Government of the People's Republic of Bangladesh

BANGLADESH ROAD TRANSPORT AUTHORITY

DHAKA URBAN TRANSPORT PROJECT

PHASE II CONSULTANCY

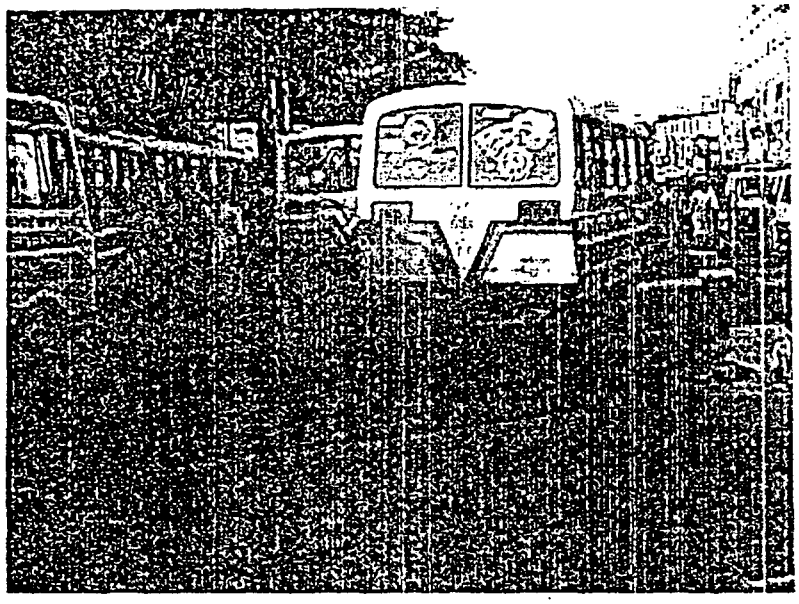
E-338

DRAFT FINAL REPORT (VOLUME III)

APPENDIX K:

ENVIRONMENTAL ACTION PLAN

(EAP)



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Environment & Infrastructure

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ANNEXURES:

11. As well as the effect of implementing road infrastructure, the likely impacts of management strategies were also assessed. These strategies included:

- Better enforcement of vehicle condition regulations such that fuel consumption and emission levels would reduce; and
- Achieving modal shifts from smaller vehicles to larger vehicles i.e. from 3-wheelers and passenger cars to buses.

12. Perhaps the main finding from this work is that measures to improve vehicle condition are likely to be more significant than traffic management improvements or modal shifts. Within a "vehicle condition" strategy, the major emphasis should be on improving the performance (in pollution terms) of 3-wheeler 2-stroke vehicles. Several measures have been recommended for consideration such as:

- Encouraging the use of higher quality oils;
- Banning the use of 2-stroke engines for new vehicles; or
- Restricting 2-stroke powered vehicles to local trips as feeder services to bus routes.

13. Air pollution is not the only environmental issue associated with transport infrastructure development. The study reveals that in some locations, open spaces are affected (positively or negatively) and this is weighted against the expected transport benefits.

14. Mitigation measures against probable increase in noise pollution levels at flyovers where these are located near high-rise commercial and residential buildings may be provided by in-built noise barriers with the structures and creation of effective sound barriers by planting leafy plants on the medians and roadsides.

15. As regards biological environment, extreme care has been taken to minimise the negative impact. In making proposals for infrastructure improvements in road intersection geometry and design, minimum number of the existing trees of economic value have been earmarked to be removed as being unavoidable. As regards smaller plants on the road sides, re-siting will be done without destroying it. Beyond this, no fragile ecosystem has been disturbed.

16. The findings from environmental evaluation matrix which addresses both 'without' and 'with' project scenario indicate a substantial gain in EIV units which can be termed as beneficial impact.

2. Introduction

17. DITS Consultants (1994) identified that Urban transport activities contributes maximum environmental impact to the people of Dhaka Urban area. This area, which covers approximately 4 sq. miles (10 km^2), constitutes the heart & central business district of Dhaka. Much of this area has been developed after partition in 1947 and substantial investment in terms of buildings & widening of several roads has been carried out. Continuous development of this area is evidenced in the new multi-storeyed construction mushrooming all over the place, changing the skyline, land use, traffic and environmental character at a repaid rate. Old Dhaka, located south of Fulbaria, also been rapidly developed/redeveloped, without commemorate increase in infrastructure capacity resulting in acute congestion. Some of this congestion and generated slow moving non-motorised traffic spill over into new Dhaka, causing capacity constraints in some of the main arterial.

18. Morphologically, post 1947 development of Dhaka has taken place along the south-north, & south - north west corridor extending to nearly 30 km. The CBD, however, has continued to grow vertically in the southern-most portion of these linear corridors. Naturally, the entire thrust of movement is towards this central employment and activity centre. Increasing affluence has caused greater demand on motorised transportation infrastructures. However the mixture of motorised and non-motorised traffic, where cycle-rickshaws predominate, create conditions of chaos, congestion and accidents. Since the cycle-rickshaws provide the cheapest mode of public transport, it is in greater demand by the ascending scale of economic well being (ref.: DITS study of distribution of trips of different income groups), and cycle rickshaws constitute between 60% to 90% of total PCE's.

19. Thus, although the road infrastructure is quite substantial, and architecture of Dhaka is of significant value, the entire area has a chaotic environment with traffic snarl up, delays and air pollution by idling vehicles. Bringing order to this area calls for a comprehensive interface study between the traffic modes & volume, land use, built form & traffic, capacities of carriageways under alternate scenarios of land use and modal split.

20. The traffic congestion has been found responsible for increasing air and noise pollution caused by the older vehicles and 2-stroke engine transport vehicles. Moreover, the existing number of Motor vehicles and N.M.V. is about 600,000 and their haphazard movement in the roads increased the constant traffic jam in the existing narrow roads of the city. The problem of traffic congestion and uncontrolled vehicle exhaust emission made life miserable for this city dwellers causing threat to health and economic loss as well.

21. Therefore, as per recommendation of DITS Consultants, priority schemes or Immediate Action Plan (IAP) has been taken up to partially get rid of this traffic congestion problem by implementing some infrastructure development works on an emergency basis. The development of roads and planning of a traffic engineering and management program aimed at increasing road capacity, vehicle speeds etc., aimed at reducing the environmental impacts and improving socio-economic status of urban life.

22. This study intends to present a detailed Environmental Impact Analysis (EIA) of the priority schemes taken up by the Govt. under DUTP-II, which will be carried out as per World Bank's Environmental Assessment Source books, 1991 and OD-4.01 and OD-4.30, both for Development and Resettlement works.

2.1 Terms of Reference (TOR)

23. During the feasibility study, DITS–1994 and DUTPI–1996 have identified many issues relating to engineering and environmental aspects needing more detailed investigation during the detailed planning, design and implementation phases. Based on this analysis, the TOR has been framed for this DUTP–II, those are particularly related to the project components and re-settlement issues. The consultant is supposed to address the relevant environmental impact during civil construction works plus impacts during re-settlement issues, including environmental management action plan and monitoring plan.

2.2 Scope of Works

24. The scope of works for environmental impact assessment and management action plan for DUTP-II comprises the following main tasks:

(A) Air quality level at base year 1997-98, which include base line data collection, inventory of vehicles, existing emission standards, measurement of ambient air quality and vehicle air quality at selected major intersections using Govt. supplied equipment, air quality monitoring program etc.

(B) Environmental screening of the project components to assess the probable positive and negative impacts which are likely to be caused from it and to give weight for environmental design either for reducing the adverse impact or enhancing the beneficial impacts.

(C) Mitigation measures for adverse impacts caused out of project components by

- (i) Environmental design
- (ii) Environmental specification in tender documents
- (iii) Framing Rules and Regulation for mitigating long term impacts

(D) Environmental Management Action Plan

For Management program for implementation and supervision of each component of works:

- (i) Preparing monitoring program during construction and during O & M period.
- (ii) Institutional strengthening and training requirement of the implementing authorities
- (iii) Formation of environmental unit & scope of works.

2.3 Policy, Legal and Administrative Framework under which the EIA is prepared

25. In connection with this environmental studies and management action plan of DUTP – II, the following polices, legal and administrative frameworks of Bangladesh have been consulted in connection with air pollution and noise pollution.

- (i) Environmental Policy – 1992 and Implementation Activities, Ministry of Environment and Forest, Bangladesh.
- (ii) Motor Vehicle Act - 1984 (revised), BRTA, Bangladesh.
- (iii) Environmental Conservation Rules 1997, Government of Bangladesh.

26. But there is no standard guidelines for Bangladesh to prepare EIA for any development works and no sectoral guideline for development of urban transport of Bangladesh is available.

3. Description of the Project

3.1 Project Background

27. The Dhaka Urban Transport project (DUTP) has been constituted to arrive at improvement programmes & militating measures, in order to alternative chaotic traffic condition and result in environmental improvement. In order to evaluate the benefits of development proposals Environmental Assessment is carried out, not only to establish the benefits, but also the arrive at mitigating measures for advise impacts. Environmental assessment comprises the analytic functions of three sequential elements identification, prediction and evaluation. Identification essentially revolves around characterising the existing environment and those components of a development project that may have an effect on environment. This in known a Box line study, where in addition to formulating a factual base, impact values of different factors are identified. Prediction of the impact of proposed action depends on addressing the impact values against the action parameters. The cumulative values of predicted impact in used for evaluation and identifying mitigation measures.

28. In this case the project, having made detailed study of various alternations have narrowed drown to the proposals for improvement of 20 intersection & construction of two fly-overs. The objectives of intersection improvements identified by DUTP, are as the following : (i) realignment of approach roads, (ii) widening of approach road, (iii) installing traffic divides, traffic signals, (v) construction and improvement of footpaths, (vi) improving storm water drainage, (vii) providing for additional lanes of traffic, (viii) improving and moving street fighting, (ix) improving and providing for left turn corner lanes. However, a study of the locations of these intersections reveal that they are part of a closely knit network, those roads are major article roads proving, in the main, south -north axis. Also, these roads serve all the major land uses abutting them as well as within the grid formed by these networks of roads. Unfortunately no data is available on the land uses, traffic generation pattern of these land uses, potential for further development. The assessment methodology is therefrom constrained by these factors. This is particularly true for assessment of environmental impact assessment.

29. Since Dhaka is the capital city of Bangladesh, and a primate city, it is likely to grow at a rapid rate. ADB has recently forecast Dhaka's population by 2021 to be around 24 millions, i.e. almost these times the current population. It is imperative that as capital city, it must project an image, a quality of environment, ambience in its space and architecture. Therefore, the present proposals should be an integral part of the vision for the future. The structure plan for Dhaka needs to be related to this project. Any major structural adjustment, in terms of mass rapid transit system, creation of alternative focus for central area functions may have impact. In the absence of these insights, the evaluation is limited to the concern of the project.

30. The rapid growth of Dhaka City population is directly related to the increase in vehicular traffic to meet the growing transport demand of its people. Thus huge number of motorised and non-motorised vehicles are plying together on the city roads and constant traffic congestion are created in every road intersections resulting serious air and noise pollution, causing threat to the health of the city people.

31. The main reasons for traffic congestion are:

(I) Narrow road
(II) Increased traffic volume
(III) Poor intersection design and geometry

(IV) Road blockage by haphazard parking of vehicles
(V) Amalgamated traffic flow by mv & nmv etc.
(VI) Indiscriminate road crossing by the pedestrians
(VII) Lack of private buses and truck depots.

32. DITS in the year 1994, identified these specific causes of such traffic congestion and recommended an Immediate Action plan (IAP) for early development of some component programs. Out of which construction of infrastructure components were given the top priority and DUTP-I reviewed these components by conducting detailed field-survey and recommended an investment project for early implementation. The present DUTP-II is concerned with the planning, design and implementation of many of the IAP recommendations of DITS and DUTP-I respectively. It is expected that with the completion of 8 (eight) primary components of work under DUTP-II, environmental pollution e.g. air pollution and noise pollution, of Dhaka City will be reduced to a great extent assuring better health to the city people.

3.2 Project Category

33. The present DUTP- Phase-II is concerned with the planning, design and implementation phase, recommended by the DITS and DUTP-I along with some relevant environmental and re-settlement studies which are appropriate during this phase. Under this DUTP-II, there includes 8 (eight) primary components and more than 50 (fifty) secondary components of civil construction infrastructures, for the improvement of urban transport system. During implementation of the above works, environmental impacts from civil construction works plus impacts resulted from resettlement issues may be caused whose detail studies will be performed as per World Bank Guide line 0D.4.00 and 0D-4.30.

34. The environmental impact have been screened out by field survey for each and every individual Components in respect of physical, biological, socio-cultural and health environmental issues and found that there no significant impacts caused on the above environmental issues except few impacts which are very minimal in nature and easily mitigable.

35. Hence this type of project falls under category "B" of the World Bank Guidelines-0D-4.00 Annex-3, because temporary impacts caused during construction period are only for the project preparation. As such, this project may only perform environmental impact analysis.

3.3 Project Components and Locations

36. Dhaka Urban Transport project phase-II is concerned with the detailed engineering and design works for the road improvement and traffic management program termed as immediate action plan (IAP) as recommended by the DITS Consultants in 1994 and also by the DUTP-I Consultants in 1996. The urban transport program involves widening of existing roads, new link roads, construction of bridges and widening of bridges, construction of fly over, foot overpass, provision of separate NMT routes, construction of foot-path, improvement of Bus terminals, provision of city bus terminals, provision of truck terminals, parking spots for MV & NMV and provision of standard vehicle repairing workshops at each bus/truck terminals and depots. These improvement works may have an expected improvement results for controlling air, noise, water and soil pollution of Dhaka urban area.

37. Out of above improvements, the following infra-structure component have been taken up in and for improvement work, on priority basis.

- Road intersections 20 Nos.
- Fly -Overs 3 Nos.
- Foot Overpass 3 Nos.
- NMT link road 3 Nos.
- Underpass for NMT 3 Nos.
- Foot-path 24 km.
- Inter-dist. Bus terminals 3 Nos.
- City Bus terminals 2 Nos.
- Truck Terminal & Depot 5 Nos.
- Vehicle parking facilities 2 Nos.

The locations of these components are shown are shown in maps placed in **Appendix-E.**

4. Environmental Assessment

38. The Dhaka Urban Transport project (DUTP) has been constituted to arrive at improvement programmes & militating measures, in order to alternative chaotic traffic condition and result in environmental improvement. In order to evaluate the benefits of development proposals Environmental Assessment is carried out, not only to establish the benefits, but also the arrive at mitigating measures for advise impacts. Environmental assessment comprises the analytic functions of three sequential elements identification, prediction and evaluation. Identification essentially revolves around characterising the existing environment and those components of a development project which may have an effect on environment. This in known as a Base Line study, where in addition to formulating a factual base, impact values of different factors are identified. Prediction of the impact of proposed action depends on addressing the impact values against the action parameters. The cumulative values of predicted impact in used for evaluation and identifying mitigation measures.

39. In this case the project, having made detailed study of various alternatives, have narrowed drown to the proposals for improvement of 20 intersection & construction of two fly-overs. The objectives of intersection improvements identified by DUTP-II, are as the following : (i) realignment of approach roads, (ii) widening of approach road, (iii) installing traffic dividers and traffic signals, road signs, railings and pedestrian crossings, (iv) resurfacing the road pavements, (v) construction and improvement of footpaths, (vi) improving storm water drainage, (vii) providing for additional lanes of traffic, (viii) improving and moving street lighting, (ix) improving and providing for left turn corner lanes.

40. However, a study of the locations of these intersections reveal that they are part of a closely knit network, those roads are major arterial roads providing, in the main, south -north axis. Also, these roads serve all the major land uses abutting them, as well as within the grid formed by these network of roads. Unfortunately no data is available on the land uses, traffic generation pattern of these land uses, potential for further development. The Assessment methodology, is therefore, constrained by these factors.

41. Since Dhaka is the capital city of Bangladesh, and a primate city, it is likely to grow at a rapid rate. ADB has recently forecast Dhaka's population by 2021 to be around 24 millions, i.e. almost three times the current population. It is imperative that as capital city it must project an image, a quality of environment, ambience in its space and architecture. Therefore, the present proposals should be an integral part of the vision for the future. The Structure Plan for Dhaka needs to be related to these project. Any major structural adjustment, in terms of mass rapid transit system, creation of alternative focii for central area functions may have impact. In the absence of these insights, the evaluation is limited to the concern of the project.

4.1 Methodology for conducting EA for DUTP-II

4.1.1 Establishment of base line:

: Definition of Project area boundaries.
: Identification of existing land use/areas of high activity generating traffic.
: Record the entire network of roads including tertiary & secondary roads.

: Record the current distribution of urban infrastructure facilities, constrains and possible impact.
: Estimate the current air pollution load.
: Estimate the ambient level of noise.
: Record the landscape elements.
: Survey of sites proposed for improvements of road intersections, infrastructures and utilities.
: Record availability of parking space.
: Collect data on health, safety, working environment and areas of specific interest.

4.1.2 **Assignment of Impact Values:**

: Environmental impact values ascribed to all parameters.

: Determination of baseline impact values for all baseline parameters. The distribution of impact values to each parameter cumulatively indicates the state of the environment.

: Assessment of Impact due to proposed improvements & compared against base line values.

4.1.3 **Evaluation criteria:**

The resulting matrix will show the quantitative index of change in different components of the project. The indicators will be:

: Positive high values will justify the project intervention by the component.

: Poor values will indicate increased need for mitigating measures.

: Negative values will indicate adverse impact by the project component which will draw attention for review and dropping of the concerned project intervention.

: Mitigation measures for adverse values will be formulated .

: Cumulative positive value will indicate quantitative index of positive impact to be attained by the project on its entirety.
: Cumulative negative value will indicate quantitative index of negative impact to be attained by the project in its entirety which will call for further mitigation measures and review of design and concepts.

4.2 Formulation of Environmental Evaluation Matrix

42. The EE is used to evaluate the expected further condition of environmental quality, both 'with' and 'without' the project. The difference in Environmental Impact values (EIV) between these two conditions constitutes either an adverse impact, which corresponds to the loss of EIV, or a beneficial impact with corresponding gain of values.

Mathematically, this process may be represented as follows :

$$EI = \sum_{i=1}^{m} (Vi)_1 \, wi - \sum_{i=1}^{m} (Vi)_2 \, wi$$

Where:

EI = environmental impact.

$vi)_1$ = Value of environmental quality of parameter *i* with the project

$(vi)_2$ = Value of environmental quality of parameter *i* with the project

wi = relative weight (Importance) of parameter *i*

m = total number of parameters.

43. The process involves preparation of scaling and weighing checklist. It provides description of the environmental parameters that are included in the checklist and instructions for their relative scaling with respect to other perimeters and for assignment of important units.

44. Due to paucity of data and constraints of time it was proposed to create a composite matrix which covers the most essential parameters, both for establishing base line as well as for assessing impact. This assessment has four stages (i) establishing base lie for existing environmental quality, (ii) evaluation of proposed design of intersection improvement & fly-overs, (iii) impact during construction period, and (iv) post construction impacts & mitigating measures. The impact values were to be subjective based on value judgement, in a scale of 1 to 5, where 1 is the least & 5 is the maximum.

45. The relative weight of a parameter is culture dependent. Assuming this to be similar to that of India, it could be adopted from parallel studies carried out in India. But these values were not available.

46. However, all parameters have been assumed to be of equal weight for the purpose of this study. This , in fact, is a very approximate simplification.

4.3 Impact values and scaling

4.3.1 Air Pollution Impact Values

Table 1: Air pollution Impact Values

Assigned Impact Values	Air Pollution ($\mu g/m^3$)				
	CO	SO_2	NO_x	SPM	Pb (Lead)
5	<1000	<30	<30	<70	<0.5
4	<2000	<60	<60	<100	<0.75
3	<4000	<80	<80	<200	<1.00
2	<5000	<120	<120	<500	<1.50
1	>5000	>120	>120	>500	>1.50

4.3.2 Noise Pollution Impact Values:

4.3.2.1 Table 2: Noise Pollution impact Values

Noise Pollution (values in decibels, dBA)

Impact values	Sensitive	Residential / Commercial	Commercial
5	<35	<50	<60
4	<40	<60	<70
3	<45	<70	<75
2	<50	<75	<80
1	>50	>75	>80

.3.3 Landscape Impact Values:

Table 3 : Landscape Impact values

Impact value	4.3.3.1.1.1.1 Landscape elements
5.	Mature tree with more than 30 years of life
4.	Trees with less then 10 years of life
3.	Recently planted trees
2.	Semi - mature tree
1.	Shrubs/grass

17. In the process of widening of carriage ways some landscape elements may be affected & ...pact value needs to be established.

