CO concentrations of about 6 percent. This is mainly due to the attraction of traffic to that location, particularly due to the proposed grade separations.

Table 3.5-2 summarizes the results, and highlights the relation between master plan projects and simulation results. Note that NO_2 concentrations decrease with time at most locations, with and without project implementation.

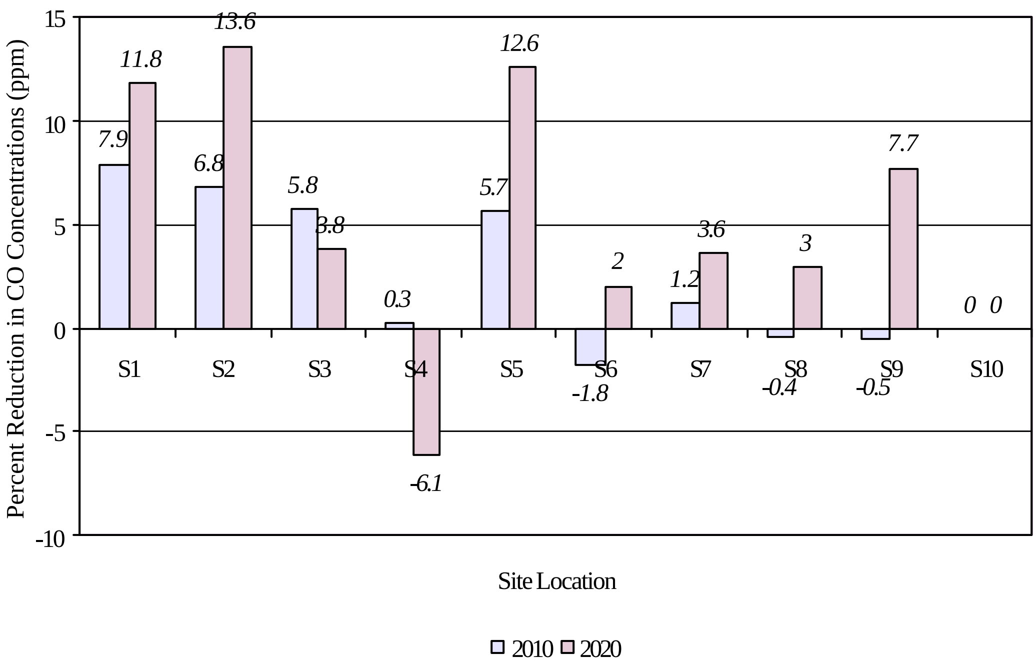


Figure 3.5-5 Percent Reduction in CO Concentrations with Master Plan Implementation in 2010 and 2020

Table 3.5-2 Summary of Air Quality Impact Assessment

Site Location	Impact Assessment	Comments
S1	Positive impact from project implementation in all years, with CO reductions varying from 5 to 12 percent compared to no project implementation scenarios, with most reductions achieved in year 2020	The construction of the east ring road in 2005 and the Arab highway in 2020 successfully divert traffic from Tripoli Boulevard, hence reducing overall traffic emissions
S2	Positive impact from project implementation in all years, with CO reductions varying from 3 to 13.6 percent compared to no project implementation scenarios, with most reductions achieved in year 2020	The construction of the east ring road in 2005 and the Arab highway in 2020 successfully divert traffic from Tripoli Boulevard, hence reducing overall traffic emissions; in addition, construction of the Boulevard underpass in 2005 divert through traffic and reduce surface emissions
S3	Positive impact from project implementation in all years, with CO reductions varying from 3 to 6 percent compared to no project implementation scenarios, with most reductions achieved in year 2010	The construction of the east ring road in 2005 and the Arab highway in 2020 successfully divert traffic from Tripoli Boulevard, hence reducing overall traffic emissions; in addition, construction of the Boulevard underpass in 2005 divert through traffic and reduce surface emissions
S4	Only slight improvements if ever were observed in years 2005 and 2010; however a 6 percent increase in CO concentration was predicted in year 2020 with project implementation	Grade separation projects in year 2020 improve traffic conditions leading to an increased attraction of traffic to the highway, thus resulting in increased emissions
S5	Positive impact from project implementation in all years, with CO reductions varying from 4.1 to 12.6 percent compared to no project implementation scenarios, with most reductions achieved in year 2020	The construction of the east ring road in 2005 and the Arab highway in 2020 successfully divert traffic from Tripoli Boulevard, hence reducing overall traffic emissions
S6	Negative impacts in 2005 (4.8 percent) and in 2010 (1.8 percent); positive impact in 2020, with a decrease of 2 percent in CO concentrations	The bus terminal constructed in 2005 near S6 attracts a large number of buses, thus locally increasing emissions; general traffic is however gradually diverted with the implementation of other projects until 2020, and particularly the Arab highway
S7	Slight improvements of around 1 percent in 2005 and 2010, and a 3.6 percent reduction in CO concentrations in 2020	The Abou Samra area is not significantly affected by the master plan implementation; small improvement in 2020 can be attributed to some traffic diversion towards the Arab highway
S8	No major impact; 3 percent reduction in CO concentrations in 2020	This area is not significantly affected by the master plan implementation
S9	Negative impacts in 2005 and 2010, with an increase from 2 to 4 percent in CO emissions; positive impact in 2020, with an 8.5 percent reduction in emissions	Grade separation projects in 2005 and 2010 increase traffic attraction to the west ring road, consequently increasing emissions; in 2020, with the construction of the Arab highway, some flow is diverted and emissions decrease again
S10	No impact at all on emissions	The Mina area is totally isolated from the rest of the study area, is not affected by project implementation