...4 Impact Values of Roads:

Table 4 : Impact values for roads

Impact Value	Volume/Capacity	Encroachment	Abutting landuse	Underground infrastructure					
				Gas (a)	Electricity (b)	Water pipe (c)	Sewage (d)	Surface drainage (e)	Telephone (f)
5	<1.0	Nil	Open space	in terms of depth below road surface	Same as at (a)	Same as at (a)	Same as at (a)	Same as at (a)	Same as at (a)
4	>1.0	Temporary spillover	Service lane						
3	<1.5	Marginal spillover	footpath						
2	<2.0	1/2 lane	shops						
1	>2.0	>one lane	hawkers						

18. The existing traffic carrying capacity of the carriage-ways of various links & intersection requires estimation, as it is a critical factor in traffic environment. Since traffic consists of heterogeneous modes, each mode is given equivalence factor so that the volume can be considered as a homogeneous flow. Substantial variation (ref. table: 12, PCE : comparative values) is observed between different standards, giving widely varying PCE values & consequently carriage-way capacity. Since Dhaka has a very large volume of non - motorised transport, who are mainly responsible for the chaotic condition, assumption of lower PCE values can have dramatic impact on capacity values. Unrealistic values may lead to erroneous results.

49. Also, it is noticed that the carriage-way width is not uniform. Three lanes require 3.5 x 3 m = 10.5 metres. Marginally larger width has no impact on traffic carrying capacity. In such cases the surplus land may be added to footpath or the central verge, to allow for landscaping. The design impact over the link thus needs careful EA.

Table 5 : Passenger Car Equivalents : Comparative Values

Sl. No.	Vehicle Type	DITS Values	Indian Standard Values	UK Standards
1.	Tanker	2.0	3.0	3.0
2.	Truck	2.0	3.0	3.0
3.	Bus	2.5	3.0	3.0
4.	Minibus/Micro	2.0	1.5	-
5.	Light motor vehicle	-	1.5	2.0
6.	Tempo	0.5	1.5	-
7.	Passenger car/jeep/stn Wagon	1.0	1.0	1.0
8.	Auto-rickshaw	0.5	0.8	-
9.	Motor cycle	0.5	0.3	0.75
10.	Bicycle	0.2	0.5	0.33
11.	Cycle - rickshaw	0.8	2.0	-
12.	Rickshaw van	0.8	2.0-3.0	-
13.	Push cart	4.0	3.0	-
14.	Bullock cart	-	6-8.0	-
15.	Horse drawn vehicles	-	4.0	-

4.3.5 Impact Values of Infrastructure :

50. The network of roads serve both as provider of accessibility to user, as well as a corridor for several urban infrastructure, in addition to various mode of transport. The quality & satisfaction level of these on ground infrastructure contribute to the quality of urban environment. Following physical factors have been considered as crucial :

Table 6: Infrastructure impact values

Impact Values	Surface Drainage	Water Supply	Sewerage
5	Adequate	100% coverage 24 hrs. supply	100% flush W.C. System.
4.	Marginal Water Logging	100% " 8 hrs. supply	100% coverage of sanitary disposal
3	WL >1 hr.	<50% " coverage	50% coverage of sanitary disposal.
2	WL 1 - 8 hrs.	<25% " coverage	Service Latrines > 25%
1	WL > 8 hrs.	Nil coverage	Open defecation (%)>20%)

Impact Values	Electricity	Street lighting	Solid waste collection
5	100% households covered	as per standards	100% collection & access to collection
2.	>50% households covered	>75% "	>80% " "
3.	<50% households covered	>50% "	>50% " "
4.	>50% consumers with stand-by generators	>25% "	no access to collection vehicles.
5.	Nil coverage	<25% "	No collection

51. The entire area has to be divided into discreet blocks, & impact values ascribed to each block. The cumulative values would indicate the environmental impact value, of a particular infrastructure facility. Also the data would indicate need for initiating mitigating measures for various infrastructures in area specific content.

4.3.6 Public Transport :

Table 7: Public transport impact value base data

Impact values	Travel demand	Parking Demand	Location of Parking
5	100%	drop off	Nea the intersection / junction
4	>80%	Waiting <2 mins	>5 m. from intersection /junction
3	<60%	Waiting <5 mins.	>10 m. from intersection /junction

2	>40%	Waiting <10 mins.	>30 m. from intersection /junction
1	<40%	Waiting > 10 mins.	>100 m. from intersection /junction

4.3.7 Parking for Private vehicles : Base line data input

Table 8: Impact values of parking spaces

Land use Category	Availability of parking place				
	On- site parking provision				
	100%	80%	50%	25%	<25%
Impact Values	**(5)**	**(4)**	**(3)**	**(2)**	**(1)**
Commercial/govt Offices					
Shops/other commercial Establishments.					
Mixed commercial /residential					
Social facilities, e.g. Hospitals, colleges etc.					
Purely residential					

4.3.8 Human well being

Table 9: Impact value of human well being

Impact Values	Health % of Persons affected by URT diseases	Safety		Working Environment	Areas of cultural/historic values
		Accidents	Mugging		
5	Nil	Nil	Nil	very satisfactory	Good state of conservation /preservation
4	<25%	Rare	Rare	Satisfactory	Conferred / notified
3	<50%	Occasional	Occasional	Partially satisfactory	Poor state of conservation
2	<80%	fairly frequent	Fairly frequent	Poor satisfaction	State of decay

1	100%	frequent	Frequent	Not satisfactory	Utter neglect

4.3.9 Impact of construction Activities

4.3.9.1 Table 10 : Impact value of construction activities

Impact Values	Dumping of building materials	Traffic flow	Electric cables/ poles	Gas	Tel. Cables /dist Posts.	Water pipes	Sewage lines	Storm water drains	Trees to be felled	Properties to be demolished
5	on site	No disturbance	No disturbance	No disturbance	No disturbance	No disturbance	No disturbance	No disturbance	None	None
4										
3										
2										
1	on carriage-way	complete blockages	all	All	all	all	all	all	all	all

52. The foregoing set of tables are designed to establish base line data & subjective impact values of various occurrences. In the light of local knowledge the values have been varied. As the preparation of base line data is prerequisite for preparation of EA the methodology adopted here is designed for repaid assessment, & does not deal extensively with all the parameters. The base-line data prepared so far, though inadequate for EA, cannot be meaningfully used to evaluate the environmental condition or its impact. However some indicative values for the weighing factors have been calculated using the available baseline data and the proposed improvements on the infrastructures. These values, although very inadequate, show some quantitative index of change in different components of the project as a result of DUTP-II interventions. These are presented in Chapter 7.

5. Air pollution from Dhaka's Transport System

53. Air pollution caused by motor vehicles follows a distinct cycle: *emission* of pollutants (depending on type of vehicle, type of engine, engine maintenance, and fuel quality; *propagation* in the air (depending on the local topography, temperature, rainfall, and wind); and *reception* by humans, soil, fauna, and flora.

54. Motor vehicle exhaust emissions are the major contributor to air pollution of Dhaka city. The severity of air pollution of Dhaka city has been observed to be depending on the following factors:

- poor quality of vehicles e.g. old and defective vehicles on road.
- Rapid growth of 2 - stroke engine vehicles e.g. Baby taxi/Tempo/Motor Cycles etc.
- Use of additive fuels- e.g. leaded petrol and sulfur mixed diesel fuel.
- Slow driving speed at traffic congested spots and road intersections.

(1) More than 230, 000 numbers of vehicles are plying in the city road of which about 70 - 80% are old and defective, over 5-10 years of age. Excessive exhaust emissions are produced from these vehicles causing severe air pollution.

(2) About 45,000 Nos. Baby taxis/Tempos and 80,000 Nos. Motor Cycles are plying in the road. They are powered by 2-stroke engine and emit excessive exhaust of unburnt fuels with white smoke which are 10(ten) times higher than those of 4-stroke engine vehicles of equal power.

(3) The use of leaded petrol (0.10 g/l) in the gasoline fueled vehicles emit volatile lead compounds which are serious air pollutants. Again sulfur mixed diesel fuel (0.5%) in Bangladesh used in heavy duty vehicles e.g. buses and trucks emit air pollutants like $S0_2$ along with TSP, NO_x and VOC and black smoke.

(4) At slow driving speeds, LDV emit maximum levels of CO, HC, CO_2 in the traffic congested intersections and spots, while NO_x emission has been observed to be highest at higher driving speeds.

55. For the above causes, serious air pollution is marked at each road intersections & bus terminals. Affecting thousands of people like passengers, pedestrians, road side shop-keepers and road side dwellers.

5.1 Motor vehicle exhaust emission

56. Efficiency of internal combustion engines and character of fuels are the main factors for producing typical vehicle exhaust emission. Leaded petrol and sulfur-contained diesel fuel emit lead compounds and sulfur dioxide with the exhaust emission. petrol driven LDVs normally emit CO, HC, NO_x, lead compounds, CO_2 and SPM while diesel driven HDVs emit SPM, $S0_2$, NO_x, VOC and very little of HC and CO. But old and defective diesel driven vehicles can produce black smoke (suspended particulate matters containing PAH). White smoke consists of atomized lubricating oil, produced from mixed lubrication motors, used in motor-cycles and 3-wheel vehicles. The above mentioned exhaust components have been positively identified poisonous air pollutants which causes serious adverse impacts to human health and to the environment.

5.2 Effect of air pollutants upon human health.

57. Normally motor vehicle exhaust emission contain air pollutants like CO, HC, NO_x, SO_2, Pb and SPM. Urban people are the prime victim of these air pollutants and morbidity and mortality are found enormous in every year, if monitored regularly by the medical institutions. The effects of air pollutants upon human health is briefly described below:

- CO (Carbon-dioxide): Motor vehicles contributes major percentage of CO in the air. It is rapidly absorbed in lungs and by the blood, reducing its oxygen carrying capacity and thus less oxygen gets to heart and brain causing headaches, fatigues and exacerbates cardiovascular diseases. Large numbers of sensitive people experience adverse health effects at concentration level of 15 ppm (8 hrs. average).

- NO_x (Nitrogen Oxides): It is mostly emitted during fuel combustion in motor vehicles as nitric oxides (NO). It can remain for several days In the air and it is oxidised and converted into nitrogen dioxide ($N0_2$) which is more toxic. It affects human respiratory system and plants (either as an acid or as an oxidant). It is sensitive to bronchities and bronchial pneumonia and causes airway resistance in asthamatics and decrease lung function.

- HC (Hydro-Carbon): This pollutant is termed as assorted hydrocarbaon to include all organic compounds emitted both in the exhaust (created by incomplete combustion of fuel) and by evaporation from the fuel system and embraces many hundreds of different compounds. Some are toxic or carcinogenic. The composition of HC emission's is strongly influenced by the composition of the fuel, So changes in fuel specifications can modify their effects.

- SO_2 (sulphur-dioxide): This pollutant is emitted as exhaust from diesel driven vehicles and can remain in the air from a few hours to several weeks. The emission rate is directly linked to the sulphur contained in the fuel. Sulphur is mixed with diesel fuel normally from 0.1 to 1.1 percent by weight. But some developing countries like Brazil, India and Pakistan allow 1.0 percent or even higher amounts of sulphur in diesel oil. Most of the sulphur in the fuel burns to $S0_2$ and emitted to air as diesel exhaust and acts as a significant contributors to ambient $S0_2$ levels in some area. $S0_2$ is acidic and soluble in water. It acts as a powerful irritant to the mucus membranes of the eyes and the upper respiratory tract causing hacking cough, shortness of breath and spasm of the larynx. Its acidity also attacks plants, aquatic life, and materials.

- Pb (Lead Compounds): Tetra-alkyl lead compounds added to fuel to raise the octane rate and help lubricate the engine extensively as "anti-knock". Leaded petrol normally contain 0.10 g /l. After combustion volatile lead compounds are formed and expelled in the exhaust gas. The inorganic lead compounds are emitted as fine particles which can penetrate deep into the lungs and ultimately into blood and other body tissues. It affects the haematopoietic system, nervous system, and renal system. In addition, it affects the normal function of reproductive, endocrine, hepatic, cardio-vascular, immulogic and gastro-intenstinal system. The most sensitive group of lead poisoning is children, affecting their learning ability, behaviour and intelligence and anemia. Lead emitted into the air can be breathed in directly or consumed through drinking water or vegetables.

- SPM (Suspended Particulate Matters): This include suspended airborne particles from diesel fuel, naterials produced by friction, tire wear, heavy metals, and dust. Diesel driven vehicles emit black smoke which contain carbon nuclei combined with wide range of organic and other compounds. They have a high staining power and gathers as coating to buildings and other materials. Health effects of these particles include increased mortality, morbidity, and irrevocable pulmonary function. It accelerates respiratory irritation, lung diseases, thoracic, allergenic, carcinogenic or mutagenic problems and may give rise to discomfort and annoyance.

5.3 Air quality standards

58. Air quality standards such as ambient air quality standard and vehicle emission standard may be expressed in terms of max. allowable concentration level or limit value for vehicle exhaust emission, protecting human health from air pollution. They are expressed in $\mu g/m^3$ in terms for concentration level and in g/km in terms for quantities per unit distance. Air quality standards is used as a legal instrument by the law enforcement authority to take measure against the polluters.

5.3.1 Ambient air quality standard

59. Air quality standard is expressed in terms of maximum allowable concentration level for air pollutants protecting human health. Ambient air quality Guidelines set levels at which no adverse health impacts is expected from any component of air pollutants. Standards based on relatively short averaging periods (1,8, or 24 hours) are better at accounting for peak hours concentrations than standards based on yearly average values. In developed countries like USA and International Organization like WHO, standards have been set up for concentration levels for some limited number of air pollutants like CO, HC, NO_x, SPM, PM_{10}, O_3, PAN, VOC, PAH and lead. The reason for selecting these compounds is that they are probably the most serious ones in terms of health damage. US air quality standard is shown in TABLE - 4, and WHO air quality guidelines is shown in TABLE - 5.

Table : 11 US Standards for Air Quality

Parameter	$\mu g/m^3$	Averaging Time
SO2	80	1 yr.
	365	24 hr.
CO	10,000	8 hr.
	40,000	1 hr.
NO_X	100	1 hr.
O_3	235	1 hr.
TSP*	75	1 hr.
		24 hr
Pb	1.5	per quarter

Source : (USAID and USEPA, 1990)

*TSP standard was abandoned in US in 1987 and was replaced by size fractionated Particulate Matters (PM).

60. Current US standards are for size fractionated particulates namely $PM_{2.5}$ and PM_{10}. The numbers 2.5 and 10 refer to effective areodynamic diameter in micro meters. The new standards were introduced in July, 1997 to incorporate the recent scientific understanding of the effects of PM on human health. The current standards are shown in Table -12.

Table 12: US National Ambient Air Quality Standards for PM_{10} and $PM_{2.5}$

Standard	µg/m3	Statistical Form	Remarks
PM_{10} Annual	50	Annual Average	
PM_{10} 24-hour	150	Not to be exceeded more than once per year in any four years	
$PM_{2.5}$ Annual	15	Annual Average	
$PM_{2.5}$ 24-hour	65	95th percentile of data distribution of 3 years of measurements.	Average measurements made at several monitoring sites.

61. PM load being the foremost air pollution problem in Dhaka, all information in this connection should be made up to date and should correspond to current understanding in the world. The $PM_{2.5}$ particles, which are produced in high temperature processes, are more hazardous as these penetrate deep into the lungs and enter blood stream. In fact large fraction of the particulate (probably to the extent of ~90%) produced by motor vehicles fall into $PM_{2.5}$ category.

Table 13 : **WHO Air Quality Guidelines**

Compound	Guideline value	Averaging time
Ozone O_3	120 micrograms/cubic metre (0.06 parts per million)	8 hours
Nitrogen dioxide NO_x	400 micrograms/cubic metre (0.22 ppm)	1 hour
	150 micrograms/cubic metre	24 hour
	40 to 50 micrograms/cubic metre (0.021 to 0.026 ppm)	Annual
Sulfur dioxide SO_2	500 micrograms/cubic metre (0.175 ppm)	10 min
	125 micrograms/cubic metre (0.044 ppm)	24 hours
	50 micrograms per cubic metre (0.017 ppm)	Annual
Particulate matter	150 – 230 micrograms/cubic metre	24 hours
	60 – 90 micrograms/cubic metre	Annual
Carbon monoxide CO	100 milligrams/cubic metre (90 ppm)	15 min
	(b) 60mg/cubic metre (50 ppm)	30 min
	30mg/cubic metre (25 ppm)	1 hour
	10mg/cubic metre (10 ppm)	8 hours
Lead Pb	0.5 to 1.0 micrograms/cubic metre	Annual

a) The guideline is to prevent carboxyhemoglobin levels in the blood from exceeding 2.5%. The values above are mathematical estimates of some of the CO concentrations and averaging times at which this goal should be achieved.

b) The guideline for lead was established by WHO in 1987

Source : Update and revision of the air quality guidelines for Europe.

62. In Bangladesh, there is no basic criteria "e.g. dose response curves for the different air pollutants, for different effects particularly on human health, for developing such air quality standard. But considering the geographical positions, climatic condition and Socio-Economic condition of Bangladesh, a draft National air quality standards was set up by the DOE Bangladesh in the year 1992 which was subsequently approved by the govt. in the year 1995 and enacted as Environment Conservation Rules 1997, Government of Bangladesh, and is shown in Table -1 4.

Conversion Factors:

CO	1 ppm	=	1.15 mg/m^3
NO_2	1 ppm	=	1.88 mg/m^3
SO_2	1 ppm	=	2.60 mg/m^3
O_3	1 ppm	=	1.96 mg/m^3

Table :15 Motor Vehicle Emission Standard
(USA, ECE and Asian Counties)

Sl. No.	Counties/ Organizations	Year for setting Standard	Vehicle Types	Emission Standard (in g/km)			
				CO	HC	NO_x	TSP
1.	US.-EPA	Pre-1968	LDV-gasoline – fueled	54	9	3.7	
	US.-EPA	1970	LDV-gasoline – fueled	20	2.45	3.7	
	US.-EPA	1973-74	LDV-gasoline – fueled	17	1.8	1.8	
2.	US Federal States	1978	Motorcycle - 50cc – 750 cc	17	5	-	
	California	1978-79	Motorcycle - 50cc – 750 cc	17	5	-	
	California	1978-79	Motorcycle > 750 cc	17	14	-	
3.	ECE - 40	1992	Motorcycle an Mopeds				
			Two stroke, <100 kg wt. >300 kg	16 40	10 15	- -	
			4-stroke - <100 kg >300 kg	125 50	7 10	- -	
4.	European Standard						
	ECE 49 (13 mode)	1988	HDV (g/kwh)	14	3.5	18	
	ECE 49.01 (88/77/EC-1988)		HDV (g/kwh)	13.2	2.6	15.8	
5.	Argentina	1994	LDV - gasoline/diesel	24	2.1	2	
6.	Australia	1996	Passenger car	24.2	2.1	1.9	
7.	Brazil	1988-1992	LDV	24.0	2.1	2.0	
8.	Brazil	1987-94	HDV (g/kwh) Urban	11.2	2.45	14.4	
9.	Canada	1975-87	LDV	25	2	3.10	
	"	1988	HDV (g/bhp/h < 6350 kg)	14.4	1.1	6.0	
			HDV >6350 KG	37.1	1.9	6.0	
10.	INDIA	1990-92	2 and 3 wheel vehicles <150 kg	12	8	-	
			< 350 kg	30	12	-	
		"	LDV <1020 kg	14.3	2		
			<2150 kg	27.1	2.9		
11.	Mexico	1991-93	LD Truck 2727 kg	22	2.0	2.3	
			MD Truck 3000- 3857 kg	28	2.8	2.8	
	"	1991	Urban Bus	10	0.6	1.5	

Source : The World Bank Publication, Washington, D.C "Air pollution from Motor vehicles", standards and technologies for controlling emission - 1996.

Parameters	Unit	Standard Value	Remarks
• Black Smoke	Hartridge Smoke Unit (HSU)	65	Equivalent to 1985-89 (ECE – R15/04) Standard
CO	g/km percent volume	24.00 4 %	
Hydrocarbon (HC)	g/km percent volume	2.00 180 (ppm)	
Oxides of Nitrogen	g/km percent volume	2.00 600 (ppm)	

• Measuring at two thirds of maximum rotating speed.

Note: Diesel engines currently operate at constant rpm.

Standard Values for Black Smoke Emission for Boat/Ship/vessel

Parameters/Determinants	Unit	Standard Value
• Black smoke	HSU	65

• Measuring at 2/3 of maximum rotating speed.

Source : DOE, Bangladesh, 1995

65. Immediate sources of air pollution include domestic fire, motor traffic and industrial works. Therefore, the ambient quality of air measured over an area has several contributions. Unfortunately, monitored data on air pollution level collected for a period is not available. In the absence of data regarding other pollutant sources, even if data is collected in this area, it would be difficult to ascribe the contribution of traffic to it. However, using mass emission factors, an approximate scenario has been established.

5.4 Climatic Factors

66. Meteorological conditions play a major role in dispersion, dilution & transportation of air pollutants. The velocity and direction of wind are critical factors in dispersal and consequent reduction or increase in the level of air pollutants over an area. More stable the air, greater in the likely concentration. Data on wind movement patterns is essential for formulating stability factors & application of Gaussian models.