3.5.2 Noise Impact Assessment

Noise propagation from vehicles is a function of the average vehicle speed and vehicle conditions, pavement quality, propagation medium, and presence and characteristics of barriers. The last item includes for example building heights, distance from road's edge, and barrier density.

1) Noise Modeling Methodlogy

Noise impact assessment was conducted using the Traffic Noise Model developed by the FHWA. The model accounts for accelerating and decelerating traffic, vehicles on grade, and different pavement types such as Dense Graded Asphaltic Concrete, Portland Cement Concrete, and average pavement. It computes adjusted speeds based on the user-imput speeds, roadway grade, and traffic control devices.

The first step prior to using TNM consists of inputting the road network indicating the roadways centerlines, the building lines, as well as receiver locations. The same network sub-division used for air quality assessment was used for noise impact assessment. Receiver locations were chosen to match sampling locations S1 to S10. The next step consists of identifying for each road segment, or link, the off-peak hourly traffic volume (in vehicles per hour) as well as the average cruising speed (in km/hour). The model also allows to simulate flow control at the links, such as stop control, signal or on ramp control as well as noise barriers. In this case, noise barriers were not planned to be built as part of the Master Plan. The average building heights and percent of buildings along the roads were estimated from field observations. Average building heights of 15 meters and percent of buildings of about 80 percent, reflecting the high urbanization level of the city, were used. It was assumed that the off-peak hourly volumes occurred between 11 AM and 12 AM, following the morning peak-hour and just before the afternoon peak-hour. Hourly traffic distribution was also assumed to be the same for all scenarios and was taken from the field results.

2) Noise Modeling Results

Modeling results of the baseline scenario (scenario 1) approximated fairly well the field monitoring data. Absolute deviations from measured values varied between 0.1 dBA at S10 and 6.7 dBA at S7 (Figure 3.5-6). Simulations at sites S6 and S7 showed the highest deviations from measurements. In fact, the topographic features of these sites are not easily simulated using TNM, which may have affected the results. A summary of the results obtained is presented in Figure 3.5-7.

In general, the scenarios that include project implementation exhibited lower noise levels at receptor locations than its counterpart (same year) scenario without project implementation. The most significant reductions in noise levels were achieved near the Tripoli Boulevard (sites S2, S3, and S5), due to the partial diversion of traffic through the underpass. Site S4 is the only one exhibiting negative impacts in the long term (2020), mainly because of increased traffic volume and consequently of sources of noise emissions. Sites S8 and S10 did not experience significant reductions in noise levels. Table 3.5-3 summarizes the noise impact assessment results.