67. Temperature plays a significant role in creating a larger or smaller mixing volume. Meteorological data on temperature gradient is necessary at intervals of height above the surface in determining the mixing height. This enables calculation of the volume of air and the quantify of pollutants, which can be extrapolated to provide the level of concentration of various pollutant gases & other factors in a cubic volume, which can be compared with the standards established for

possible levels of maximum concentration in a cubic volume of air. [ref. : Table-4 National ambient air quality standards of Bangladesh]

68. However, the situation is completely reversed if there is atmospheric inversion, which takes place when the ground temperatures is not high enough to warm the air to rise. No data on intrusion occurrence is available from the meteorological sources. In highly polluted environments, incursions can have very significant impact & may cause abnormal rise in pollutant level during winter.

69. Monsoon plays a significant role in reducing the level of air pollution, as the pollutants are mixed with water vapours and get precipitated. In highly industrialised nations, they may cause acid rain. Considering the level of industrialisation in Bangladesh at the moment, monsoon should be viewed as a pollution mitigating factor.

Table 17 : Meterological Data available for Dhaka

Factor	Year	Jan	Feb	Mar	April	May	June	July	Aug	Sept.	Oct	Nov.	Dec.
Wind speed (M/Sec)	1991	0.5	0.7	0.85	1.70	2.65	1.65	1.95	1.8	1.25	0.40	0.25	0.65
Monthly Avg. temp °C	1997	25.2	27.7	33.1	33.1	32.7	34.5	32.7	32.7	31.5	32.1	30.6	25.0
	Max												
	min	11.5	14.5	21.1	21.1	24.5	25.8	26.4	26.6	25.5	22.1	18.9	18.7
Monthly Avg. humidity (%)	1997	70	64	67	74	77	82	86	84	86	77	75	80
Monthly Avg. rainfall (mm)	1997	02	07	82	151	151	249	549	230	440	30	01	22

70. The data available is inadequate to take climatic factors into consideration. Rainfall, humidity factors & temperature suggest that air pollutant concentration is likely to be comparatively high for the months between November to February. No data was made available on the direction and speed of wind or periods of storms & high velocity. Wind direction & speed varies during the day & built form modifies it considerably. Wind rise with speed and direction is necessary for predicting on estimating air pollution level, as dispersal is a major factor in reduction of air pollution level.

71. Data is not also available regarding the change of temperatures according to height. Usually air temperature falls by 0.5°C to 1° C for every 100 meter gain of height above m.s.l. Observed temperature gradients provide mixing heights, which determine the volume of air available over an area in which the emitted pollutants are held. Measurement of the volume of air, vis-à-vis, the amount of pollutant emitted indicates the concentrations of particular pollutant's level of concentration per meter cube. These then can be compared with the prescribed ambient air quality [ref. Table-14]. Since this method ignores several other parameters, the results can only be indicative. However, in the absence of proper equipments and laboratory facilities for monitoring air quality regularly, this method using mass emission factors has been used to compute emission levels at different road intersections. These indications and findings can provide guidelines for policy decisions. [Ref. Tables-18 & 19). The emission factors adopted in Table 18 are based on rigorous research by Central Road Research Laboratory of India and is considered to be reliable. Since Bangladesh has not yet introduced control over engine emission factors, the 1991 values of India, i.e. prior to introduction of emission control measures, has been adopted.

Table 18 : Emission Factors for different types of vehicles *

Type of vehicle	Year				gm/km		
		CO	SO_2	NO_x	SPM	Particulate	Lead
Car Jeep	upto 1991	25	5.00	2.00	0.053	-	0.030
And Taxi	91-94	19.8	2.73	2.00	0.053	-	0.030
	94-95	19.8	2.73	2.00	0.053	-	0.008
	95-2000	6.45	1.14	1.14	0.053	-	0.0003
	20000-2005	3.16	0.56	0.56	0.053	-	0.0003
2 Wheelers	utp 1991	8.30	5.18	0.1	0.023	-	0.008
	91.-94	6.49	4.5	0.1	0.023	-	0.008
	94-96	6.49	4.5	0.1	0.023	-	0.002
	96-2000	5.00	4.32	0.1	0.023	-	0.002
	2000-2005	2.4	2.4	0.1	0.023	-	0.0002
3 Wheelers	upto 1991	12.0	7.0	0.26	0.029	-	
	91-94	12.0	7.0	0.26	0.029	-	
	94-96	12.0	7.0	0.26	0.029	-	
	96-2000	8.1	6.48	0.26	0.029	-	
	2000-2005	4.8	2.4	0.26	0.029	-	
Buses and	upto 91	12.7	2.1	21.0	1.5	3	-
Goods	91-96	12.7	2.1	21.0	1.5	3	-
	96-2000	9.96	1.44	16.8	0.75	2.4	-
	2000-2005	5.35	0.66	9.34	0.37	2.4	-

Source: Central Road Research Laboratory of India.

* Reduction in emission level to be achieved within 15-yr period (between 1991-2005).

Table 19: Vehicular Emission Factor *

Sl. No.	Vehicle type	Emission level in gm/km				
		CO	HC	SO_2	No_x	SPM
1.	Bus/minibus	12.0	2.0	1.5	21.0	1.0
2.	Truck	12.0	2.0	1.5	21.0	1.0
3.	Jeep	40.0	6.0	0.08	19.0	0.33
4.	Car	40.0	6.0	0.08	19.0	0.33
5.	Taxi	40.0	6.0	0.08	19.0	0.33
6.	Baby taxi	10.0	10.0	0.02	0.07	0.20
7.	Tractor	7.2	2.0	1.5	21.0	1.00
8.	Motor cycle	10.0	10.0	0.02	0.07	0.29

Emission factors have been deduced from Department of Environment (1970) data, reproduced in DITS Working Paper No : 28.

Table 20: Number of on road vehicle In Bangladesh 1996 & Dhaka urban area – 1997

	M. Car	Taxi	Jeep/Station/ Wagon/Pick up vans	Big bus	Mini Bus	Truck	Auto-ricksha w	Motor cycle	Other s	Total
% of growth	18.4	1.0	40.6	1.6	7.5	6.9	20.0	5.8	6.4	
1996	72,478	2,015	41,102	13,627	11,052	35,475	62,548	1,88,669	8,685	4,35,311
Assumed % of growth for 1997	20	1.0	20	1.6	10	7	20	6	7	
1997	86,974	2,035	49,322	13,845	12,157	37,958	75,053	2,00,000	9,293	
Assuming % of distribution for Dhaka Urban Area	50%	50%	50%	50%	50%	50%	60%	40%	50%	
1997	43,487	1,018	24,666	6,923	6,079	18,979	45,035	80,000	4,647	2,30,834

Source : BRTA (Bangladesh Road Transport Authority)
BBS (Bangladesh Bureau of Statistics)
DUTP – II, 1996-97

Table 21: Annual vehicle exhaust emission (Ton/Yr) computed for Dhaka metro area

Vehicle Mode	Vehicle Number 1997	5.5.1.1.1 /yr/veh	Emission Factor (gm/km)			Total emission (ton/year)		
			CO	HC	NO_x	CO	HC	NO_x
LDV	69,171	21,600	42.67	5.62	2.70	63,749	8,396	4,034
Trucks	23,626	43,200	7.31	2.52	15.55	7,464	2,573	15,876
Urban Buses	13,002	72,000	21.16	5.57	10.40	19,806	5,214	9,734
3 – Wheelers	45,035	36,000	32 9	20.2	0.26	53,298	37,724	421
Motor Cycle	80,000	18,000	24.6	19.0	0.04	35,424	27,360	58
Total	2,30,834					1,79,471	81,267	30,123

Key Assumption on daily run for the different types of vehicles in km/day (average).
Cars – 100. Trucks – 120, Buses – 200
Auto – Rickshaw – 100, Motor Cycle – 50

72. Emission factors of different types of engines vary, even within the same mode category. Averages have been arrived at through several observations. Dependability of the factors, is based on regimens of testing procedure. However, in the absence of any other alternate dependable method, mass emission factors are used to estimate approximate level of concentration of various pollutant gases. It must, however, be remembered that since the mass of gases vary, the transportation and concentration characteristics also vary, which are not taken into consideration in the mass emission based calculations, which are used in the absence of adequate micro-climatic data.

73. The usefulness of the emission factors are limited to the data base, which indicates the level of emission made by a particular made in terms of gms. per km travelled. This is suitable for working out mass of pollutants over a larger network. However, it has been adopted to provide the pollution level of of all iintersections, where the height of concentration is assumed to be 15m on the basis of surrounding built from form. The following detailed calculation used is for the intersection at Zero Point [based on 1992 traffic census].

Table 22: Computation procedures for determining emission levels

Location	Vehicle type	No.

ZERO POINT	Heavy	Auto -Taxi	Car	Auto - rickshaw	Motorcycle	Total
Nos. of vehicles (1993)	7,684	675	9,359	11,427	4,172	33,317
CO Emission Factor	12.7	12	25	12	8.3	
CO Emission Level	97,587 gm	8,100	233,975	137,124	34,628	511,414 gm/km
HC EF	2.1	7	2.73	7	4.5	
HC EL	16,136 gm	4,725	25,550	79,989	18,774	145,175 gm/km
NO_x EF	21	0.26	2	0.26	0.1	
NO_x EL	161,364 gm	175.50	18,718	2,971	417.20	183,646 gm/km
SO_2 EF	1.5	0.03	0.053	.029	0.023	
SO_2 EL	11,526.0 gm	19.58	496..03	331.383	95.956	12,469 gm/km
SPM EF	1	0.2	0.33	0.20	0.29	
SPM EL	7,684 gm	135	3.088	2,285	1,210	14,403 gm/km

Intersection area (1993) = 1,003.68 sq.m.

CO = 511,414 gm / km for 16-hr volume.
Assuming peak hour to be twice the average volume, the total CO emission in peak hour would be (511,414/16 x 2= 63,927 g/km which comes to 64 gm per metre.
(Assuming that all vehicles have traversed 31.68 m distance in the junction)

∴ the total emission emitted during peak hour is 31.68 m x31.68 = 2,025 gm.

i) **Assuming a dispersion height of 15m:**

The cubic volume of the junction is 15,055.2 cu.m (15 x 30.6 x 32.8)
The CO concentration is 2,025/(15,055.2)= 0.1345 gm/cu.m. = 134.522mg/m^3 = 134,522 µg/m^3

ii) **Assuming a dispersion height of 100 m:**

The cubic volume of the junction is 100,036.80 cu.m (100x 30.6 x 32.8)
The CO concentration is 2,025/(100,036.80)= 0.02024 gm/cu.m. = 20.24 mg/m^3 = 20,242.71 µg/m^3

74. On the basis of this, emissions at 25 intersections including the proposed 3 fly-over sites have been computed based on 1993 traffic volume as compared to projected figures for 1997 traffic volume and with assumed dispersion heights of 15m and 100m. The changes in emission levels have been calculated for individual pollutants.

75. (The summary spreadsheets computed with assumed dispersion heights of 15m and 100m are presented successively in Appendix B and C.)

Table 23: (A) Emission levels at road intersections
Measured In Micrograms Per Cubic Metre (g/m^3)
('without project' based on projected 1992 traffic volume and an assumed dispersion height of 15m)

Location of Intersection	CO	SO_2	NO_x	HC	SPM
Zero Point	134,522	3,280	48,306	38,187	3,788
Dholaikhal – Nawabpur Road	84,306	2,120	30,150	31,347	2,485
Baldha Garden	111,822	5,094	71,903	35,967	1,487
Golap Shah Mazar	88,480	2,241	31,781	33,766	2,593
North South Road/English Road	165,406	12,929	181,238	43,263	9,534
Kataban	235,752	2,989	47,723	62,770	4,945
Newmarket	163,702	8,144	117,081	34,504	6,752
Mahakhali (Flyover Site)	138,534	2,594	39,969	33,396	3,306
Airport Rd/Gulshan 1 Road	243,779	4,616	70,669	61,233	5,901
Bangla Motor	369,353	5,475	86,346	93,457	8,037
Moghbazar	354,483	5,944	91,316	96,459	8,197
Mouchak	120,325	3,002	43,948	35,931	3,398
Kakrail	163,071	4,068	59,561	48,696	4,605
Topkhana	162,954	4,726	68,468	49,291	4,950
Malibagh	141,256	3,341	49,331	40,535	3,867
Fakirapool	168,069	1,781	28,156	52,981	3,395
Shapla Chattar	75,973	1,707	25,663	19,283	1,989
Rajarbagh	117,065	1,505	22,836	39,340	2,590
Ittefaq	105,661	3,732	53,704	30,,165	3,597
Saidabad	171,574	7,647	108,039	55,481	6,727
Khilgaon	109,217	2,176	32,206	34,159	2,792
Jatrabari (Flyover Site)	161,339	6,657	55,412	52,809	5,997
Bijoy Nagar	270,641	3,342	53,150	75,751	5,590
Kadam Chattar	118,409	2,885	42,747	32,089	3,279
Sonargaon (Flyover site)	286,342	4,471	69,704	74,169	6,458

NB : All the values of emission per cu.m is very much on the higher side because:

(a) no factor of wind movement or dispersal has been taken into account. There would be a factor depending on speed & direction of the wind & surrounding landuse.
(b) the lowest value of dispersion height (15m) has been taken, resulting in smaller mixing volume.
(c) peak hour volume is arbitrarily taken at twice the average volume.
(d) the volume of pollutants is worked out at junction where the volume is the highest.

However the value of the exercise is in its ability to compare relative changes.

Table 23: (B) Emission levels at road intersections
Measured In Micrograms Per Cubic Metre (g/m^3)
('with project' based on projected 1998 traffic volume and an assumed dispersion height of 15m)

Location of Intersection	CO	SO_2	NO_x	HC	SPM
Zero Point	122,607	3,014	44,029	37,455	3,470
Dholaikhal – Nawabpur Road	108,715	4,983	70,012	37,343	4,387
Baldha Garden	105,424	3,544	49,938	39,226	3,488
Golap Shah Mazar	70,277	2,040	24,365	33,960	2,412
North South Road/English Road	262,068	5,703	76,659	73,337	6,479
Kataban	219,091	2,343	39,608	49,234	4,271
Newmarket	97,802	1,892	28, 875	24,672	2,414
Mohakhali (Flyover Site)	129,865	2,523	38,092	35,896	3,195
Airport Rd/Gulshan 1 Rd	259,657	4,970	75,145	71,855	6,348
Bangla Motor	290,305	5,557	84,015	80,337	7,097
Moghbazar	313,740	5,237	79,427	93,630	7,281
Mouchak	136,529	3,300	47,,943	44,543	3,807
Kakrail	267,036	4,510	68,248	80,277	6,228
Topkhana	143,039	4,105	59,087	46,542	4,331
Malibagh	155,359	3,314	48,723	49,340	4,070
Fakirapool	191,736	2,014	31,139	66,304	3,,884
Shapla Chattar	83,104	1,896	28,221	22,952	2,201
Rajarbagh	121,537	1,490	22,201	45,020	2,652
Ittefaq	115,465	4,021	57,568	35,609	3,904
Saidabad	195,128	8,121	114,353	68,,377	7,344
Khilgaon	110,453	2,064	30,220	38,405	2,759
Jatrabari (Flyover Site)	68,579	2,626	37,048	24,399	2,444
Bijoy Nagar	294,833	3,696	57,,671	90,,086	6,158
Kadam Chattar	125,829	3,120	45,818	36,779	3,522
Sonargaon (Flyover site)	279,997	4,455	68,405	79,389	6,390

NB : All the values of emission per cu.m is very much on the higher side because:

(a) no factor of wind movement or dispersal has been taken into account. There would be a factor depending on speed & direction of the wind & surrounding landuse.
(b) the lowest value of dispersion height (15m) has been taken, resulting in smaller mixing volume.
(c) peak hour volume is arbitrarily taken at twice the average volume.
(d) the volume of pollutants is worked out at junction where the volume is the highest.

76. The computed values in Table 23(A) and 23(B) seems to be highly exaggerated which may be caused by, among other factors, very simple approximations made for a very complex system. In order to make these calculations more realistic, attempts are made to normalize these calculated values to median observed values as per Table-24.

77. These normalizing factors have been observed to be different for each component of the pollutants as each pollutant interacts differently with the atmosphere.

The normalised emission levels are presented in Table-25(A) and Table-25(B) and anticipated change in emission levels are presented in Table-26.

Table 24 : Dhaka Air Quality Values for Selected Pollutants

5.5.1.2 Parameter	Observed Value ($\mu g/m^3$)	Median Observed Value ($\mu g/m^3$)	5.5.1.3 Location
SPM	1,000-2,000 600-1,200	1,500 900	Along major roadways – commercial districts Residential areas
NO_2	50-150	100	Non residential areas
CO	3,000 to 32,000 (instantaneous)	16,000	Along major roadways
SO_2	130-180 60-80	155 70	Industrial Non residential
Pb	<= 1.0	<=0.5	Along major roadways

79. The foregoing calculations were made on the assumption that NMT can be ignored in pollution calculation. But in reality this is not correct If MT and NMT are allowed to interact. Currently more than 60% of the roadway is occupied by NMT with a maximum vehicular speed of less than 10km/h. If NMT is removed, the carrying capacity of the road can be doubled, which will result in increased vehicular speed and eventually a decrease in pollution levels.

80. This interaction between MT and NMT has not been considered in the present computations although it is very crucial and needs further attention.

Table 25: (A) Normalized emission levels at road intersections

Measured In Micrograms Per Cubic Meter ($\mu g/m^3$)

('without project' based on projected 1992 traffic volume and an assumed dispersion height of 15m)

LOCATION OF INTERSECTION	CO	NORMLIZED VALUE	SO_2	NORMLIZED VALUE	NO_X	NORMLIZED VALUE	SPM	NORMLIZED VALUE
ero Point	134,522	12,632	3,280	118	48,306	97	3,788	1,224
olaikhal – Nawabpur ad	84,306	7,916	2,120	76	30,150	60	2,485	803
ldha Garden	111,822	10,500	5,094	183	71,903	144	1,487	480
lap Shah Mazar	88,480	8,308	2,241	81	31,781	64	2,593	838
rth South ad/English Road	165,406	15,532	12,929	465	181,238	362	9,534	3,079
taban	235,752	22,137	2,989	108	47,723	95	4,945	1,597
ewmarket	163,702	15,372	8,144	293	117,081	234	6,752	2,181
ahakhali lyover Site)	138,534	13,008	2,594	93	39,969	80	3,306	1,068
rport Rd/Gulshan ad	243,779	22,891	4,616	166	70,669	141	5,901	1,906
ngla Motor	369,353	34,682	5,475	197	86,346	173	8,037	2,596
oghbazar	354,483	33,286	5,944	214	91,316	183	8,197	2,648
ouchak	120,325	11,299	3,002	108	43,948	88	3,398	1,098
krail	163,071	15,312	4,068	146	59,561	119	4,605	1,487
opkhana	162,954	15,301	4,726	170	68,468	137	4,950	1,599
alibagh	141,256	13,264	3,341	120	49,331	99	3,867	1,249
kirapool	168,069	15,782	1,781	64	28,156	56	3,395	1,097
apla Chattar	75,973	7,134	1,707	61	25,663	51	1,989	642
jarbagh	117,065	10,992	1,505	54	22,836	46	2,590	837
faq	105,661	9,922	3,732	134	53,704	107	3,597	1,162
idabad	171,574	16,111	7,647	275	108,039	216	6,727	2,173
lgaon	109,217	10,255	2,176	78	32,206	64	2,792	902
rabari over Site)	161,339	15,150	6,657	240	55,412	111	5,997	1,937
y Nagar	270,641	25,413	3,342	120	53,150	106	5,590	1,806
am Chattar	118,409	11,119	2,885	104	42,747	85	3,279	1,059
argaon over site)	286,342	26,888	4,471	161	69,704	139	6,458	2,086
RAGE	170,481	16,008	4,259	153	61,176	122	4,650	1,502
MALIZING TOR (%)	9.39		3.6		0.2		32.3	

No measured values are available for HC. However, same normalizing factor as that of SPM has been used assuming similar interaction with the atmosphere.