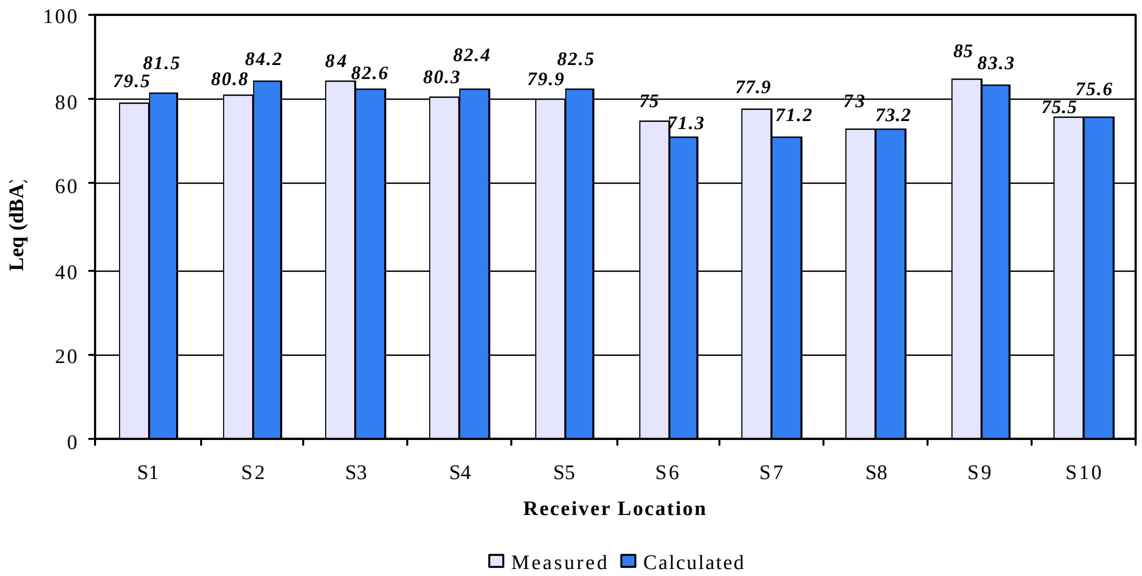


Figure 3.5-6 Simulations of Measured Noise Levels in Greater Tripoli

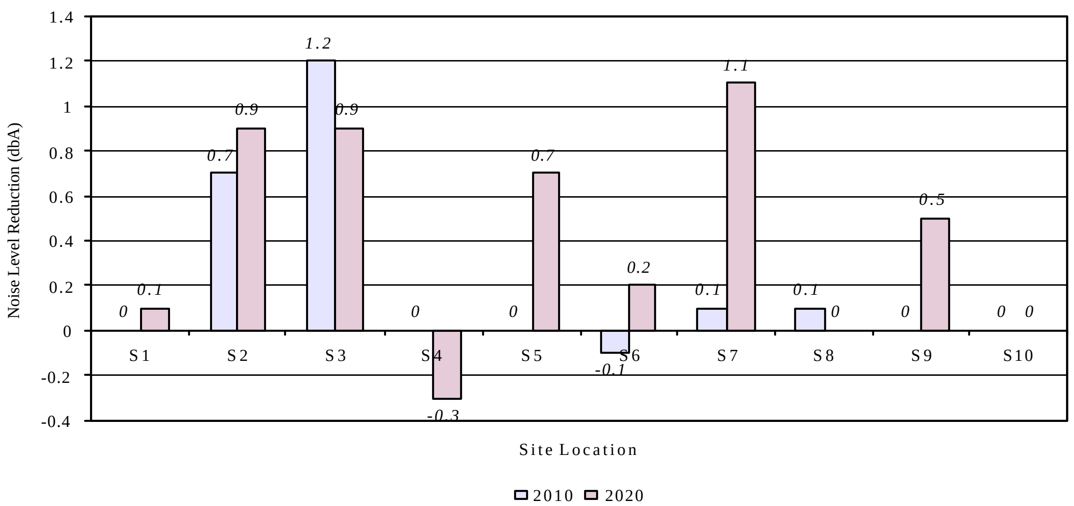


Figure 3.5-7 Noise Level Reductions at the Site Locations with Master Plan Implementation in 2010 and 2020

Table 3.5-3 Summary of Noise Impact Assessment

Location	Noise Impact
S1	No impact with project implementation
S1	Positive impact with noise reductions from 0.3 to 0.9 dBA
S3	Positive impact with noise reductions from 0.3 to 1.2 dBA
S4	No impact with project implementation
S5	Positive impact with noise reductions up to 0.7 dBA
S6	Negative impact in 2005, with noise increase of 0.6 dBA; no impact in other years
S7	Positive impact in 2020, with noise decrease of 0.3 dBA; no impact in other years
S8	No significant impact with project implementation
S9	Negative impact in 2005 with noise increase of 0.6 dBA; positive impact in 2020 (0.5 dBA)
S10	No impact at all from project implementation

3.6 MITIGATION MEASURES

3.6.1 Air Pollution

The results from the air pollution assessment showed that although air quality conditions will improve in most locations of the study area, pollutant levels might still remain relatively high as compared to available standards. Besides, the proposed measures do not directly affect vehicle emission factors. Measures that reduce composite vehicle emission factors can be very effective in improving urban air quality conditions.