Table 25: (B) Normalized emission levels at road intersections

Measured In Micrograms Per Cubic Metre ($\mu g/m^3$)
('with project' based on projected 1992 traffic volume and an assumed dispersion height of 15m)

LOCATION OF INTERSECTION	CO	NORMALIZED VALUE	SO_2	NORMALIZED VALUE	NO_x	NORMALIZED VALUE	SPM	NORMALIZED VALUE
Zero Point	122,607	11,488	3,014	129	44,029	84	3,470	1,220
Dholaikhal – Nawabpur Road	108,715	10,187	4,983	213	70,012	147	4,387	1,542
Baldha Garden	105,424	9,878	3,544	152	49,938	105	3,488	1,226
Golap Shah Mazar	70,277	6,585	2,040	87	24,365	51	2,412	848
North South Road/English Road	262,068	24,556	5,703	244	76,659	161	6,479	2,278
Kataban	219,091	20,529	2,343	100	39,608	83	4,271	1,502
Newmarket	97,802	9,164	1,892	81	28875	61	2,414	849
Mohakhali (Flyover Site)	129,865	12,168	2,523	108	38,092	80	3,195	1,123
Airport Rd/Gulshan Road	259,657	24,330	4,970	213	75,145	158	6,348	2,232
Bangla Motor	290,305	27,202	5,557	238	84,015	176	7,097	2,495
Moghbazar	313,740	29,397	5,237	224	79,427	167	7,281	2,560
Mouchak	136,529	12,793	3,300	141	47943	101	3,807	1,339
Kakrail	267,036	25,021	4,510	193	68,248	143	6,228	2,190
Topkhana	143,039	13,403	4,105	176	59,087	124	4,331	1,523
Malibagh	155,359	14,557	3,314	142	48,723	102	4,070	1,431
Fakirapool	191,736	17,966	2,014	86	31,139	65	3,884	1,376
Shapla Chattar	83,104	7,787	1,896	81	28,221	59	2,201	774
Rajarbagh	121,537	11,388	1,490	64	22,201	47	2,652	932
Ittefaq	115,465	10,819	4,021	172	57,568	121	3,904	1,373
Saidabad	195,128	18,283	8,121	348	114,353	240	7,344	2,582
Khilgaon	110,453	10,349	2,064	88	30,220	63	2,759	970
Jatrabari (Flyover Site)	68,579	6,426	2,626	112	37,048	78	2,444	859
Bijoy Nagar	294,833	27,626	3,696	158	57671	121	6,158	2,165
Kadam Chattar	125,829	11,790	3,120	134	45,818	96	3,522	1,238
Sonargaon (Flyover site)	279,997	26,236	4,455	191	68,405	144	6,390	2,247
AVERAGE	170,727	15,997	3,622	155	53,072	111	4,421	1,555
NORMALIZING FACTOR (%)	9.37		4.28		0.19		33.93	

Note: No measured values are available for HC. However, same normalizing factor as that of SPM has been used assuming similar interaction with the atmosphere.

Table 26: Anticipated change in emission levels at road intersection
(Comparison of *'Without Project'* and *'With Project'* scenario)

Pollutant	CO				SO2			
Location of Intersection	Without Project	With Project	Change (%)	Without Project	With Project	Change (%)	Without Project	
ro Point	12,632	11488	-9.06	118	129	9.32	97	
olaikhal – Nawabpur Road	7916	10187	28.69	76	213	180.26	60	
idha Garden	10500	9878	-5.92	183	152	-16.94	144	
ilap Shah Mazar	8308	6585	-20.74	81	87	7.41	64	
rth South Road/English Road	15532	24556	58.10	465	244	-47.53	362	
taban	22137	20529	-7.26	108	100	-7.41	95	
wmarket	15372	9164	-40.39	293	81	-72.35	234	
hakhali (Flyover Site)	13008	12168	-6.46	93	108	16.13	80	
port Rd/Gulshan 1 Rd	22891	24330	6.29	166	213	28.31	141	
ngla Motor	34682	27202	-21.57	197	238	20.81	173	
ghbazar	33286	29397	-11.68	214	224	4.67	183	
uchak	11299	12793	13.22	108	141	30.56	88	
krail	15312	25021	63.41	146	193	32.19	119	
pkhana	15301	13403	-12.40	170	176	3.53	137	
alibagh	13264	14557	9.75	120	142	18.33	99	
kirapool	15782	17966	13.84	64	86	34.38	56	
apla Chattar	7134	7787	9.15	61	81	32.79	51	
jarbagh	10992	11388	3.60	54	64	18.52	46	
efaq	9922	10819	9.04	134	172	28.36	107	
idabad	16111	18283	13.48	275	348	26.55	216	
ilgaon	10255	10349	0.92	78	88	12.82	64	
rabari (Flyover Site)	15150	6426	-57.58	240	112	-53.33	111	
oy Nagar	25413	27626	8.71	120	158	31.67	106	
dam Chattar	11119	11790	6.03	104	134	28.85	85	
nargaon (Flyover site)	26888	26236	-2.42	161	191	18.63	139	

Table 27: Emission Factors based on consumption of fuel *

Serial No.	Components of exhaust gases	Emission in kg per klitre of fuel consumed.	
		Petrol engine	Diesel engine
1.	Carbon monoxide (CO)	274	7.1
2.	Hydro Carbons (HC)	24	16.4
3.	Nitrous Oxides (No_x)	13.5	26.4
4.	Sulphur dioxide (SO_x)	1.1	4.8
5.	Suspended particulate matter (SPM)	1.4	13.2
6.	Lead (Pb)	5-30	-

1971 - study in W. Germany by f.J Dreihaput. Same study also shows that the emission of CO at idling is approximately 3.3 to 3 times more than a vehicle in motion.

Table 28: Fuel consumption characteristics of different vehicles (km/litre) *

Tuck	Bus	D-Decker	Minibus	Jeep	Car	Tempo	Auto-rickshaw	Mishuk
3	4	3	5	6	6	12	20	30

(Source: DUTP I - Working Paper V)

These consumption values can be extrapolated with the emission factors (ref. Table no : to assess the emission volume of different parameters.

1 Alternately, the emission factors for vehicle and engine type, i.e., petrol or diesel, based on ıe amount of fuel consumed [ref.: Table-12 Emission factors based on consumption of fuel]. The ıte of consumption of fuel, per vehicle type has been provided in DUTP I, Working Paper V. [ref. - 3]. The reduction in congestion & increase in travel speed can be computed to estimate the ıduction in mass emission level, which them can be translated into tangible benefits.

2. Therefore, emission level can be estimated by the following formula :

$= \sum N_i Ut_i Ef_i$, where N = number of vehicle,

Ef= emission factor

Ut= Rate of Utilization

i= vehicle type

P = pollutant type.

5.6 Traffic volume

83. The data of detailed traffic volume mode wise is available only for 1992 when a detailed traffic census was conducted. The current volume & projected volume of traffic, mode wise, on the links to all the intersections has been arrived at. The level of pollution in the junction & the links has been estimated. The relative difference between values indicate the levels of benefits or disbenefits.

84. The most important factor that emerges is that given the present emission factors, rise in volume of traffic is directly proportional to the level of pollution. Therefore, emission control and progressive reduction is sine qua non. Similarly, improvement in fuel quality, i.e. low sulphur, & lead free fuel would have considerable impact on the air pollution scenario.

85. Alternately, the emission factors for vehicle and engine type, i.e. petrol or diesel, based on the amount of fuel consumed (Table 6: Emission Factors Based on Consumption of Fuel) can be used. The reduction in congestion and increase in travel speed can be computed to estimate the reduction in mass emission level, which then can be translated into tangible benefits.

6. Noise Pollution

86. A noise is commonly defined as being any unwelcome sound. This definition has been broadened to indicate that sound is considered a noise if the person concerned feels that it interferes or conflicts with his activities.

87. Problems caused by noise are becoming more severe both in modern industrialised countries as well as in the developing countries. Noise can cause loss of hearing, or it can annoy and disturb people's various activities which require greater concentration of mind. The other ill-effects include fatigue, loss of sleep, mental stress, increase of heart diseases, blood pressure, diminishing capability of hearing and communication etc.

88. That is why permitted levels of sound varies depending on the land use and activity pattern. The disturbance evoked by noise depends on various factors, most important are the following:

i) The intensity of the sound or noise level
ii) The duration of separate impulses
iii) The frequency of sound impulses
iv) The subjective reaction to noise or individual sensitivity

6.1 Traffic Noise:

89. Noise is notified as pollutant under the Bangladesh Environment Conservation Act. 1997. Out of many other sources of noise pollution, the road traffic noise has been recognized as a single very significant pollutant for urban community environment. Traffic noise is influenced by the following factors:

a) Noise from engines, exhaust pipes and electric and Hydraulic horns
b) Density of traffic flow
c) Vehicle speed and rolling noise of tyres in contact with the road surfaces
d) Road surface characteristics and road gradients

90. Traffic noise constitutes a linear source, rather than a point source, radiating noise in a sphere and representing more of a cylindrical form. Traffic thus creates two zones of noise:

i) Inner Zone

ii) Outer Zone

91. Denser the traffic, narrower is the inner zone. If the volume and composition is the same, the noise level of the inner zone can be calculated as 20 log (PCU/h) and outer zone by 10 log(PCU/hr). Since the composition of traffic is unlikely to be uniform, it is desirable to measure the noise level, and relate them to traffic volume.

Table 29: Traffic noise related to traffic volume

Year	Location	Vehicle Volume for 16 hours period			
		HTV	CAR/JEEP	AR/MC	TOTAL
1997	MOGHBAZAR	11676	23273	39589	74538
PCE		2.5	1.0	0,5	
PCU VALUES		29190	23273	19795	72258
PCU/h		1824	1455	1237	4516

Noise Level = 20 log PCU/h = 20 log 4516 = 73.09
Observed Noise Level = 82 dBA (as on 22/06/98)

By June 1998, the traffic volume has increased considerably. As such, assuming a 3% increase in volume,

Noise Level = 20 log PCU/h = 20 log 4651 = 73.35
Observed Noise Level = 82 dBA (as on 22/06/98)

92. Therefore, the resulting model may be considered as a rough guide for estimating noise level. However, empirical testing is essential to validate or modify the model, to account for local conditions. Non-motorised traffic volume may not be taken into consideration.

93. The existing status of noise pollution in the project area is worse. This may be perceived at every intersections and bus terminals of Dhaka City. During traffic congestion, the terrible noise produced from the old engines of the buses and trucks combined with the high pitched sound of air and hydraulic horns make the noise level more than the standard limits and thus thousands of peoples around those intersections and roads are adversely affected by such noise pollution.

Particularly, partial loss of hearing of bus and truck drivers may be attributed to the effect of constant or repeated exposure to higher levels of noise of their vehicles. In addition to that, this has adverse effect on roadside residents and traffic police on duty. But the magnitude and overall effect of noise pollution over these groups of people is not yet monitored for Dhaka urban area.

6.2 Noise Standards

94. Weighted noise level is used to express the subjective loudness. This is a measure of the overall intensity after the lowest and the extreme top notes have been filtered out. Three kinds of weightage are used, giving readings in dBA, dBB and dBC scales. The most commonly used is the dBa curve, which gives measured values for the weighted noise level that are nearly proportional to the subjective impression of loudness. The perceived noise level (PNL) is used as a measure of the disturbance produced by noise from a single source, and is defined by a mandatory comparison with a standard source.

95. Normally 50 dBA is Considered as standard values for noise pollution by the international experts e.g. WHO experts. But according to the Environment and Transport Departments, France (?) Ministry, noise level 'Leq' (8.00 hours-20.00 hour) of 65 dBA should not be exceeded for urban zones and 60 dBA for rural zones.

96. But with the rapid development of communication system in the urban areas of Bangladesh, the traffic load has been increasing day by day. Thus the road noise level is increasing every year. To control the ever growing problem of noise pollution in Bangladesh, the Department of Environment (DOE) Bangladesh has promulgated an Ambient Noise Standard Level and Noise Emission level for vehicles in 1995. These are presented in Table - 31 and Table - 32

6.3 Noise Level Measurement of Dhaka City

97. Measurement of noise level was conducted by the DOE, Bangladesh at 20 different points particularly at Schools and Hospitals during the period from 3rd March to 7th April/1997 both at 9.00 a.m. to 10-30 a.m. in the morning and 3.00 to 4.00 p.m. in the evening and recorded noise level 56 dBA to 79 dBA in the morning and 68 dBA to 84 dBA in the evening time, against standard level 45 dBA for these sensitive areas.

6.4 Noise Level Measurement in DUTP-II Project Area

98. Ambient Noise Levels have been monitored at 20 locations at intersections and 3 locations at proposed Fly-over sites and shown in Table-30.

99. It has been observed that the average ambient noise levels at these locations exceed the standards during day time. Vehicular noise is the major source of noise pollution in all the intersection areas where observations were made.

100. For DUTP II, Noise Levels were studied by recording the noise values at the intersections during busy hours (morning and afternoon peak hours) with the help of a noise meter. Precision Integrating Sound Level Meter Type 2218 by Beuel & Kjaer of Denmark was extensively used for these observations.

The very harmful or annoying effect of noise is basically a question of its level, duration and frequency content. These three factors are combined in the concept of Equivalent Continuous Sound Levels (L_{eq}).

6.5 Equivalent Level of Sustained Noise (L_{eq}) :

The L_{eq} values were calculated using the following formula:

$$L_{eq} = L_{eq(D)} - 10 \log \frac{T + 27.778}{}$$

where T = duration of observation (displayed elapsed time in hours, correct to 3 decimal places.

Leq(D) = displayed noise value.

Table 30: Observed noise levels at road intersections

NO.	LOCATION	OBSERVED NOISE LEVEL AT DAY-TIME DBA	EQUIVALENT LEVEL OF SUSTAINED NOISE (L_{eq}) dBA
1	MOGHBAZAR	112	82
2	MOUCHAK	115	85
3	MALIBAGH	115	85
4	RAJARBAGH	112	82
5	KHILGAON	112	89
6	FAKIRAPOOL	112	75
7	BIJOYNAGAR	119	89
8	KAKRAIL	105	75
9	KATABON	110	80
10	NEW MARKET	105	75
11	KADAM CHATTAR	107	77
12	TOPKHANA	112	82
13	ZERO POINT	102	72
14	GOLP SHAH MAZAR	110	80
15	SHAPLA CHATTAR	96	66
16	ITTEFAQ	107	77
17	BALDAH GARDEN	111	81
18	SAIDABAD	106	76
19	N.S/ENGLISH ROAD	113	83
20	DOLAIKHAL	116	86
21	JATRABARI	103	73
22	MOHAKHALI	98	68
23	SONARGAON	116	86

Table 31: Ambient noise standards for Bangladesh

(max. permissible limits in dBA)

Serial No.	Area Category	Description of the Area	Max. permissible noise levels (dBA) Day time	Night time
1	A	Sensitive Areas	45	35
2	B	Purely residential Areas	50	40
3	C	Residential - cum. Commercial Areas	60	50
4	D	Purely Commercial Areas	70	60
5	E	Purely Industrial Areas	75	70

Source: Environmental Conservation Rules'97, Government of Bangladesh.

Note: I) Maximum allowable limit in working place is 90 dBA, when working upto 8 hrs. a day, but 80 dBA when working for more than 8 hrs. a day.

ii) Ear plug or ear muffs shall be provided to the workers/labours by the plant or factory management where noise level exceeding 80 dBA.

Table 32: Noise standards for motor vehicles of Bangladesh

Sl. No.	Vehicle Type	Unit	Standard Value	Receptor distance (m) from the exhaust pipe
1.	Heavy vehicles and Light petrol car, vehicles	dBA	100	0.5m
2.	Heavy vehicles and light petrol car, vehicles	dBA	80	7.5m

Source: Environmental Conservation Rules '97, Government of Bangladesh, 1995.

Note: When sound level is measured, motor vehicle is stationary and engine conditions are as follows:

i) Diesel engine – max. rotating speed
ii) Petrol engine – ¾ of max. rotating speed.
iii) Motor cycle – ½ rpm 5000 & ¾ for less than 5000 rpm.

102. However, it is necessary to record noise level regularly, so that the legal requirement of noise level is respected [ref. Table-31 : Ambient Noise standards] measurement of noise produced by traffic depends on the frequency of traffic. To arrive at logical expression of street noise, it is necessary to combine loudness of noise with its frequency of occurrence. Following methods are used.

(i) summated frequency of occurrence.

(ii) Equivalent level of sustained noise

(iii) Traffic noise index

6.6 Summated Frequency of Occurrence :

103. Noise level during a given period (1 hr. 8 hr. etc.) is recorded at short intervals, preferably continuously. The number of times the sound level exceeded a particular level is noted. The summated frequency of occurrence, i.e. the percentage of al occurrences, which exceed a particular noise level. Produces an Index. For example, L50 = 60 dBA, means that 50% of all measurements exceeded 60 dBA. Similarly l1 = 60 dBA would mean that 1% of all measurements exceeded the level of 60 level of 60 dBA. L50 represents the mean noise level, and L1 express mean level of peak noises.

Equivalent level of sustained noise level = L e. Le values can be calculated by the following

formula : $Le = 10 \log \{\frac{I}{T}\sum, \ 10^{0\ 1\ Li\ ti}\}$

Where T = duration of observation

ti = length of time the noise reached Li during observation period.

By this method the fluctuating noise can be converted into a steady sound of equivalent energy content.

Relationship between lo and traffic density can be expressed as :

Ie (m) = 30 + 10 log N. where m = distance of observer from source and
N = number of PCU h^{-1}.
Traffic Noise Index (TNI) is calculated over a period of 24 hours. L10 & L90 are measured every hour , & afterwards the 24 measurements are averaged.

TNI = 4 (4L10 – L90) + L90 - 30.

104. However, these calculations of noise level may indicate approximate levels. Since these are based on European conditions, where traffic is reasonably homogeneous, and use of horn is raise, the sudden peaks of noise experienced in the sub-continent, cannot be taken into account.

6.7 Other factors

105. Noise, in addition to the volume of traffic depends on the following factors:

106. (i) Road surface, (ii) speed of traffic, (iii) composition of traffic, proportion of heavy, (iv) gradients & intersections, (v) obstructs passage of sound, (vi) Vegetation, (vii) meteorological factors, (viii) reflection from other buildings.

107. All these factors are locations specific & needs careful measurement. In this project, two flyovers have been proposed. Since these are elevated structures, the dispersal of sound & impact of sound may affect larger area & annoy people. These can be understood by supplying the outer core model of noise & using climatic factors for dispersal. Mitigating measures, need to be carefully considered.

108. The central reservations of corridors are to be widened to 2m, to accommodate thick hedge & trees. These may have considerable impact on the noise level, abate air pollution and improve the aesthetics of street since. Design options are be evaluated to achieve these objectives.

7. Environmental Imapct Evaluation

7.1 Environmental Impact value matrix

109. The EE is used to evaluate the expected future condition of environmental quality, both 'with' and 'without' the project. The difference in Environmental Impact values (EIV) between these two conditions constitutes either an adverse impact, which corresponds to the loss of EIV, or a beneficial impact with corresponding gain of values.

Mathematically, this process may be represented as follows :

$$EI = \sum_{i=1}^{m} (V_i)_1 \, w_i - \sum_{i=1}^{m} (V_i)_2 \, w_i$$

Where:

EI = environmental impact

$(v_i)_1$ = Value of environmental quality of parameter i 'with' the project

$(v_i)_2$ = Value of environmental quality of parameter i 'without' the project

w_i = relative weight (Importance) of parameter i

m = total number of parameters.

110. The process involves preparation of scaling and weighing checklist. It provides description of the environmental parameters that are included in the checklist and instructions for their relative scaling with respect to these parameters and for assignment of important units.

111. Due to paucity of data and constraints of time it was proposed to create a composite matrix which covers the most essential parameters, both for establishing base line as well as assessing impact. This assessment has four stages (i) establishing base line for existing environmental quality, (ii) evaluation of proposed design of intersection improvement & fly overs, (iii) impact during construction period, and (iv) post construction impacts & mitigating measures. The impact values are subjective based on value judgement, in a scale of 1 to 5, where 1 is the least & 5 is the maximum.

112. Annexure D contains two nos. of Environmental Impact Evaluation Matrices. The first matrix is for the present scenario i.e. 'without project' and the second one is for 'with project' scenario when project interventions take place.

7.2 Interpretation of environmental impact values (EIV)

113. Following ascribing environmental impact values to all parameters, baseline impact values have been meticulously determined. Assessment of Impact due to proposed improvements has been made & compared against base line values.

114. The quantitative index of change are evident from the resulting Table-33. The distribution of impact values to each parameter cumulatively indicates the state of the environment.

115. Out of the 25 locations, only a small proportion (5 nos.) show a remarkably high gain of EIV (+20 and above) and the majority of locations (17 nos.) indicate a moderate gain of EIVs (from +11 upto +20). The remaining 3 locations show very poor gain of EIVs (upto +10).

116. Positive high values justifiy the project intervention. Moderate values indicates moderate gains from the project and the poor values indicate increased need for mitigating measures. Since no negative value was encountered, indications are that there is no adverse impact by the project.

117. The cumulative gain in value, from 1891 to 2307, i.e. a gain of +416 (about 21 %), is an indication of an appreciable quantitative index of positive impact predicted to be achieved by the project interventions in its entirety.