Generally, there are two basic approaches to reducing vehicular emissions: reducing emissions per vehicle kilometer traveled and reducing the total number of kilometers traveled. There are a number of ways to meet the first objective of reducing emissions per vehicle kilometer traveled: (1) enforcing higher maintenance standards on existing vehicles, in order to keep emissions closer to the design standards of the vehicles; (2) introducing vehicles designed to meet stricter emission standards; (3) introducing unleaded fuels (with or without catalytic converters) for the rapid reduction of atmospheric lead; and (4) retrofitting motor vehicles to use other kinds of fuel modifications such as Compressed Natural Gas (CNG) and propane.

Proper air quality management requires an integrated approach that encompasses coordination and consensus building across sectors, identification of technically feasible abatement options, and introduction of policies and instruments to support implementation. Regulatory instruments to control vehicle emissions are presented in Table 3.6-1. Table 3.6-2 summarizes environmental measures with suggested enforcement; incentives and effects to further reduce emissions.

Table 3.6-1 Regulatory Instruments to Control Vehicle Emissions

Target area	Command and control
Transport management	❑ Management measures (bans and restrictions on private vehicle movements, creation of high occupancy vehicle lanes, and timely clearance of road encroachments) ❑ Engineering measures (provision of cycle tracks and parking space, pedestrian walkways, redesigning intersections, road maintenance, grade separation, and setting up of freight and bus terminals) ❑ Control measures (traffic signals synchronization, display diversion maps) ❑ Parking restraints ❑ Augmenting public transport ❑ Land use planning with regulations
Vehicles	❑ Emission norms, monitoring and evaluation ❑ Fuel efficiency standards ❑ Inspection and maintenance ❑ Vehicle scrappage programs ❑ Retrofit programs
Fuels	❑ Fuel quality standards ❑ Setting up of more CNG supply outlets
Institutions & regulations	❑ Roles and responsibilities of each relevant institution ❑ Revisit rules and regulations to plug the loopholes ❑ Strengthen institutional linkages through effective communication ❑ Develop and maintain a credible database (inventorization of vehicles and their attrition, speed, emission factors, monitoring of air quality) ❑ Audit pollution checks ❑ Capacity building of local bodies

Table 3.6-2 Medium Term Measures to Reduce Traffic Induced Emissions in Urban Areas

Measure	***Activity***	***Enforcement requirements***	***Incentive***	***Effects***
Fuel improvement strategy	Phase out leaded gasoline Reducing sulfur content in diesel Check use of alternative fuel	Determination of limit values of health impacting for content in gasoline and diesel Gather information on gasoline and diesel qualities from various mineral oil companies Gather information on prices for Compact Natural Gas (CNG) and CNG-running vehicles Cost-benefit analysis of phasing in CNG vehicles	Cut down of subsidies on diesel Provide subsidies on the use of vehicles running with alternative fuel	Direct decrease of emissions (lead, SO2, and particulate) Running buses on alternative fuel as example for the private sector to run similar buses
Compulsory annual test of the vehicles´ emission levels	Certification and control of garages to force regular technical inspections (annual emission test) and to control them	Orientation towards an enforcement of controls and severe penalties to improve the efficiency of the compulsory annual test of vehicle emission Feasibility study on the implementation of compulsory annual emission tests	Tax privileges on owner of tested cars and additional regular inspections at certified garages	Minimizing vehicle emissions by 50%. Improvement of the technical standard of the garages through financial support
Emission-related taxes on mineral oil	Taxes or raising of taxes on mineral oil for leaded fuel and diesel No taxes or freezing of taxes on unleaded fuel Substitution of value added taxes by emission related taxes on fuel	Announcement and publication of vehicle types, that are able to drive on unleaded fuel without any technical changes or devices	Self-induced incentive by the lower price of unleaded fuel	Reduction of lead and particulate in the air Decrease in vehicle-movement Higher revenues from taxation Sensitization of population for buying cars driven on unleaded fuel Preparation for selling cars fitted with catalytic converters or setting catalytic converters for refitting
Emission-related registration fees and annual taxes on vehicles	Classification of vehicles by type and age into emission brackets Determination of emission related rates of taxation on vehicles	Definition and establishment of emission brackets and assignment of vehicle types of to the brackets	Rates of taxation for low-level-emission cars will not be raised for the next 5 years Taxes on high level-emission vehicles with respect to their classification	Improvement of the vehicle fleet step by step within 5 years Decreasing of the emission Higher taxes revenues to use for environmental and health issues

3.6.2 Noise Pollution

Noise levels in Tripoli consistently exceed international standards, and additional mitigation measures need to be implemented to reduce noise. Traffic noise mitigation measures can be classified into four categories: (1) reduction in source emission levels, (2) land-use planning and control, (3) improvement in roadway alignment and geometric design, and (4) finally transportation system management (TSM) measures.

While enforcement of the annual vehicle inspection program should effectively reduce noise emission levels at the source, inexpensively and over a short period of time, comprehensive land use-transportation planning and control may provide the most effective ways to reduce traffic noise in the long run. Improvement in existing urban roadway alignment and geometric design due to its interference with daily traffic and other activities is a complicated, costly and time-consuming task. Construction of noise barriers and improved shielding of the structures, along with lower speed limits and prohibition of heavy trucks may be the only alternatives that will reduce traffic noise.

Placing areas of outdoor living and residential buildings as far from traffic noise source is also a possible mitigation measure. Thus, the sound levels experienced by residents will be lower due to longer propagation path from the source of the receiver. This strategy can be encouraged by requiring that the development contain a specific amount of land area per housing unit, in addition to meeting the normal requirement for minimum lot size for each unit. The additional land area can then be distributed to create buffer zones.

The location of residential buildings, garages, parking lots, etc. can also be planned to reduce the noise levels experienced by receivers. For instance, the parking areas for multiple family dwelling units can be located nearest the noise source, thus producing a separation between the residential buildings and the roadway. In addition, buildings can be oriented for less exposure to the direct path of noise propagation, as well as to reduce noise reflections that tend to increase overall levels for the receiver. Of course, such measures are applicable only in the framework of new development areas, and not in already established ones.

In addition, the floor plan for residential buildings can be arranged to place utility rooms and workshop areas near the exterior walls of high incident noise levels. On the other hand, bedrooms can be located in a more protected part of the building where they are less influenced by roadside noise. Where land area constraints are particularly high, a noise wall alone may be the only acceptable solution for reducing noise. For a standard building the interior noise levels can be improved by installing windows and doors that produce a higher noise transmission loss than standard components. Noise reductions of about 5 dB can result from such treatment.

TSM could prove most effective in reducing traffic noise pollution. These techniques are generally policy oriented, require a short time to implement, and demand little resources. They include elimination of establishment of curb parkings, prohibition of left turns, creation of one-way/two-way street networks, time/space prohibition of heavy vehicles, creation of pedestrian only areas, reduction of speed limits, promotion of public transit, implementation of coordinated signal progression, control of excessive use of horn and inappropriate driving behavior, and promotion of vehicle inspection programs.

3.7 CONCLUSIONS AND RECOMMENDATIONS

A master plan was developed in an attempt to improve the transportation and environmental conditions in Greater Tripoli, including road network improvement programs, enhancement of public transport systems, and implementation of innovative traffic management schemes.

The EA focused on the evaluation of air quality and noise levels in case the project is executed for current as well as future conditions (2000, 2005, 2010, and 2020). Prior to estimating future conditions, a field-monitoring program was designed and conducted to obtain baseline levels for meteorological, air quality, and noise conditions. Baseline levels represent benchmark values for future monitoring and comparison purposes. They can also be useful to calibrate mathematical models. An emission inventory model (MOBILE5) coupled with an air dispersion model (CALINE4) were used to estimate exposure levels of CO, NO_2 and HC in the study area. The TNM model was used to evaluate noise levels.

The air quality assessment showed as shown in Figure 3.7-1, that concentrations of contaminants will decrease at most locations with the implementation of the master plan. The Tripoli Boulevard and surrounding areas are the main beneficiaries with the construction of the underpass, the east ring road, and the Arab roadway, which will divert significant traffic from that location.

Noise levels remained quite high for all scenarios, and the sites along the Tripoli Boulevard would experience significant reductions in noise levels, mainly because of diversion of traffic though the underpass.