Table 33: Quantitative index of change in Environmental Impact Values (EIV)

INTERSECTION LOCATION	Cumulative Impact values *'Without'* project	Cumulative Impact values *'With'* project	Perceived Change in Impact Values (EIV)
ZERO POINT	85	101	+16
DHOLAIKHAL-NAWABPUR	77	86	+9
BALDHA GARDEN	77	97	+20
GOLAP SHAH MAZAR	85	100	+15
N-S RD./ENGLISH RD.	62	81	+19
KATABON	76	92	+16
NEW MARKET	73	100	+27
MOHAKHALI FLY-OVER SITE	76	94	+18
AIRPORT RD./GULSHAN-1	66	83	+17
BANGLA MOTOR	60	82	+22
MOGHBAZAR	65	83	+18
MOUCHAK	78	94	+16
KAKRAIL	81	88	+7
TOPKHANA	77	92	+15
MALIBAGH	79	97	+18
FAKIRAPOOL	83	98	+15
SHAPLA CHATTAR	96	109	+13
RAJARBAGH	84	100	+16
ITTEFAQ	77	89	+12
SAIDABAD	64	85	+21
KHILGAON	76	93	+17
JATRABARI FLY-OVER SITE	68	97	+29
BIJOY NAGAR	73	86	+13
KADAM CHATTAR	90	100	+10
SONARGAON FLY-OVER SITE	63	80	+17
	1891	**2307**	**+416**

8. Network Model

118. DUTP II consultancy included a task to prepare a traffic network model for Dhaka using data obtained in the 1992 DITS study and updated where possible from recent traffic surveys. This model was used to estimate traffic volumes and speeds on links of the network representing the major roads in Greater Dhaka. Trips were assigned to the network in the following categories:

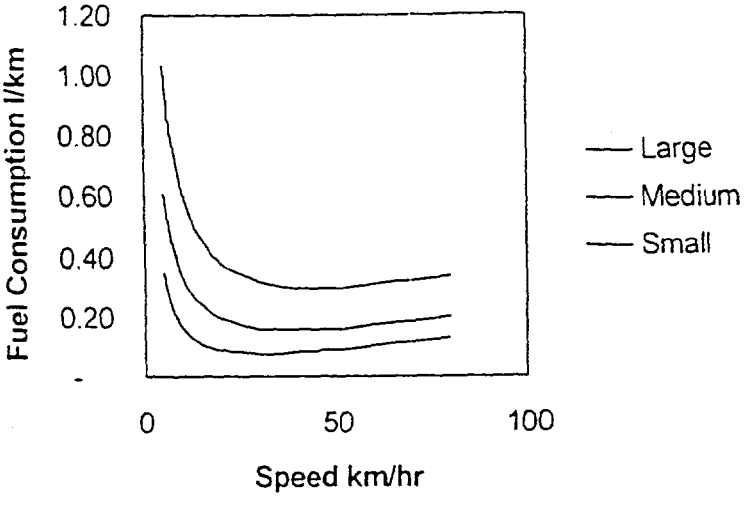
- Non-motorised vehicles that for this analysis of air pollution can be ignored. (Although the interaction between motorized and NMT is very important and this interaction has not been considered in pollution calculations.)
- Public transport trips that involve diesel buses and 3-wheeler 2-stroke tempos;
- Other motor vehicle trips that involve passenger cars and 3-wheeler 2-stroke auto-rickshaws; and
- Trucks that are assumed to be diesel powered.

119. Vehicle emissions are related to the quantity of fuel consumed, which in turn is a consequence of vehicle condition, traffic congestion, driving behaviour and environmental conditions. In general terms, vehicles consume more fuel per unit of travel distance at very low speeds or very high speeds than at moderate speeds. Stop-start travel conditions, typical of congested roads, will also increase fuel consumption per unit of travel distance compared with smooth traffic flow. Poorly maintained vehicles will have higher fuel consumption and significantly worse emissions of pollutants than well maintained vehicles.

120. Any strategy designed to tackle air pollution from motor vehicles will need to be multi-faceted (vehicle condition, traffic congestion, driver behaviour etc.) but priorities also need to be established so that limited resources are used to best effect. As a contribution to the setting of priorities, the DUTP network model was used as basis for estimating the likely impact of different air pollution strategies.

to the lack of local data, information from India was used to estimate the pollution load ılting from vehicle use in greater Dhaka under various scenarios. Fuel consumption s by speed of travel for three vehicle types (2-stroke petrol engines, 4-stroke petrol ines and diesel engines) are shown in Figure 1: Fuel consumption rates.

Figure 1: Fuel consumption rates



lutants emitted by motor vehicles include:

Carbon monoxide (CO)

Hydro-carbons (HC);

Nitrous oxides (NO_x);

Suspended Particulate Matter (SPM); and

_ead (Pb).

ssion rates as a function of fuel

Consumption were derived from data collected in India on similar vehicles to those used in ka. These rates are summarised in Table-23.

Table 34 : Pollutant emission rates

Vehicle type	Pollutant (gms/litre of fuel)			
	CO	HC	NO_x	SPM
Large (diesel engine)	90	8	37	8
Medium (4 stroke petrol)	240	31	16	0.5
Small (2 stroke petrol)	280	188	1.8	3.5

Source: Indian Institute of Petroleum

ssumptions made in these projections include:

) emission control exists in the base year 1992;

ne average km per year per vehicle is calculated based on engine efficiencies and fuel onsumption amounts by class of vehicle;

uto diesel and petrol contain 0.8 percent sulphur and 0.45 grams/litre lead respectively;

nnual growth rates for motor cars is 20 percent;

Annual growth rates for mini buses is 10 percent; and 1.6 percent for big buses,

Annual growth rates for motor cycles is 6 percent;

Annual growth rates for auto-rickshaws is 20 percent.

2. Estimates of vehicle flows and speeds on links (representing road sections) for the base case) DUTP investment) and the project case (after DUTP investment) were used to compute llutant loads for the greater Dhaka area. Traffic flows and speeds from the network model are ak hour estimates. Pollutant loads are probably lower in periods outside peak hours but for this alysis the relationship between peak hour and all-day is assumed to be constant.

23. As well as the effect of implementing road infrastructure, the likely impacts of management rategies were also assessed. These strategies included:

Better enforcement of vehicle condition regulations such that fuel consumption and emission levels would reduce; and

Achieving modal shifts from smaller vehicles to larger vehicles i.e. from 3-wheelers and passenger cars to buses.

Results of this analysis are summarised in Table-24.

Table 35: Emission of pollutants for various management strategies

ategy		CO		HC		NO_X		SPM	
		Kg/Hour	Reduction	Kg/Hour	Reduction	Kg/Hour	Reduction	Kg/Hour	Reduction
rrent situation		39.52		17.59		1.80		0.47	
ject (traffic management)		38.43	2.75%	17.11	2.69%	1.74	3.34%	0.45	3.22%
duce fuel sumption 10% for:	Small vehicles.	36.18	5.86%	15.60	8.84%	1.73	0.83%	0.42	6.25%
	Medium vehicles.	37.00	3.73%	16.93	1.08%	1.65	5.48%	0.45	0.66%
	Large vehicles.	38.28	0.40%	17.10	0.08%	1.68	3.61%	0.44	3.02%
	All vehicles.	34.59	10.00%	15.40	10.00%	1.57	10.00%	0.41	10.00%
de shift of s	10% from small vehicles to large vehicles.	37.56	2.27%	16.35	4.44%	1.86	-6.57%	0.46	-2.62%
	10% from medium and small vehicles to large vehicles.	37.98	1.19%	16.87	1.44%	1.79	-2.63%	0.46	-2.17%

...from this work is that measures to improve vehicle condition are likely to be more significant than traffic management improvements or modal shifts. Within a "vehicle condition" strategy, the major emphasis should be on improving the performance (in pollution terms) of 3-wheeler 2-stroke vehicles. Several measures could be considered such as:

- Encouraging the use of higher quality oils;
- Banning the use of 2-stroke engines for new vehicles; or
- Restricting 2-stroke powered vehicles to local trips as feeder services to bus routes.

125. Air pollution is not the only environmental issue associated with transport infrastructure development. The study reveals that in some locations, open spaces are affected (positively or negatively) and this is weighted against the expected transport benefits. Extreme care has been taken to minimize the negative impact on biological environment. In making proposals for improvement in road intersection geometry and design, minimum number of the existing trees have been have been marked to be removed. As regards smaller plants on the road sides, re-siting will be done without destroying it.

- The net effects of DUTP on pollution levels are shown in Table-35 (Chapter-8). It was expected that the primary results of such a model would be the increments in the average traffic speed along the network. When these numbers are coupled to the model for speed dependence of fuel consumption for vehicles, data in Table–35 result.

- The fuel saving of 10% shown in Table-35 appears as an adhoc approximation rather than an output of the network model calculation. A complex model is highly unlikely to yield such a round number. The model appears to provide the perceived impact of 10% fuel saving on pollution level.

- Only marginal improvements are shown in most cases but marginally negative impacts are shown in the case of mode shift of trips. In view of the uncertainties in the model input data, the uncertainties in the results could be quite high.

8.1 Alternative model:

126. Increment of average speeds is considered to be helpful in the DUTP impact evaluation both in terms of traffic management and pollution levels. In order to make DUTP worthwhile, achievement of an increment in vehicular speed of 10 km/h may be attempted. A simple model showing considerable fuel saving due to reduced transit and idling time would translate to lesser pollution loads. Such a model is described in Table-25.

Table 36: A simple model for fuel saving calculation as a result of increased mean speed of vehicles

Assumption: Vehicles either move at constant speed or they are at stand still.
The speed of a vehicle can be expresses as

$$S = S_f (1 - F_{(t)})$$

Where

S = Speed of a vehicle
S_f = Free flow speed of vehicle if there is no congestion
$F_{(t)} = T_{(t)} / T$ = Idling time/Transit time

127. S_f of 50km/hr. or higher can be achieved on Airport road or city roads after 10 pm. Currently reported value for S in Dhaka is 25km/hr. As a result of DUTP-II project interventions, it is anticipated to increase to 35 km/hr. (Key assumption : DUTP is not worthwhile if it can not achieve an increment in speed of more than 10km/hr.).

Indicative values

S_f km/hr	S km/hr	$F_{(t)}$
50	25	0.5
50	35	0.3
40	25	0.375
40	35	0.25

Fuel consumption can be written as: $C = C_f (1+0.7 F_{(t)})$

C= Actual fuel consumed, C_f= Fuel consumed for free flow.

128. The rather high value of 0.7 as the coefficient for $F_{(t)}$ partially corrects for the initial simple assumption of constant speed or stand still motion.

129. Real motion consists of transit at variable speed with higher fuel consumption per km at lower speed.

Indicative values

Sf km/hr	Change in S (km/hr.)	C_{25}/C_{35}	Fuel Saving (%)
50	25 → 35	1.116	11.6
40	25 → 35	1.160	16.0

130. Thus, it appears that considerable fuel saving could be achieved even with moderate increment in speed and this would result in substantial reduction in pollution levels.

9. Environmental Action Plan

131. An environmental action plan (EAP) for DUTP should address a number of issues that relate to environmental quality in Dhaka. Recommendations for action are summarised on the following sections:

9.1 Air Pollution:

132. This is a high priority concern as it is seriously affecting quality of life in the city and represents a major public health issue. Improvements in the levels of pollution from mobile sources are not likely to flow from DUTP investments for some years. Hence, a strong commitment to enforcement of vehicle condition regulations is needed urgently.

9.1.1 Recommended Actions:

Institutional

1. Formation of Air Pollution Advisory Committee of Stakeholders. MOEF Ministry will finalize the Action Plan with assistance from the proposed Advisory Committee.

2. Establish capability for vehicular safety and emissions related research and long-term planning through formation of Air Pollution Research Consortium of Academic Laboratories and Scientific Establishments

Transportation Planning Measures

1. Promoting and funding mass transit through fuel taxes.

2. Improved traffic planning, engineering & enforcement of traffic laws.

3. Progressive reduction of polluting vehicles over time through taxation and other fiscal incentives

4. Introduction of auto-Rickshaw fare meters to make cycle –Rickshaws increasingly uneconomical for distances greater than 3 km.

5. Road designs should be mandatory to cater for medians and other unpaved areas for planting trees and leafy shrubs. Vegetation filters some dust and particulate matter created by road use.

Regulations & Enforcement Measures

1. Establish a reliable system for monitoring vehicle condition and quality of the exhaust gases.

2. Provide fixed and mobile automotive emissions enforcement equipment for monitoring vehicle emission levels.

3. Set up a mobile enforcement group to test vehicles and issue notices requiring owners to maintain and repair defective vehicles. Acquire vehicle emission inspection monitoring equipment required for strict enforcement.

4. Promote better vehicle maintenance by introducing comprehensive fitness certificates. Inspection and maintenance pollution checks are determined to be an effective way of increasing public awareness of the air pollution problem in Dhaka. It also provides a simple means for the law enforcement agency to determine if a vehicle has satisfactorily passed the smog test. Utmost care has to be exercised to ensure the genuineness and validity of the certificates.

5. Introduce a program to phase out the use of 2-stroke engines in road vehicles.

6. Promotion of high performance semi-synthetic lubricating oil and premix standards for the two stroke engine vehicles and ways to reduce emissions.

7. Implement a lubricating oil Pilot Project for 3-wheelers.

8. Make oil companies responsible for quality of their products delivered to their customers.

9. Demonstrate pumpless lubricating systems for the three wheelers.

10. Demonstrate alternatives to use in two-stroke three wheelers (upgrade kits, CNG, Policy alternatives etc.)

11. Assess requirement of four-stroke engines for the new three-wheelers through progressive emission standards.

12. Evaluate alternatives to reduce diesel vehicle emissions (inspection and maintenance, replacement, enforcement, CNG buses, traps, policy incentives, etc.)

Public Awareness & Training

1. Initiate awareness raising campaigns for the drivers through media campaigns, drivers' training, involvement of teachers and school children through arts and dramatic performances.

2. Introduce public information campaign to alert the people to the seriousness of air pollution problem in Dhaka. Increased public awareness on health concerns is needed to justify regulations that must be taken to clean up the air.

3. Provide training for vehicle owners, drivers and mechanics. Educating the auto-rickshaw drivers as well as bus and truck owners and drivers is very important. The auto-rickshaw drivers and owners shall be required to use quality fuels, semi-synthetic lubricating oil premix, avoid use of loose lubricating oil and buying fuel from unauthorised street vendors. Training camps to be organised to demonstrate clean vehicle technology, quality fuels and importance of regular servicing and proper maintenance.

Ensure Effectiveness of Control Programs Through Air Monitoring

1. Implement quality assured monitoring program through equipment & training.
2. Develop knowledge base which can absorb and contribute information independently.
3. Open analysis and reporting of air pollution data.
4. Use of monitoring data for mid-course corrections of action plan.
5. Provide modern DOE facilities needed for quality assurance for offices, air monitoring equipment and laboratories.
6. Capacity building with additional doe manpower, training programs and technical exchanges.

Assessment Requirements

1. Compile a GIS-based emissions inventory of pollution sources by category and type of pollutant.
2. Studies on impact of air pollution on human health in different professional groups vulnerable to air pollution.
3. Conduct policy analysis and mitigation studies

Privatization

1. Divest the oil companies and their refinery.
2. Deregulate fuel pricing.
3. If prices are to be regulated, gasoline & diesel/kerosene prices should be similar.
4. Promote private sector participation in inspection and maintenance.

9.2 Noise Pollution:

133. Many locations in Dhaka experience unacceptably high noise levels due in large part to road traffic. A significant proportion of this noise level is due to aggressive and unnecessary use of vehicle horns – a practice that appears to serve little purpose other than to demand unreasonable use of the roadway.

9.2.1 Recommended Actions

1. Establish a reliable system for monitoring noise levels at all important locations.

2. Introduce a program to create awareness in the general public on the long-term impacts of high noise levels on people's health.

3. Develop training programs for drivers specifically geared towards encouraging less aggressive driving practices and reduced need for unwanted traffic noise and rampant use of high pitched horns.

4. Creating noise barriers at important locations/sites.

5. Plantation of trees and shrubs as these have some practical effect as well as a psychological benefit in reducing perceived nuisance of traffic noise.

6. Adopt appropriate legislation and regulatory measures to impose stricter controls on residential building construction near major road intersections, limiting speed near especially sensitive areas like schools and hospitals, enforcing by-pass routes for the noisiest vehicles, such as trucks at night.

9.3 Water Pollution:

134. Dhaka's water bodies are important to the quality of life of many of its residents. These areas are breathing spaces for the city as well as a source of fish and water for various purposes. However, road surfaces drain into these water bodies through a network of secondary and tertiary drains which carry large concentrations of dissipated motor oils and other forms of toxic pollution.

9.3.1 Recommended Actions:

1. Initiate a campaign to ban the repair and washing of vehicles on public roads.

2. Provision of adequate dustbins and efficient means of garbage disposal without spilling onto the road-side drains.

3. Provision of adequate, well-maintained and functional public toilets on all important roads and intersections for road users which are located near parks, lakes and water bodies.

4. Legislation and regulation measures should be considered with the definition of protection perimeters, retention ponds, constructions in floodable zones, and discharge capable of changing the quality of surface or ground water.

9.4 Soil Pollution:

135. Soil contamination rises from daily traffic operation on very busy road intersections. Metals such as chromium, D, and zinc remain in the soil for hundreds of years. Soil contamination in Dhaka mostly comes from uncontrolled spillage of lubricant wastes dispensed by roadside parked vehicles and unauthorised workshops.

9.4.1 Recommended Actions:

1. Regulate roadside workshops.
2. Provide used motor oil recovery system.
3. Prompt replanting and plant maintenance.
4. Controlling the speed and volume of water flows.
5. Concrete dissipitation structures designed to slow down fast-running stormwater in drains, and hence reduce downstream erosion.
6. Settlement basins to allow silt, pollutants and road rubbish to settle out of runoff water before it flows into downstream watercourses.
7. Legislation dealing with soil conservation should be considered, including limits on land use along the road and requirements for erosion control, especially for roads susceptible to flooding.

9.5 Biological Environment:

136. Road side projects have significant effects on natural plant, animal and aquatic life or more explicitly, on flora and fauna. These effects, when they occur, have very distinct effect on the ecosystem.

137. Consumption of natural space by physical road right of way, disturbance of surface water flow, erosion, modifications in biodiversity, cutting of trees of economic importance etc. are the prime concerns for protection of biological environment.

9.5.1 Recommended Actions:

1. Road development and improvement works would attempt to avoid areas sensitive to environments in order to avoid severe adverse impacts on flora and fauna.
2. Stop indiscriminate felling of trees without considering the related environmental issues.
3. Stop indiscriminate use of open spaces for residential or institutional purposes. Existing pattern should not be altered without considering the environmental impact thereof.
4. Road cross sections to be adjusted to reduce impact on adjacent natural environments such as open spaces and parks.

5. Adequate and systematic planting of road reserves and adjacent areas to support existing flora and fauna.

9.6 Socio-cultural Environment:

138. Road improvement projects can have varying consequences on socio-cultural environment such as: physical damage caused to related sites, aesthetic impacts on cultural sites, positive impacts of improved access to sites recognized for their cultural value.

9.6.1 Recommended Actions:

1. Dismantling of all unauthorised structures within immediate vicinity.

2. Provide adequate public toilets in the neighborhood of places of heritage and cultural value such as museums, monuments, architectural sites, etc.

3. Provide functional dustbins for disposal of garbage/ litters made by the visitors.

4. Stop indiscriminate felling of trees within the sites of historical and cultural importance on the plea of extension and development works.

9.7 Health Environment:

139. Blockage of road side drains and poor maintenance measures pose a great threat to human health for the road side users and the general public. Roadside drains are amply blocked by household garbage and polythene / plastic shopping bags. In the design of road intersections considerations should be made for increased accessibility and functional layout for the drains to be cleaned and wastes disposed off. The absence of adequate number of functional toilets also cause health hazard due to defecation of road sides, footpaths, drains and open spaces by human and animal excreta.

9.7.1 Recommended Actions:

1. Dismantling of all unauthorised wastewater and sewer connections from nearby dwellings to the road side drains.

2. Provide adequate and functional public toilets in the neighborhood as well as at all road intersections, bus terminals and open parks and other places of public gathering.

3. Stop indiscriminate use of road corners and footpaths for use as open latrines.

4. Stop indiscriminate use of parks, open spaces etc. for public meetings, gatherings where littering takes place and no authority / arrangement is there to remove/dispose of it.

9.8 Garbage/Waste Pollution:

140. Inadequate garbage disposal measures pollute the environment and pose a great threat to human health for the road side users as well as the general public. Prior demand survey and appropriate location of garbage bins in the design of road intersections are very important. Considerations should be made for increased accessibility and functional layout for the garbage disposal vehicles to operate unhindered by traffic flow. Public awareness has to be created against throwing kitchen wastes / household garbage on the roadsides, footpaths and drains.

9.8.1 Recommended Actions:

1. Provide adequate and functional dustbins / garbage collection points in the neighborhood as well as at all road intersections, bus terminals, markets, restaurants and hotels as well as open parks and other places of public gathering.

2. Provide functional and an efficient garbage disposal system with proper and adequate equipment, vehicles and trained manpower.

3. Stop indiscriminate use of road corners and footpaths for garbage disposal.

4. Stop indiscriminate use of open spaces for public gatherings where littering takes place and nobody is to remove it.

ANNEXURES:

A. Environmental impact assessment of project components

B. Summary Spreadsheets containing emission calculations with assumed dispersion height of 15m.

C. Summary Spreadsheets containing emission calculations with assumed dispersion height of 100m.

D. Environmental Impact Value Matrix:

'*Without Project*' Scenario
'*With Project*' Scenario

E. Location Maps showing Project Components.

F. List of Tables

G. References

H. Abbreviations and Acronyms

ANNEXURE A: Environmental Impact Assessment of project components

(a) ENVIRONMENTAL IMPACT ASSESSMENT OF ROAD INTERSECTIONS

AIR POLLUTION	NOISE POLLUTION	WATER POLLUTION	SOIL POLLUTION	BIOLOGICAL ENVIRONMENT	SOCIO-CULTURAL ENVIRONMENT	HEALTH ENVIRONMENT
The traffic congestion is observed at each road intersection every day by all types of vehicles and NMT and this congestion is mainly caused by inaccurate geometric design of intersections, narrow road arms, absence of footpath and ineffective traffic control management. Although normal speed of vehicles for Urban Traffic is 25 km/hr., about 42,000 vehicles of different types get stuck at each intersections at speed level less than 5km/hr with observed delays of 10 to 30 minutes. This scenario results in excessive exhaust emission from old and re-conditioned vehicles as well as from 3-wheelers which eventually cause serious air pollution affecting the road users and the people living within the immediate environs. The air pollution concentration level of these intersections have been measured for CO, NO, HC, TSP, $S0_2$ and Pb (shown in Table 10). This is recorded as base line data for air quality of Dhaka Urban Area, Concerning DUTP-II, 1997-98. **Impact:** Reduced traffic congestion will substantially reduce air pollution at the intersections.	Noise produced from old and defective engines and by rampant use of air/hydraulic horns has been measured to be within a range of 73 dBA to 106 dBA at these intersections. These levels are very high compared to the standards and prolonged exposures to such high noise levels, though for a short but intermittent period, may cause adverse impact to the occupational health e.g. vehicle drivers and other users at these road intersections. **Impact:** Reduced traffic congestion will substantially reduce noise pollution at the intersections.	During traffic congestion at these road intersections, the spillage of fuel and lubricating oil from the running vehicles are very minimal and possibilities of water pollution is very less. **Impact:** Reduced traffic congestion will substantially reduce spillage at the intersections thus reducing toxic pollution.	The spillage of fuel, lubricating oils etc. from the running vehicles at these intersections are very minimal and hence possibilities of soil pollution by leaching is very less. **Impact:** Reduced traffic congestion will substantially reduce spillage at the intersections thus reducing toxic lubricant wastes polluting the soils.	Environmental screening made by the field survey revealed that not much flora and fauna or water bodies are tampered by the improvement of these road intersections. This may be attributed to the fact that these improvement or rehabilitation works are done on the existing sites without involving any new land. Intersections at Kadam Chattar and Balda Garden will involve some trees of economic and ecological value. **Impact:** Proposed improvements in the intersection geometry will attempt to preserve maximum number of trees. The smaller plants will be re-planted along the medians and the sidewalks.	This environmental issue addresses heritage and archaeological sites/ monuments, mosques, temples, grave yard, recreational parks or lakes & sensitive spots etc. But this improvement works have no significant impact upon this issue at most of the intersections except at North-South Road/English Road intersections where the children's park is being occupied by parked trucks. **Impact:** Proposed improvements in the will significantly improve the environmental condition by making free the park from truck occupation..	At most of the intersections, roadside drains are found blocked by garbage and wastes dropped by the road side hawkers and shop-keepers. Resulting water logging at different points provides breeding ground of mosquitoes. Decomposed garbage and foul smell is posed as a health hazard. In most places road side drains are polluted by defecation and urination by the floating people and squatters resulting in poor sanitation and a threat to public health. **Impact:** Reduced traffic congestion and physical improvement to the footpath and drains will substantially reduce water clogging at the intersections thus improve local sanitation.

b (1) ENVIRONMENTAL IMPACT ASSESSMENT OF MOHAKHALI FLY-OVER SITE

AIR POLLUTION	NOISE POLLUTION	WATER POLLUTION	SOIL POLLUTION	BIOLOGICAL ENVIRONMENT	SOCIO-CULTURAL ENVIRONMENT	HEALTH ENVIRONMENT
Air pollution of this Fly Over site is worse because of acute traffic jam at this intersection. About 54,548 Nos. of motorised vehicles are plying over this intersection per day and frequent traffic jam at this site made worse air pollution, affecting road side people. Air pollutants like SPM level recorded 950 ug/m^3 at this point against standard level 400 set by the DOE, in 1995. The levels of other pollutants like CO, NOx, SO_2 are within the standard limit but if abatement measures are not taken right now, these levels may be exceeded in near future due to rapid urban vehicular growth.	Traffic volume is very high, 54.548 nos. of vehicles plying at this point. Noise produced from old engines and by air/hydraulic horns are the main sources of such noise pollution. Noise recorded by DUTP II on 21st June 1998, at this site was 75 dBA during peak-hours against standard level 65 dBA. *There are many offices*, residential buildings, shops, few mosques, institutions and health resorts, existing at both sides of this fly-over site, which are within the zone of influence of noise pollution. The people of the road sides are the victims of above noise exposure, every day affecting their health.	During traffic congestion at this road intersection, the spillage of fuel and lubricating oil from the running vehicles are very minimal and possibilities of water pollution is very less. No specific water and soil sample test report is available regarding pollution caused by the spillage of fuel, lubricants etc. from the motor vehicles.	The spillage of fuel, lubricating oils etc. from the running vehicles at this intersection are very minimal and hence possibilities of soil pollution by leaching is very less.	The field survey has been carried out of this site and environmental screening was made to collect information on biological environment. As this fly-over will be constructed on the existing road and as such no biological issues. e.g. habitats of wild life or water sheds are tampered. But some 400 Nos. planted trees along both side of footpath are existing, likely to be affected by the proposed site. All these are young trees from 3 to 10m ht and now playing a vital role to urban ecology.	Not much socio cultural resources are found present on the proposed flyover site, except existing public transport waiting areas. Hawkers from footpaths will have to be removed.	The existing health environment is similar as described in para 3.1(a). But there are some road side deep drains and garbage Bins existed at the east side of Air port road under the proposed flyover site. During footpath improvement these may likely to be tampered which may cause adverse impact to health environment.
Impact: Reduced traffic congestion will substantially reduce air pollution at the intersections.	**Impact:** Reduced traffic congestion will substantially reduce noise pollution at the intersections.	**Impact:** Reduced traffic congestion will substantially reduce spillage at the intersections thus reducing toxic pollution	**Impact:** Reduced traffic congestion will substantially reduce spillage at the intersections thus reducing toxic lubricant wastes polluting the soils.	**Impact:** Proposed improvements in the intersection geometry will not affect trees of economic importance. The smaller plants will be re-planted along the sidewalks.	**Impact:** Proposed improvements will not have any negative impact on this issue.	**Impact:** Reduced traffic congestion and physical improvement to the footpath and corner drains will substantially reduce water clogging at the intersection thus improving local sanitation.

b.(2) ENVIRONMENTAL IMPACT ASSESSMENT OF JATRABARI FLY-OVER SITE

AIR POLLUTION	NOISE POLLUTION	WATER POLLUTION	SOIL POLLUTION	BIOLOGICAL ENVIRONMENT	SOCIO-CULTURAL ENVIRONMENT	HEALTH ENVIRONMENT
Air pollution of this fly-over site is worse because of acute traffic jam. The routes e.g. Dhaka-Chittagong Highway, Dhaka-Mawa Highway, Dhaka-Narayangonj road, Dhaka-Demra road meet together at this Jatrabari junction and huge number vehicles of all categories (approx. 37,230 nos) plying on these roads are to cross this intersection, causing such traffic jam. This traffic jam is further enhanced by Saidabad inter-district bus terminal. Although no monitoring result of air pollution at this site is available but it may be presumed that it might be exceeded above the standard level. If this air pollution problem is not prevented immediately, this may aggravate further in near future posing a threat to human health causing increase of mortality and morbidity in the surrounding areas.	Regarding noise pollution of this flyover site, it is mentioned that high traffic noise is perceived from the high sound of old engines and hydraulic horns of buses and trucks plying per day. Because the traffic flow count at this intersection revealed that 37,230. Nos vehicles approximately are used to ply/day at this point causing high traffic thickness plus heavy traffic jam due to traffic mis-management are the main causes of such noise pollution. Noise recorded by DUTP II on 21st June 1998, at this site was 80 dBA during peak-hours against standard level 65 dBA. The vehicle driver, passengers, shop-keepers, pedestrians and other residents of this area are the main victims of noise pollution because they are to face the exposure of such high level of noise pollution, every day, and thus affecting their health.	During traffic congestion at this road intersection, the spillage of fuel and lubricating oil from the running vehicles are very minimal and possibilities of water pollution is very less. No specific water and soil sample test report is available regarding pollution caused by the spillage of fuel, lubricants etc. from the motor vehicles.	The spillage of fuel, lubricating oils etc. from the running vehicles at this intersection are very minimal and hence possibilities of soil pollution by leaching is very less.	As this proposed flyover will be constructed on the existing Dhaka-Chittagong Highway, there exists no such biological issues e.g. habitats of birds, water sheds, lakes etc. which are likely to be tampered. But some 53 Nos planted trees (17 coconut trees, 8 jack-fruit trees, 6 mango trees and rest other trees) are existing along two sides of road may be affected by this project component. These trees are contributing positive impact to biological environment upkeeping the urban ecology of Dhaka city.	As mentioned above, this flyover will be constructed on the existing road and as such no socio-cultural issues are existed on the flyover alignment. But some Mosques, schools, community centers are existing along the roads which are impacted by air and noise pollution at present.	At this intersection, roadside drains are found blocked by the garbage and wastes dropped by the road side hawkers and shop-keepers. As a result water logging takes place at different points causing breeding ground of mosquitoes. Again garbage are decomposed and foul smell is emitted. In most places road side drains are polluted by defecation and urination, by the floating peoples and squatters. As a result health environment is deteriorated by the poor sanitation at every intersection.
Impact: Reduced traffic congestion will substantially reduce air pollution at the intersections.	Impact: Reduced traffic congestion will substantially reduce noise pollution at the intersections.	Impact: Reduced traffic congestion will substantially reduce spillage at the intersections thus reducing toxic pollution	Impact: Reduced traffic congestion will substantially reduce spillage at the intersections thus reducing toxic lubricant wastes polluting the soils.	Impact: Proposed improvements in the intersection geometry will not affect trees of economic importance. The smaller plants will be re-planted along the sidewalks.	Impact: Proposed improvements will not have any negative impact on this issue.	Impact: Reduced traffic congestion and physical improvement to the footpath and corner drains will substantially reduce water clogging at the intersection thus improving local sanitation.

b.(3) ENVIRONMENTAL STATUS OF SONARGAON FLY-OVER SITE

AIR POLLUTION	NOISE POLLUTION	WATER POLLUTION	SOIL POLLUTION	BIOLOGICAL ENVIRONMENT	SOCIO-CULTURAL ENVIRONMENT	HEALTH ENVIRONMENT
Air pollution situation of this fly over site is very worse because of acute traffic congestion at Sonargaon Road intersection. This intersection links new Air Port Road crossed by Sonargaon –Pantha Path road and linked by Rupsha Road. During peak traffic hours, traffic congestion is found maximum and vehicular exhaust emission creates smog in the route corridor with blue haze resulting severe air pollution. The DOE have no monitoring result of air pollution of this intersection but it may be presumed that pollutant concentration levels might be exceeded for above the standard level of Bangladesh.	Regarding noise pollution at this intersection, it is mentioned that more than 80,000 vehicles are used to ply per day at this point and high sound of old engines and hydraulic horns of buses and trucks are perceived. Noise recorded by DUTP II on 21st June 1998, at this site was 93 dBA during peak-hours against standard level 65 DbA. The exposure of this noise level is detrimental to human health and causes adverse impact to the health of the city peoples.	During traffic congestion at this road intersection, the spillage of fuel and lubricating oil from the running vehicles are very minimal and possibilities of water pollution is very less. No specific water and soil sample test report is available regarding pollution caused by the spillage of fuel, lubricants etc. from the motor vehicles.	The spillage of fuel, lubricating oils etc. from the running vehicles at this intersection are very minimal and hence possibilities of soil pollution by leaching is very less.	No watershed or fish pond will be transferred by this component but road side planted trees and a portion of children park about 10'-0" near Sonargaon intersection and a portion of "Fairly House" about-10'-0" will be affected causing destraction of 162 trees (approx). These trees are playing valuable rote to uphold Urban ecology of Dhaka City. Again 8 big trees at the Eskaton Road attached to a "NAVAL" building is the habitats of wild birds of Urban area and Contributing positive impact to the Urban ecology and acting as filter media of air pollution. So removal of these trees may create serious adverse impact to the environment.	The proposed fly over will be constructed on the existing New Air Port Road over the Sonargaon Road Round about, no mosque or temple or historic sites will be tampered but a portion of recreational park will be affected. Again one underpass and one ornamental "SAARC" fountain of political issue will be affected which are very serious impacts to be addressed very carefully. Therefore this site require environmental design by optimization of alignment to avoid these adverse impact	The existing health environment of this is not so bad as of other two fly over sites, because road side hawkers and squatters are not existing in this intersection.
Impact: Reduced traffic congestion will substantially reduce air pollution at the intersections	Impact: Reduced traffic congestion will substantially reduce noise pollution at the intersections. But the noise levels at mult-storey buildings may be increased. Sound barriers will have to be in-built with the structure.	Impact: Reduced traffic congestion will substantially reduce spillage at the intersections thus reducing toxic pollution	Impact: Reduced traffic congestion will substantially reduce spillage at the intersections thus reducing toxic lubricant wastes polluting the soils.	Impact: Proposed improvements in the intersection geometry will not affect trees of economic importance. The smaller plants will be re-planted along the sidewalks.	Impact: Affected squatters abutting the existing road reserve south of the Sonargaon Hotel will need to be removed. A strip of parkland along Kazi Nazrul Islam Avenue will be lost for the flyover construction.	Impact: Reduced traffic congestion and physical improvement to the footpath and corner drains will substantially reduce water clogging at the intersection thus improving local sanitation.

c. ENVIRONMENTAL IMPACT ASSESSMENT OF FOOT OVERPASS SITES

Foot Overpasses :

1. On Mirpur Road near Asadgate
2. On Panthapath/Mirpur Road
3. On New Airport Road near West Tezturi Bazar Mosque

AIR POLLUTION	NOISE POLLUTION	WATER POLLUTION	SOIL POLLUTION	BIOLOGICAL ENVIRONMENT	SOCIO-CULTURAL ENVIRONMENT	HEALTH ENVIRONMENT
Air pollution at these three sites is worse because of acute traffic jam. There is a huge number vehicles of all categories plying on these roads causing traffic jam. Although no monitoring result of air pollution at this site is available but it may be presumed that it might be exceeded above the standard level. If this air pollution problem is not prevented immediately, this may aggravate further in near future posing a threat to human health causing increase of mortality and morbidity in the surrounding areas.	Regarding noise pollution of these three foot overpasses site, it is mentioned that high traffic noise is perceived from the high sound of old engines and hydraulic horns of buses and trucks plying on this road plus heavy traffic jam due to traffic mis-management are the main causes of such noise pollution. From the traffic pattern it is presumed that noise level may exceed 100 dBA at this point during peak traffic hours. The vehicle driver, passengers, shop-keepers, pedestrians and other residents of this area are the main victims of noise pollution because they are to face the exposure of such high level of noise pollution, every day, and thus affecting their health.	During traffic congestion at these sites, the spillage of fuel and lubricating oil from the running vehicles are very minimal and possibilities of water pollution is very less.	The spillage of fuel, lubricating oils etc. from the running vehicles at these sites are very minimal and hence possibilities of soil pollution by leaching is very less.	As these proposed foot overpasses will be constructed on the existing roads, there exists no such biological issues e.g. habitats of birds, water sheds, lakes etc. which are likely to be tampered. These trees are contributing	These foot overpasses will be constructed on the existing road and as such no socio-cultural issues are tampered with on the overpasses' alignment. But some Mosques, schools, community centers are existing along the roads which are impacted. There are instances of greater number of road accident fatalities during road crossings by the pedestrians. The construction of these overpasses will greatly contribute to safety for pedestrian traffic and resulting in smoother vehicular movement which eventually will help reduce air and noise pollution.	At this intersection, roadside drains are found blocked by the garbage and wastes dropped by the road side hawkers and shop-keepers.. As a result water logging takes place at different points causing breeding ground of mosquitoes. Again garbage are decomposed and foul smell is emitted. In most places road side drains are polluted by defecation and urination, by the floating peoples and squatters. As a result health environment is deteriorated by the poor sanitation at every intersection.
Impact: Reduced traffic congestion will substantially reduce air pollution at the intersections	**Impact:** Reduced traffic congestion will substantially reduce noise pollution at these sites.	**Impact:** No negative impact.	**Impact:** No negative impact.	**Impact:** Proposed improvements will not have negative impact except a few trees will have to be removed . The smaller plants will be re-planted along the sidewalks.	**Impact:** No negative impact.	**Impact:** Reduced traffic congestion and physical improvement to the footpath and corner drains will substantially reduce water clogging at the intersection thus improving local sanitation.

d. ENVIRONMENTAL STATUS OF NMT LINK ROAD SITES

NMT Link Road Sites :

(i) Crossing of North Banani Lake
Connecting Rd. No. 18 of Banani & Road No. 62 of Gulshan.

(ii) Crossing of South Banani Lake
Connecting Road No.-11 of Banani & Rd. No. 41 of Gulshan.

(iii) Link from Mohakhali to Rd. No. 01 of Banani

AIR POLLUTION	NOISE POLLUTION	WATER POLLUTION	SOIL POLLUTION	BIOLOGICAL ENVIRONMENT	SOCIO-CULTURAL ENVIRONMENT	HEALTH ENVIRONMENT
There is no air pollution at these three sites as there is no traffic movement. Exceeded above the standard level. If this air pollution problem is not prevented immediately, this may aggravate further in near future posing a threat to human health causing increase of mortality and morbidity in the surrounding areas.	There is no noise pollution of these three NMT Link Road sites.	As the NMT road links will cater for non-motorized traffic, there is possibility of any sort of water pollution.	There is possibility of any soil pollution from these sites	No road side trees or any vegetation will be tampered by these components. But the existing Banani lake will be crossed by these components hampering the flow of lake. As the lake has lost its recreational value at present, no social environment will be lost. No fish culture structure or fish hatchery will be affected by these link roads.	No such relics, graveyards, mosques, temples, sensitive objects, govt. reserved spots, recreational spots – etc. are tampered by these components.	There is no probable health hazard problems from these sites.
Impact: No negative impact.	**Impact:** No negative impact.	**Impact:** No negative impact.	**Impact:** No negative impact	**Impact:** Proposed improvements will not have significant negative impact except some loss of lake surface will occur at North Banani Lake crossing.	**Impact:** Some squatters will be affected and require removal..	**Impact:** The alignment at Banani-Mohakhali Link follows an embankment that ispoorly maintained and subject to erosion. Physical improvement to the drains will substantially reduce water clogging in the area thus improving local sanitation.

e. ENVIRONMENTAL STATUS OF NMT UNDERPASS SITES

NMT Underpass Sites :

(i) Uttara at Sector-7
(ii) Banani-Road No.-11
(iii) Tejgaon Industrial Area

AIR POLLUTION	NOISE POLLUTION	WATER POLLUTION	SOIL POLLUTION	BIOLOGICAL ENVIRONMENT	SOCIO-CULTURAL ENVIRONMENT	HEALTH ENVIRONMENT
At each site, traffic jam is caused when NMTs cross the main road and the prolonged stay causies air pollution for a short duration. But this type of traffic interference may occur several times per day and if delay at each cycle is half minute, then total delay time may be high. Although this exposure of air is intermittent it has detrimental impact upon the health of the road users: drivers, passengers, pedestrian and footpath hawkers etc. NMT underpasses is designed to free the main roadway, thereby achieving greater vehicular speed which, at the end, will result in reduced air pollution.	At each site, traffic jam is caused when NMTs cross the main road causing noise pollution. Although this exposure of noise is intermittent but it has detrimental and slow impact upon the health of the drivers, passengers, pedestrian and footpath hawkers etc. NMT underpasses will allow greater ease in traffic flow which will eventually help reducing noise levels resulting from horns and old engines.	NMT underpasses will not cause any water pollution to the surroundings.	NMT underpasses will not pose any pollution threat to the soil.	As these sites are on the existing Road flanks, no potential environmental elements are present on these sites. But few road side planted trees about 13 Nos. at Banani site will be affected & one Nursery garden will be affected at Uttara site. The road side trees have got vital role upon the urban ecology. But the nursery garden has occupied road side spaces unauthorisedly.	No socio-cultural objectives are affected in any of these sites except two dust-bins at two road sites. After construction of these NMT underpasses, road crossing will be very easy for NMTs at these points which will reduce road accidents and will reduce traffic obstruction resulting in lower levels of air and noise pollution.	There is no probable health hazard problems from these sites. As the NMT underpasses will be on grade with the side roads, there will be no waterlogging causing threat to public health and sanitation.
Impact: No negative impact. The area suffers from vehicular pollution which will be partly reduced by improved traffic flow.	Impact: No negative impact. The area suffers from vehicular noise pollution which will be partly reduced by improved traffic flow.	Impact: No negative impact	Impact: No negative impact	Impact: No significant negative impact except some existing smaller trees may need be re-planted at Uttara site..	Impact: No negative impact	Impact: The area suffers from pollution from bad drainage and sanitation. These will be offset by Ismoother traffic flow.