Recommended additional mitigation measures to further improve air quality conditions would include the establishment of measures and policies to further reduce emissions from the vehicles, such as scrapping of old vehicles, promotion of cleaner fuels and engine technologies, and strengthening of institutional and regulatory issues. Similarly, Transportation System Management measures, such as time/space prohibition of heavy vehicles, creation of pedestrian only areas, reduction of speed limits, implementation of coordinated signal progression, control of excessive use of horn and inappropriate driving behavior, and promotion of vehicle inspection programs, could prove useful to reduce noise levels in Greater Tripoli.

Under the Short-term Improvement Plan there are two main Projects, which are:

- Tripoli Boulevard Underpass Project

- Central Area Transport Management Project

Figure 3.7-2 shows the emission rate with and without the Underpass Construction. Figure 3.7-3 shows the emission rate with and without the implementation of Transport Management Project. Figure 3.7-4 shows the emission rate when these two projects are integrated together. As can be noticed from these figures, a recognizable decrease in the emission rates can be obtained when these two projects are integrated together where; the emission rate becomes only 1.01 by the year 2005 and 1.09 by the year 2010. This result shows the all-important to consider the both projects at the same time.

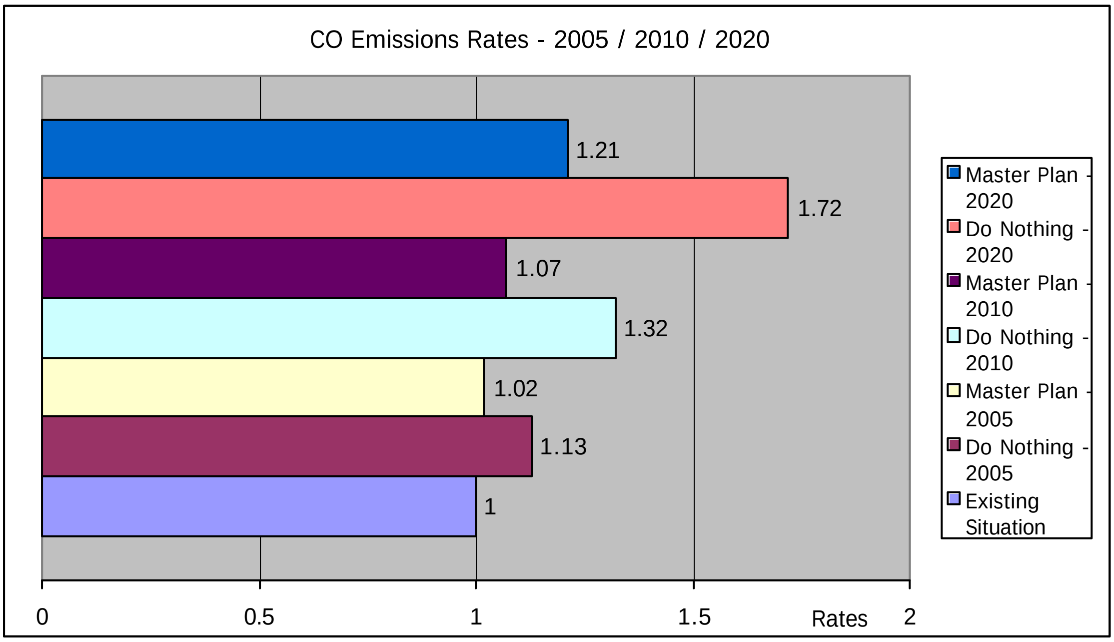


Figure 3.7-1 CO Emission Rates with Master Plan

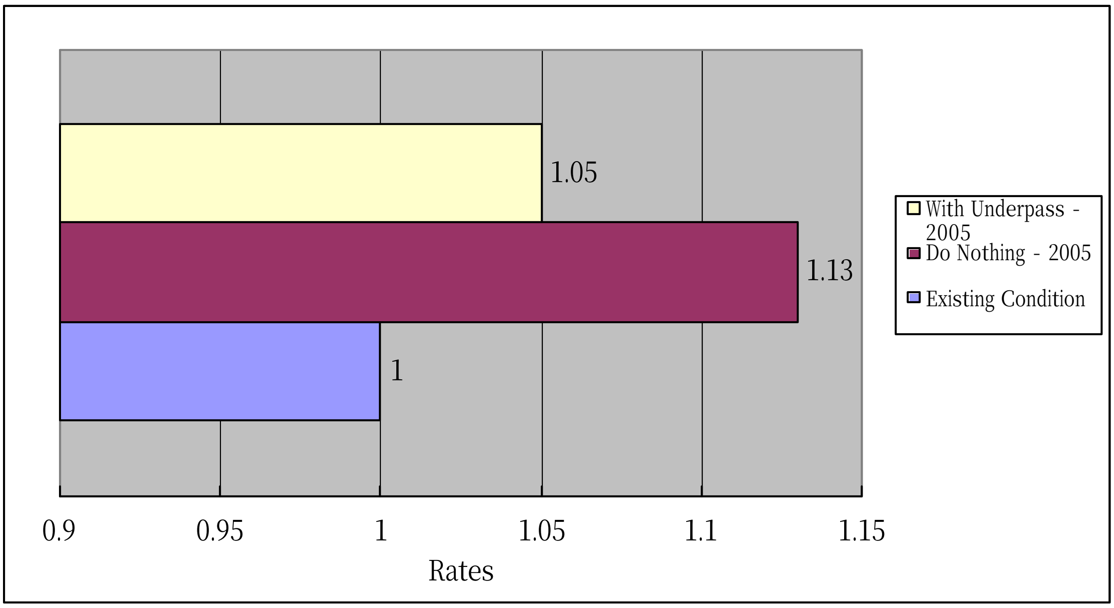


Figure 3.7-2 CO Emission Rate with Underpass

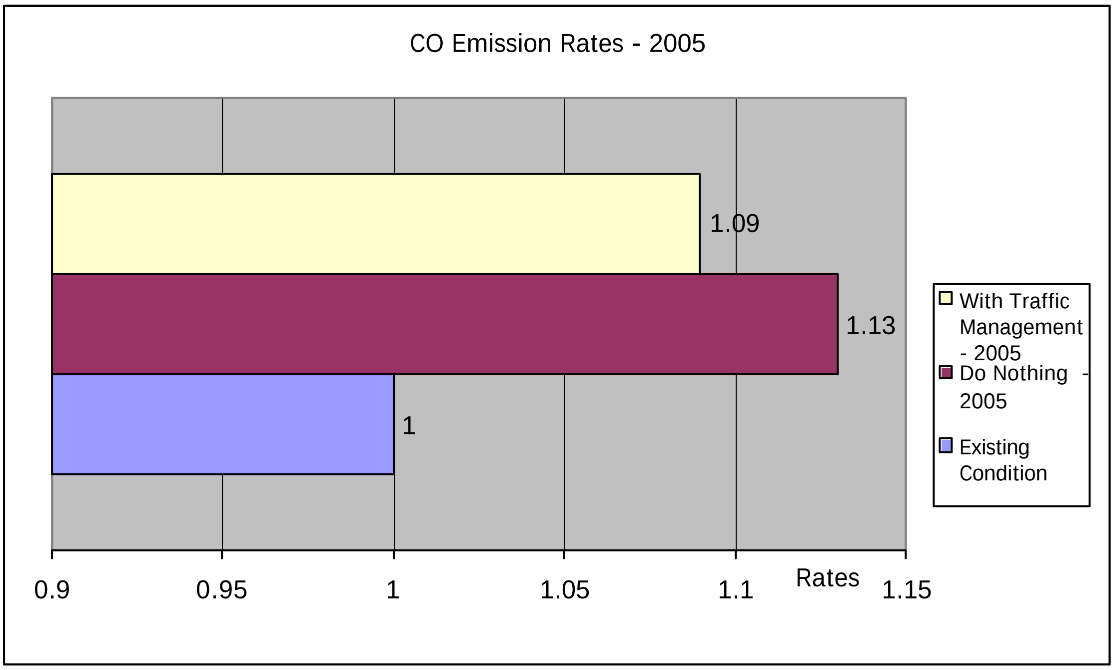


Figure 3.7-3 CO Emission Rates with Traffic Management

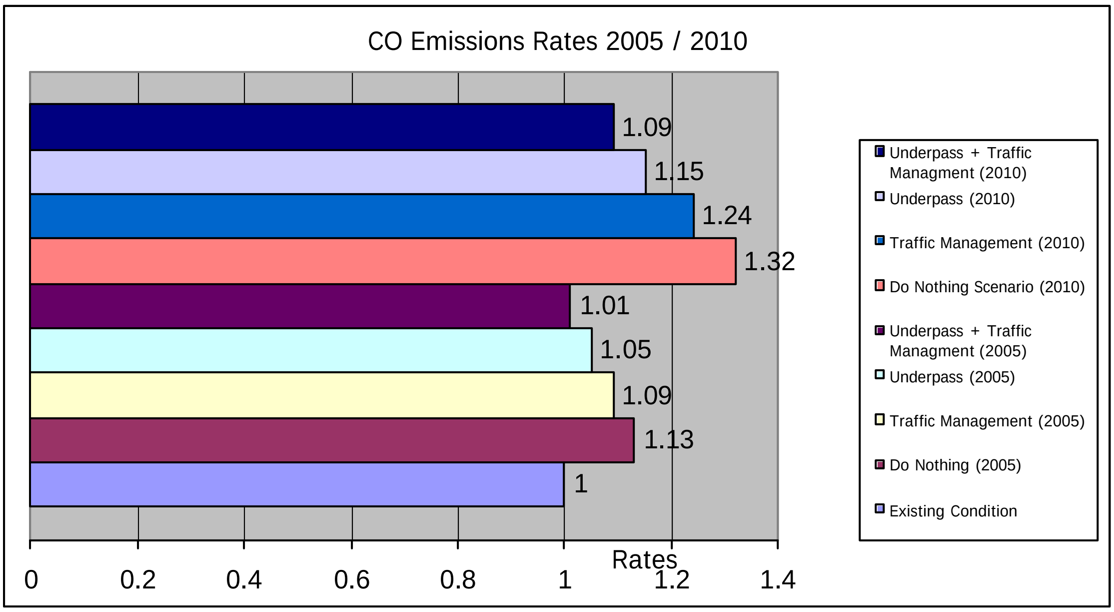


Figure 3.7-4 CO Emission Rates with Underpass and Management