f. ENVIRONMENTAL IMPACT ASSESSMENT OF FOOTPATH IMPROVEMENT SITES

Pedestrian of Dhaka City is deprived from foot-path facilities since past and they had to walk along the two sides of road with great risk of accidents. This pattern of pedestrian traffic flow constricts the main roads causing interruption of vehicular traffic flow and traffic delay. To reduce the above traffic problems, development of foot-path has been given priority under the road development ad traffic engineering management program. Under this DUTP-II. 10 (ten) road sections, for foot-path improvement have been taken up for detailed engineering and implementation as follows :

(i) Atish Depankar Road/ Bishwa Road
(ii) Zoo Road, Mirpur
(iii) Mazar Road, Mirpur
(iv) Elephant Road
(v) Sayedabad Road
(vi) Rampura Road
(vii) Shahid Bashar Road, Cantonment Area, Banani
(viii) Gabtali Road, Dhaka Aricha Road
(ix) Kallyanpur Road, Dhaka - Aricha Road
(x) Gulshan Avenue - Shooting Club to Gulshan - II

AIR POLLUTION	NOISE POLLUTION	WATER POLLUTION	SOIL POLLUTION	BIOLOGICAL ENVIRONMENT	SOCIO-CULTURAL ENVIRONMENT	HEALTH ENVIRONMENT
No air pollution factor will be affected by the improvement of these footpaths. **Impact:** No negative impact.	No considerable noise pollution improvement will be effected by the improvement of these footpaths. **Impact:** No negative impact.	These footpath improvement works will have no bearing on water pollution. **Impact:** No negative impact.	These footpath improvement works will have no impact on soil pollution. **Impact:** No negative impact.	As these foot-paths will be developed on the existing space along the road, no other biological environmental issues are found present except large numbers of road side trees. Out of these trees, some are big trees and habitats of wild birds and small animals and thus playing a significant role in urban ecology. The smaller trees are playing an important and very positive role as filter media for air pollutants, dust and noise thus protecting the urban environment. A very careful design has been made to protect these trees, both big and smaller, as far as feasible **Impact:** No negative impact. Some trees need to be re-planted..	As these footpaths will be developed on the existing space along the roads, there is no scope to tamper with objects of social and cultural importance. **Impact:** No negative impact.	The provision of proper footpaths with proper roadside drains will help to achieve improved maintenance and cleaning of the roads which will provide better health environment. **Impact:** No negative impact.

g. ENVIRONMENTAL IMPACT ASSESSMENT OF DEVELOPMENT OF INTER-DISTRICT BUS TERMINALS

The following inter-district bus terminals have been taken up for development as below:

(i) Gabtoli
(ii) Mohakhali
(iii) Saidabad
(iv)

As these improvement works will be done on the existing locations, no physical, biological and social environmental elements will be affected. The following environmental elements are found present affecting human health.

AIR POLLUTION	NOISE POLLUTION	WATER POLLUTION	SOIL POLLUTION	BIOLOGICAL ENVIRONMENT	SOCIO-CULTURAL ENVIRONMENT	HEALTH ENVIRONMENT
The constant traffic jam is observed in front of each bus terminal and vehicular exhaust emission in the form of thick black smoke from old diesel driven buses and as such thousand of passengers of these bus terminals are the victims of such severe air pollution. **Impact:** No negative impact	Noise pollution is observed in front of each bus terminals which results from blowing hydraulic horns by the bus drivers and high sound from old diesel engines. During traffic jam the measured noise levels are observed to exceed standard limits e.g. 60 dBA to 70 dBA and long exposures to such high noise level affect the health of passengers and operators of these bus terminals. **Impact:** No negative impact	There is no specific bus repairing workshops existing in any bus-terminal compounds. The defective buses are repaired in the open vacant spaces and during repairing, spillage of fuels and lubricants are caused which flows into surface drains and pollute both surface water and ground water sources with a threat of contamination of drinking water supply. **Impact:** No negative impact	The rampant repairing works of defective buses in the open vacant spaces causes spillage of fuels and lubricants which enter into soil by leaching which pollute ground water sources causing loss of soil fertility of urban area. **Impact:** No negative impact	As these proposed bus terminals will be constructed on the existing sites , there exists no such biological issues e.g. habitats of birds, water sheds, lakes etc. which are likely to be tampered. These trees are contributing **Impact:** No negative impact	This environmental issues refer to heritage sites, archaeological sites, monuments, mosques, temples, grave yard, recreational parks or lakes & sensitive spots etc. But the development of existing terminal improvement works have no impact upon this issue. **Impact:** No negative impact. The bus terminals with improved facilities and activities will enhance social interaction as it will provide better social benefits.	The inside surface drains within the terminal compound blocked by the refuse thrown from the restaurants and by the hawkers and passengers. As these drains are not regularly cleaned and garbages not removed to a safer distance. Poor sanitation is also caused by the vehicle washing wastes, which cloggs the drain causing foul smell. These water stagnancy act as mosquito breeding centres inside the bus-terminal compound affecting the people by vector diseases. Again, the existing public toilets are very very inadequate and can not serve the existing increased passengers. Very poor sanitation condition exists in each passenger toilets which is full of foul smell and practically unusable. The surface drains are polluted by defecation and urination by the floating people causing unhygienic atmosphere inside the bus-terminal compound, affecting the health of the passengers. **Impact:** No negative impact

(h) ENVIRONMENTAL IMPACT ASSESSMENT OF DEVELOPMENT OF CITY BUS TERMINALS

(i) Fulbaria Bus Terminal
(ii) Gulistan Bus Terminal

AIR POLLUTION	NOISE POLLUTION	WATER POLLUTION	SOIL POLLUTION	BIOLOGICAL ENVIRONMENT	SOCIO-CULTURAL ENVIRONMENT	HEALTH ENVIRONMENT
The constant traffic jam is observed in front of each bus terminal and vehicular exhaust emission in the form of thick black smoke from old diesel driven buses and as such thousand of passengers of these bus terminals are the victims of such severe air pollution.	Noise pollution is observed in front of each bus terminals which results from blowing hydraulic horns by the bus drivers and high sound from old diesel engines. During traffic jam the measured noise levels are observed to exceed standard limits e.g. 60 dBA to 70 dBA and long exposures to such high noise level affect the health of passengers and operators of these bus terminals.	There is no specific bus repairing workshops existing in any bus-terminal compounds. The defective buses are repaired in roadside workshops and during repairing, spillage of fuels and lubricants are caused which flows into surface drains and pollute both surface water and ground water sources with a threat of contamination of drinking water supply.	The rampant repairing works of defective buses in roadside workshops causes spillage of fuels and lubricants which enter into soil by leaching which pollute ground water sources causing loss of soil fertility of urban area.	As these proposed bus terminals will be constructed on the existing sites, there exists no such biological issues e.g. habitats of birds, water sheds, lakes etc. which are likely to be tampered.	This environmental issues refer to heritage sites, archaeological sites, monuments, mosques, temples, grave yard, recreational parks or lakes & sensitive spots etc. But this improvement works have no impact upon this issue.	The surface drains along the terminals are blocked by the refuse thrown from the shops and by the hawkers and passengers. As these drains are not regularly cleaned and garbage not removed to a safer distance. Poor sanitation is also caused by the vehicle washing wastes, which clogs the drain causing foul smell.
Impact: Bus terminals with better traffic management will ease congestion and result in reduced air pollution. No negative impact	**Impact:** Bus terminals with better traffic management will ease congestion and result in reduced noise pollution. No negative impact	**Impact:** No negative impact	**Impact:** No negative impact	**Impact:** No negative impact	**Impact:** No negative impact	**Impact:** The sites will be more visible, acceptable and with better toilet and drainage improvements, will result in overall improved sanitation conditions on-site. No negative impact envisaged.

i) ENVIRONMENTAL STATUS ASSESSMENT OF DEVELOPMENT OF TRUCK PARKS & DEPOTS

The following 5 Nos. truck terminal and depots have been taken for development as below:

i) Tejgaon Truck Park
ii) Pagla Truck Park
iii) Mohammadpur Truck Park
iv) Amin Bazar Truck Park
v) Matuail Truck Park

AIR POLLUTION	NOISE POLLUTION	WATER POLLUTION	SOIL POLLUTION	BIOLOGICAL ENVIRONMENT	SOCIO-CULTURAL ENVIRONMENT	HEALTH ENVIRONMENT
The constant traffic jam is observed in front of each truck depots and vehicular exhaust emission in the form of thick black smoke from old diesel driven trucks pose threat to users and operators of these truck depots. Removal of on-street truck parking and creation of off-street truck parking facilities will reduce traffic congestion in the surrounding area thus reducing air pollution from vehicular sources.	Noise pollution is observed in front of each truck parks which results from blowing hydraulic horns by the truck drivers and high sound from old diesel engines. Removal of on-street truck parking and creation of off-street truck parking facilities will reduce traffic congestion in the surrounding area thus reducing noise pollution from vehicular sources.	There is no repairing workshops existing in any of the truck parks. The defective trucks are repaired either on-site or in roadside workshops and during repairing, spillage of fuels and lubricants are caused which flows into surface drains and pollute both surface water and ground water sources with a threat of contamination of drinking water supply.	The rampant repairing works of defective trucks in on-site workshops causes spillage of fuels and lubricants which enter into soil by leaching which pollute ground water sources causing loss of soil fertility of urban area.	No major biological environment threat is envisaged in these truck depots except at Pagla Truck Depot where the extension area will cover a portion of an existing lake which is used for fisheries. Damage to the existing flora and fauna will be minimal. The proposed site for Amin Bazar Truck Park is nothing but the expansion of the present one to the west covering one low area which act as a drainage channel coming from the north. Blocking this drainage channel may cause tremendous back flow at the upper-side causing impact upon human habitations and crops and live stocks etc. Before selecting this site, the hydrological viability may be studied for the better environmental protection.	No such relics, graveyards, mosques, temples, sensitive objects, govt. reserved spots, recreational spots – etc. are tampered by these components.	Adequate sanitation facilities are non-existent in these truck parks which results in very unhygienic environment in these sites. Poor sanitation is also caused by the vehicle washing wastes, which clogs the drain causing foul smell.
Impact: Truck terminals with better traffic management will ease congestion on the main roads and result in reduced air pollution. No negative impact envisaged.	Impact: Truck terminals with better traffic management will ease congestion and result in reduced noise pollution. No negative impact envisaged.	Impact: No negative impact envisaged.	Impact: No negative impact envisaged.	Impact: No negative impact envisaged.	Impact: No negative impact envisaged.	Impact: The sites will be more organized, acceptable and with better toilet and drainage improvements, will result in overall improved sanitation conditions on-site. No negative impact envisaged.

ANNEXURE D: Environmental Impact Value Matrix

'Without Project' Scenario
'With Project' Scenario

EMISSION LEVEL MATRIX FOR THE SELECTED TWENTY FIVE INERSECTIONS

(WITH DISPERSION HEIGHT OF 100M)

INTERSECTION LOCATION	VEHICLE TYPE										TOTAL EMISSION DURING PEAK HOUR(gm)					AREA (SQM.)	CONCENTRATION within Intersection volume(100m height) (µg/cu.m)					CHANGE IN EMISSION LEVEL(%)				
	HEAVY	Emission Factor(E.F.)(gm/km)	AUTO-TAXI	Emission Factor(E.F.)(gm/km)	CAR	Emission Factor(E.F.)(gm/km)	AUTO-RICK.	Emission Factor(E.F.)(gm/km)	MOTOR CYCLE	Emission Factor(E.F.)(gm/km)	TOTAL	CO	SO_2	NO_x	HC	SPM		CO	SO_2	NO_x	HC	SPM	CO	SO_2	NO_x	HC	SPM
	1993 1998		1993 1998		1993 1998		1993 1998		1993 1998		1993 1998	1993 1998	1993 1998	1993 1998	1993 1998	1993 1998	1993 1998	1993 1998	1993 1998	1993 1998	1993 1998	1993 1998	1993 1998	1993 1998	1993 1998	1993 1998	1993 1998
ZERO POINT	7684		675		9359		11427		4172		33317	2025	49	727	575	57	1004	20178	492	7246	5728	568	-8.86	-8.11	-8.85	-1.92	-8.42
	9056		1175		9827		15541		4381		39980	3035	75	1090	927	86	1650	18391	452	6604	5618	520					
DHOLAIKHAL-NAWABPUR	3214		1754		2201		6114		2057		15340	531	13	190	197	16	420	12646	318	4523	4702	373	28.95	135.08	132.21	19.14	76.57
	10046		3052		2311		8315		2160		25884	1106	51	712	380	45	678	16307	747	10502	5602	658					
BALDHA GARDEN	7483	12.70	3062	12.00	2223	25.00	4482	12.00	1622	8.30	18872	604	28	388	194	22	360	16773	764	10786	5395	622	-5.72	-30.44	-30.55	9.06	135.64
	6104	(CO)	5328	(CO)	2334	(CO)	6096	(CO)	1703	(CO)	21565	814	27	386	303	27	515	15814	532	7491	5884	523					
GOLAPSHAH MAZAR	4452		701		2791		10992		2201		21137	956	24	343	365	28	720	13272	336	4767	5065	389	-20.57	-8.97	-23.33	0.57	-6.98
	5260		1220		2931		14949		2311		26671	1291	37	448	624	44	1225	10541	306	3655	5094	362					
N-S.RD/ENGLISH RD.	26885		2413		2048		6736		2284		40366	1712	134	1876	448	99	690	24811	1939	27186	6489	1430	58.44	-60.76	-57.70	69.52	-32.05
	12647		5570		22723		22909		3758		67607	4717	91	1380	1320	117	1200	39310	761	11499	11001	972					
KATABON	4619		524		15261		14847		3211		38462	1874	24	379	499	39	530	35363	448	7285	9416	742	-7.07	-21.62	-17.00	-21.88	-13.63
	3846		301		18398		10917		3058		36538	2136	23	386	480	42	650	32864	351	5941	7385	641					
NEW MARKET	19960		713		10420		6318		2377		39788	2431	121	1739	512	100	990	24555	1222	17562	5176	1013	-40.26	-76.77	-75.34	-28.50	-64.25
	5608		1241		10941		8592		2496		28878	2479	48	732	625	61	1690	14670	284	4331	3701	362					
MOHAKHALI FLY-OVER SITE	12081	1.50	3277	0.03	25613	0.05	18302	0.03	2971	0.02	62244	8728	163	2518	2104	208	4200	20780	389	5995	5009	496	-6.26	-2.74	-4.70	7.49	-3.36
	12897	(SO_2)	5570	(SO_2)	22723	(SO_2)	22909	(SO_2)	3758	(SO_2)	67857	9791	190	2872	2706	241	5026	19480	378	5714	5384	479					
AIRPORT ROAD/GULSHAN	10759		3201		21641		16845		3579		56025	3840	73	1113	964	93	1050	36567	692	10600	9185	885	6.51	7.67	6.30	17.35	7.56
	12647		5570		22723		22909		3758		67607	4869	93	1409	1347	119	1250	38949	746	11272	10778	952					
BANGLA MOTOR	11061		2845		30952		26174		3478		74611	4709	70	1101	1192	102	850	55403	821	12952	14019	1206	-21.40	1.49	-2.70	-14.04	-11.69
	12647		5570		22723		22909		3797		68609	4355	83	1260	1205	106	1000	43546	834	12602	12051	1065					
MOGHBAZAR	10067		2277		22165		23291		3763		61563	3057	51	788	832	71	575	53172	892	13697	14469	1230	-11.49	-11.90	-13.02	-2.93	-11.17
	11676		3962		23273		21676		3951		74538	4706	79	1191	1404	109	1000	47061	786	11914	14044	1092					
MOUCHAK	9439		3072		10383		13852		3621		40367	3249	81 99	1187	970	92	1800	18049	450	6592	5390	510	13.47	9.94	9.09	23.97	12.05
	10896		5345		10902		18839		3802		49784	4096		1438	1336	114	2000	20479	495	7191	6681	571					
KAKRAIL	9439	21.00	3072	0.26	10383	2.00	13852	0.26	3621	0.10	40367	2397	60	876	716	68	980	24461	610	8934	7304	691	63.75	10.85	14.58	64.85	35.23
	11485	(NO_x)	1218	(NO_x)	22305	(NO_x)	33845	(NO_x)	3751	(NO_x)	72604	5207	88	1331	1565	121	1300	40055	676	10237	12042	934					
TOPKHANA	10475		586		8895		15948		2766		38670	2127	62	894	643	65	870	24443	709	10270	7394	742	-12.22	-13.15	-13.70	-5.58	-12.51
	12321		1020		9340		21689		2904		47247	3433	99	1418	1117	104	1600	21456	616	8863	6981	650					
MALIBAGH	7694		2728		9704		11000		2920		34046	2066	49	721	593	57	975	21188	501	7400	6080	580	9.98	-0.82	-1.23	21.72	5.25
	8005		4747		10189		14960		3066		40967	2563	55	804	814	67	1100	23304	497	7308	7401	610					
FAKIRAPOOL	3589		3197		12649		17217		3350		40002	2496	26	418	787	50	990	25210	267	4223	7947	509	14.08	13.12	10.59	25.15	14.43
	4261		5563		13282		23415		3518		50039	3164	33	514	1094	64	1100	28760	302	4671	9946	583					
SHAPLA CHATTAR	8410		617		13172		12492		2187		36878	5128	115	1732	1302	134	4500	11396	256	3849	2892	298	9.39	11.06	9.97	19.03	10.63
	9882		1074		13830		16989		2296		44071	6266	143	2128	1731	166	5027	12466	284	4233	3443	330					
RAJAR BAGH	2667	2.10	4501	7.00	6467	2.73	7964	7.00	3198	4.50	24797	1229	16	240	413	27	700	17560	226	3425	5901	388	3.82	-0.98	-2.78	14.44	2.43
	3118	(HC)	7832	(HC)	6791	(HC)	10831	(HC)	3358	(HC)	31930	1823	22	333	675	40	1000	18231	224	3330	6753	398					
ITTEFAQ	6916		1062		4585		6375		1961		20899	935	33	475	267	32	590	15849	560	8056	4525	540	9.26	7.74	7.20	18.05	8.52
	8105		1848		4814		8670		2059		25496	1212	42	604	374	41	700	17320	603	8635	5341	586					
SAIDABAD	14366		3870		4471		11758		2210		36675	1518	68	956	491	60	590	25736	1147	16206	8322	1009	13.73	6.20	5.84	23.24	9.17
	16549		6734		4695		15991		2321		46290	2049	85	1201	718	77	700	29269	1218	17153	10257	1102					
KHILGAON	4083		4016		5883		6319		2115		22416	1106	22	326	346	28	675	16382	326	4831	5124	419	1.13	-5.14	-6.17	12.43	-1.20
	4669		6988		6177		8594		2221		28649	1657	31	453	576	41	1000	16568	310	4533	5761	414					
JATRABARI FLY-OVER SITE	12452		3637		4539		11914		1451		33993	1428	59	834	467	53	590	24201	999	14140	7921	900	-57.49	-60.54	-33.14	-53.80	-59.25
	14267		6328		4766		16203		1524		43088	5169	198	2793	1839	184	5025	10287	394	5557	3660	367					
BIJOY NAGAR	7225	1.00	581	0.20	23601	0.33	27851	0.20	3595	0.29	62817	4263	53	837	1193	88	1050	40596	501	7972	11363	838	8.94	10.58	8.51	18.92	10.16
	8557	(SPM)	1011	(SPM)	24781	(SPM)	37828	(SPM)	3775	(SPM)	75952	5307	67	1038	1622	111	1200	44225	554	8651	13513	924					
KADAM CHATTAR	8932		361		11565		13283		3388		37529	3108	76	1122	842	86	1750	17761	433	6412	4813	492	6.27	8.13	7.18	14.62	7.43
	10593		628		12413		18065		3557		44986	3964	98	1443	1159	111	2100	18874	468	6873	5517	528					
SONAR GAON FLY-OVER SITE	13968		3163		35576		30892		7376		90975	8590	134	2091	2225	194	2000	42951	671	10456	11125	969	-2.22	-0.36	-1.86	7.04	-1.05
	16501		5504		37355		42013		7745		109118	11760	187	2873	3334	268	2800	42000	668	10261	11908	959					

ANNEXURE C: **Emission Level Matrix**

(Summary Spreadsheet Containing Emission Calculations with Assumed Dispersion Height of 100m)