For more reference on introducing different modes in future planning., emission reduction alternatives are developed in Figure 3.7-5 based on calibrated results of an environmental study for Greater Cairo (JTCA-1998). As shown in the figure, the public transport modes and traffic management schemes reduce future emission, however, emission control techniques and regulations are the most effective alternative. That includes strict measures on strengthening of emission standards, vehicle registration and inspection, fuel improvement, promoting CNG (Consolidated Natural Gas) cars, and decreasing of modal shares of car use. A proper air quality management system is required to further improve the environment and to keep emission levels under international standard. Such system may include fuel improvement, vehicle inspection, emission regulation and the introduction of unleaded gas (ULG) and less emission vehicles (LEV) for taxis and buses.

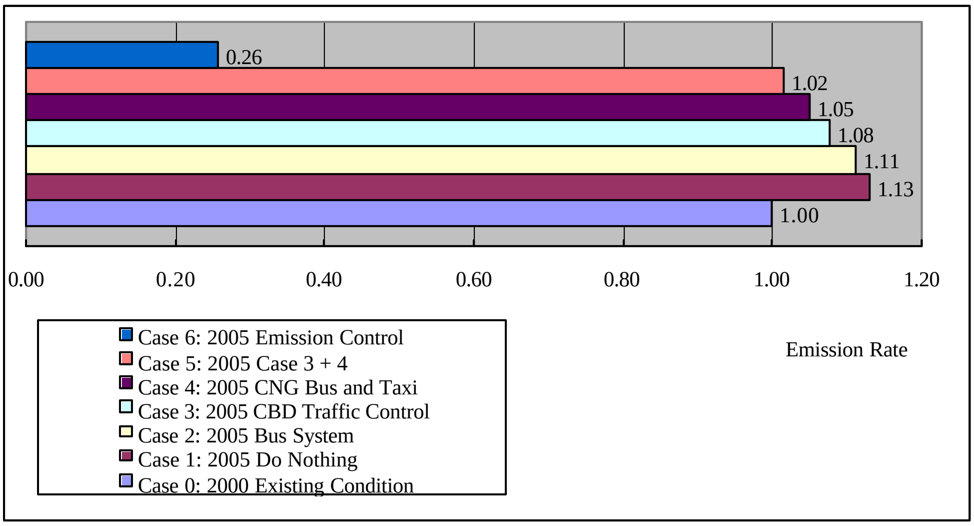


Figure 3.7-5 CO Emission Reduction of Public Transport