Annexure-B

EMISSION LEVEL MATRIX FOR THE SELECTED TWENTY FIVE INERSECTIONS

(WITH DISPERSION HEIGHT OF 15M)

INTERSECTION LOCATION	VEHICLE TYPE										TOTAL EMISSION DURING PEAK HOUR(gm)					AREA (SQM.)	CONCENTRATION within intersection volume(15m height) (µg/cu.m)					CHANGE IN EMISSION LEVEL(%)				
	HEAVY	Emission Factor(E.F.)(gm/km)	AUTO-TAXI	Emission Factor(E.F.)(gm/km)	CAR	Emission Factor(E.F.)(gm/km)	AUTO-RICK	Emission Factor(E.F.)(gm/km)	MOTOR CYCLE	Emission Factor(E.F.)(gm/km)	TOTAL	CO	SO_2	NO_x	HC	SPM		CO	SO_2	NO_x	HC	SPM	CO	SO_2	NO_x	HC	SPM
	1993 1998		1993 1998		1993 1998		1993 1998		1993 1998		1993 1998	1993 1998	1993 1998	1993 1998	1993 1998	1993 1998	1993 1998	1993 1998	1993 1998	1993 1998	1993 1998	1993 1998	1993 1998	1993 1998	1993 1998	1993 1998	1993 1998
ZERO POINT	7684		675		9359		11427		4172		33317	2025	49	727	575	57	1004	134522	3280	48306	38187	3788					
	9056		1175		9827		15541		4381		39980	3035	75	1090	927	86	1650	122607	3014	44029	37455	3470	-8.86	-8.11	-8.85	-1.92	-8.42
DHOLAIKHAL-NAWABPUR	3214		1754		2201		6114		2057		15340	531	13	190	197	16	420	84306	2120	30150	31347	2485					
	10046		3052		2311		8315		2160		25884	1106	51	712	380	45	678	108715	4983	70012	37347	4387	28.95	135.08	132.21	19.14	76.57
BALDHA GARDEN	7483	12.70	3062	12.00	2223	25.00	4482	12.00	1622	8.30	18872	604	28	388	194	22	360	111822	5094	71903	35967	1487					
	6104	(CO)	5328	(CO)	2334	(CO)	6096	(CO)	1703	(CO)	21565	814	27	386	303	27	515	105424	3544	49938	39226	3488	-5.72	-30.44	-30.55	9.06	135.6
GOLAPSHAH MAZAR	4452		701		2791		10992		2201		21137	956	24	343	365	28	720	88480	2241	31781	33766	2593					
	5260		1220		2931		14949		2311		26671	1291	37	448	624	44	1225	70277	2040	24365	33960	2412	-20.57	-8.97	-23.33	0.57	-6.98
N.S.RD/ENGLISH RD.	26885		2413		2048		6736		2284		40366	1712	134	1876	448	99	690	165406	12929	181238	4326	9534					
	12647		5570		22723		22909		3758		67607	4717	91	1380	1320	117	1200	262068	5073	76659	7337	6479	58.44	-60.76	-57.70	69.52	-32.0
KATABON	4619		524		15261		14847		3211		38462	1874	24	379	499	39	530	235752	2989	47723	62770	4945					
	3846		301		18398		10917		3058		36538	2136	23	386	480	42	650	219091	2343	39608	49234	4271	-7.07	-21.62	-17.00	-21.88	-13.6
NEW MARKET	19960		713		10420		6318		2377		39788	2431	121	1739	512	100	990	163702	8144	117081	34507	6752					
	5608		1241		10941		8592		2496		28878	2479	48	732	625	61	1690	97802	1892	28875	24672	2414	-40.26	-76.77	-75.34	-28.50	-64.2
MOHAKHALI FLY-OVER SITE	12081	1.50	3277	0.03	25613	0.05	18302	0.03	2971	0.02	62244	8728	163	2518	2104	208	4200	138534	2594	39969	33396	3306					
	12897	(SO_2)	5570	(SO_2)	22723	(SO_2)	22909	(SO_2)	3758	(SO_2)	67857	9791	190	2872	2706	241	5026	129865	2523	38092	35896	3195	-6.26	-2.74	-4.70	7.49	-3.36
AIRPORT ROAD/GULSHAN	10759		3201		21641		16845		3579		56025	3640	73	1113	964	93	1050	243779	4616	70669	61233	5901					
	12647		5570		22723		22909		3758		67607	4869	93	1409	1347	119	1250	259657	4970	75145	71855	6348	6.51	7.67	6.30	17.35	7.56
BANGLA MOTOR	11061		2845		30952		26174		3478		74611	4709	70	1101	1192	102	850	369353	5475	86346	93457	8037					
	12647		5570		22723		22909		3797		68609	4355	83	1260	1205	106	1000	290305	5557	84015	80337	7097	-21.40	1.49	-2.70	-14.04	-11.6
MOGHBAZAR	10067		2277		22165		23291		3763		61563	3057	51	788	832	71	575	354483	5944	91316	96459	8197					
	11676		3962		23273		21676		3951		74538	4706	79	1191	1404	109	1000	313740	5237	79427	93630	7281	-11.49	-11.90	-13.02	-2.93	-11.1
MOUCHAK	9439		3072		10383		13852		3621		40367	3249	81	1187	970	92	1800	120325	3002	43948	35931	3398					
	10896		5345		10902		18839		3802		49784	4096	99	1438	1336	114	2000	136529	3300	47943	44543	3807	13.47	9.94	9.09	23.97	12.0
KAKRAIL	9439	21.00	3072	0.26	10383	2.00	13852	0.26	3621	0.10	40367	2397	60	876	716	68	980	163071	4068	59561	48696	4605					
	11485	(NO_x)	1218	(NO_x)	22305	(NO_x)	33845	(NO_x)	3751	(NO_x)	72604	5207	88	1331	1565	121	1300	267036	4510	68248	80277	6228	63.75	10.85	14.58	64.85	35.2
TOPKHANA	10475		586		8695		15948		2766		38670	2127	62	894	643	65	870	162954	4726	68468	49291	4950					
	12321		1020		9340		21689		2904		47247	3433	99	1418	1117	104	1600	143039	4105	59087	46542	4331	-12.22	-13.15	-13.70	-5.58	-12.5
MALIBAGH	7694		2728		9704		11000		2920		34046	2066	49	721	593	57	975	141256	3341	49331	40535	3867					
	8005		4747		10189		14960		3066		40967	2563	55	804	814	67	1100	155359	3314	48723	49340	4070	9.98	-0.82	-1.23	21.72	5.25
FAKIRAPOOL	3589		3197		12649		17217		3350		40002	2496	26	418	787	50	990	168069	1781	28156	52981	3395					
	4261		5563		13282		23415		3518		50039	3164	33	514	1094	64	1100	19173	2014	31139	66304	3884	14.08	13.12	10.59	25.15	14.4
SHAPLA CHATTAR	8410		617		13172		12492		2187		36878	5128	115	1732	1302	134	4500	75973	1707	25663	19283	1989					
	9882		1074		13830		16989		2296		44071	6266	143	2128	1731	166	5027	83104	1896	28221	22952	2201	9.39	11.06	9.97	19.03	10.6
RAJAR BAGH	2667	2.10	4501	7.00	6467	2.73	7964	7.00	3198	4.50	24797	1229	16	240	413	27	700	117065	1505	22836	39340	2590					
	3118	(HC)	7832	(HC)	6791	(HC)	10831	(HC)	3358	(HC)	31930	1823	22	333	675	40	1000	121537	1490	22201	45020	2652	3.82	-0.98	-2.78	14.44	2.4
ITTEFAQ	6916		1062		4585		6375		1961		20899	935	33	475	267	32	590	105661	3732	53704	30165	3597					
	8105		1848		4814		8670		2059		25496	1212	42	604	374	41	700	115465	4021	57568	35609	3904	9.28	7.74	7.20	18.05	8.5
SAIDABAD	14366		3870		4471		11758		2210		36675	1518	68	956	491	60	590	171574	7647	108039	55481	6727					
	16549		6734		4695		15991		2321		46290	2049	85	1201	718	77	700	195128	8121	114353	68377	7344	13.73	6.20	5.84	23.24	9.1
KHILGAON	4083		4016		5883		6319		2115		22416	1106	22	326	346	28	675	109217	2176	32206	34159	2792					
	4669		6988		6177		8594		2221		28649	1657	31	453	576	41	1000	110453	2064	30220	38405	2759	1.13	-5.14	-6.17	12.43	-1.2
JATRABARI FLY-OVER SITE	12452		3637		4539		11914		1451		33993	1428	59	834	467	53	590	161339	6657	55412	52809	5997					
	14267		6328		4766		16203		1524		43088	5169	198	2793	1839	184	5025	68579	2626	37048	24399	2444	-57.49	-60.54	-33.14	-53.80	-59.2
BIJOY NAGAR	7225	1.00	581	0.20	23601	0.33	27851	0.20	3595	0.29	62817	4263	53	837	1193	88	1050	270641	3342	53150	75751	5590					
	8557	(SPM)	1011	(SPM)	24781	(SPM)	37828	(SPM)	3775	(SPM)	75952	5307	67	1038	1622	111	1200	294833	3696	57671	90086	6158	8.94	10.58	8.51	18.92	10.1
KADAM CHATTAR	8932		361		11565		13283		3388		37529	3108	76	1122	842	86	1750	118409	2885	42747	32089	3279					
	10593		628		12413		18065		3557		44986	3964	98	1443	1159	111	2100	125829	3120	45818	36779	3522	6.27	8.13	7.18	14.62	7.4
SONAR GAON FLY-OVER SITE	13968		3163		35576		30892		7376		90975	8590	134	2091	2225	194	2000	286342	4471	69704	74169	6458					
	16501		5504		37355		42013		7745		109118	11760	187	2873	3334	268	2800	279997	4455	68405	79389	6390	-2.22	-0.36	-1.86	7.04	-1.0

ANNEXURE B: **Emission Level Matrix**

(Summary Spreadsheet Containing Emission Calculations with Assumed Dispersion Height of 15m)

ENVIRONMENTAL IMPACT VALUE MATRIX

('WITH PROJECT' SCENARIO)

ENVIRONMENTAL IMPACT VALUES (I.V.)

INTERSECTION LOCATION	AIR POLLUTION				NOISE	LAND-SCAP	ROADS								INFRASTRUCRURE						PARK-ING	HUMAN WELL BEING					TOTAL I.V.
	CO	SO_2	NO_x	HC	SPM	NOISE POLLUTION	LANDSCAPE	VOLUME/CAPACITY	ENCROACHMENT	ABUTTING LANDUSE	GAS	ELECTRICITY	WATER PIPELINE	SEWERAGE	TELEPHONE	SURFACE DRAINAGE	ELECTRICITY	WATER PIPELINE	SEWERAGE	STREET LIGHTING	SOLID WASTE COLLECTION	PARKING SPACE	HEALTH	SAFETY (ACCIDENTS)	SAFETY(MUGING)	WORKING ENVIRONMENT	AREAS OF CULTURAL/HIST	
ZERO POINT	2	5	4		4	4	4	5	4	3	4	3	3	4	3	4	5	4	4	5	4	2	4	4	4	4	5	101
DHOLAIKHAL-NAWABPUR	3	1	2		3	3	4	4	4	2	3	4	2	3	4	4	5	4	4	5	4	2	4	4	4	3	1	86
BALDHA GARDEN	3	3	3		4	3	5	4	4	3	4	3	3	4	4	4	5	4	4	5	4	3	4	4	4	3	3	97
GOLAPSHAH MAZAR	4	5	4		5	2	5	4	4	3	3	2	3	4	4	4	5	4	4	5	4	2	4	4	4	3	5	100
N.S.RD/ENGLISH RD.	1	1	1		1	4	4	4	4	3	2	3	2	3	4	3	5	4	4	5	4	3	4	4	4	3	1	81
KATABON	1	5	4		3	3	3	4	5	3	3	3	3	4	3	4	5	4	4	5	4	2	4	4	4	4	1	92
NEW MARKET	3	5	4		5	2	5	4	5	3	3	4	3	4	4	4	5	4	4	5	4	3	4	4	4	4	1	100
MOHAKHALI FLY-OVER SITE	2	5	4		4	4	3	5	5	3	4	2	2	3	3	4	5	4	4	5	4	2	4	4	4	4	1	94
AIRPORT ROAD/GULSHAN	1	1	1		1	2	3	5	5	3	3	4	2	3	4	4	5	4	4	5	4	2	4	4	4	3	2	83
BANGLA-MOTOR	1	1	1		1	3	3	5	5	2	2	4	2	4	4	3	5	4	4	5	4	2	4	4	4	3	2	82
MOGHBAZAR	1	1	1		1	2	3	4	4	3	3	4	3	4	4	4	5	4	4	5	4	3	4	4	4	3	1	83
MOUCHAK	2	4	3		3	3	3	4	4	3	3	4	3	4	4	3	5	4	4	5	4	2	4	4	4	3	5	94
KAKRAIL	1	1	2		1	3	3	4	5	3	3	4	3	4	3	4	5	4	4	5	4	3	4	4	4	3	4	88
TOPKHANA	2	2	2		3	4	4	4	4	3	4	4	3	4	3	3	5	4	4	5	4	2	4	4	4	3	4	92
MALIBAGH	2	4	3		3	4	4	4	4	3	3	4	3	4	4	4	5	4	4	5	4	3	4	4	4	4	3	97
FAKIRAPOOL	1	5	4		3	3	4	4	5	3	4	4	3	4	4	3	5	4	4	5	4	2	4	4	4	4	4	98
SHAPLA CHATTAR	3	5	4		5	4	5	5	5	3	4	4	4	4	4	4	5	4	4	5	4	3	4	4	4	4	5	109
RAJAR BAGH	3	5	5		5	2	5	4	5	3	3	4	3	2	4	4	5	4	4	5	4	2	4	4	4	3	4	100
ITTEFAQ	3	2	2		3	3	3	4	4	3	4	4	2	2	3	3	5	4	4	5	4	3	4	4	4	3	4	89
SAIDABAD	1	1	1		1	3	3	5	4	3	4	3	2	2	4	4	5	4	4	5	4	2	4	4	4	3	5	85
KHILGAON	3	5	4		5	2	3	4	4	3	3	4	4	1	3	4	5	4	4	5	4	3	4	4	4	3	1	93
JATRABARI FLY-OVER SITE	4	5	4		5	4	3	5	5	3	3	3	2	2	4	3	5	4	4	5	4	2	4	4	4	4	2	97
BIJOY NAGAR	1	3	2		1	2	4	5	5	3	4	4	3	1	3	3	5	4	4	5	4	3	4	4	4	4	1	86
KADAM CHATTAR	2	4	3		4	3	5	5	5	3	3	3	4	3	4	4	5	4	4	5	4	2	4	4	4	4	5	100
SONAR GAON FLY-OVER SITE	1	1	2		1	2	3	5	5	3	4	3	2	2	3	3	5	4	4	5	4	2	4	4	4	3	1	80
																												2307

ENVIRONMENTAL IMPACT VALUE MATRIX

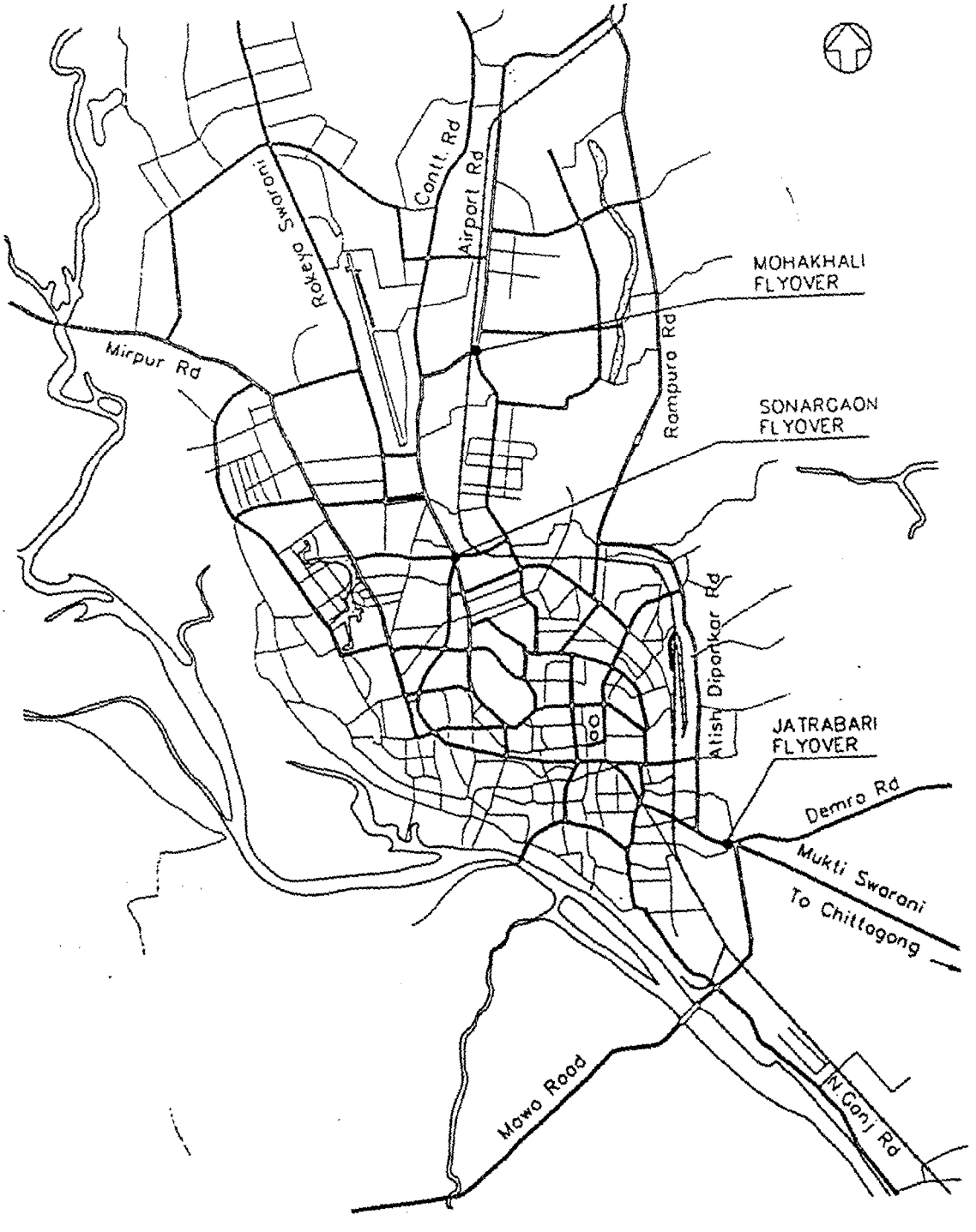
('WITHOUT PROJECT' SCENARIO)

INTERSECTION LOCATION	ENVIRONMENTAL IMPACT VALUES (I.V.)																											TOTAL I.V.
	AIR POLLUTION					NOISE	LAND-SCAP	ROADS								INFRASTRUCRURE						PARK-ING	HUMAN WELL BEING					
	CO	SO_2	NO_2	HC	SPM	NOISE POLLUTION	LANDSCAPE	VOLUME/CAPACITY	ENCROACHMENT	ABUTTING LANDUSE	GAS	ELECTRICITY	WATER PIPELINE	SEWERAGE	TELEPHONE	SURFACE DRAINAGE	ELECTRICITY	WATER PIPELINE	SEWERAGE	STREET LIGHTING	SOLID WASTE COLLECTION	PARKING SPACE	HEALTH	SAFETY (ACCIDENTS)	SAFETY(MUGGING)	WORKING ENVIRONMENT	AREAS OF CULTURAL/HIST.	
ZERO POINT	2	5	3		4	3	4	1	4	3	2	1	3	4	1	4	5	4	4	4	3	1	4	4	4	3	5	85
DHOLAIKHAL-NAWABPUR	3	5	4		5	1	4	1	4	2	1	1	2	3	1	4	5	4	4	4	3	1	4	4	4	2	1	77
BALDHA GARDEN	3	1	2		5	1	5	1	2	3	2	2	3	4	1	4	5	4	4	4	3	1	4	4	4	2	3	77
GOLAPSHAH MAZAR	3	5	4		5	1	5	2	1	2	2	2	3	4	2	3	5	4	4	4	3	2	4	4	4	2	5	85
N-S.RD/ENGLISH RD.	1	1	1		1	1	4	1	2	2	1	1	2	3	2	3	5	4	4	4	3	1	4	4	4	2	1	62
KATABON	1	5	3		3	1	3	2	5	2	2	1	3	4	1	3	5	4	4	4	3	1	4	4	4	3	1	76
NEW MARKET	1	1	1		1	1	5	3	4	2	2	1	3	4	1	4	5	4	4	4	3	3	4	4	4	3	1	73
MOHAKHALI FLY-OVER SITE	2	5	4		4	4	2	2	3	2	1	1	2	3	1	3	5	4	4	3	3	2	4	4	4	3	1	76
AIRPORT ROAD/GULSHAN	1	2	2		2	1	2	2	2	2	2	2	2	2	2	3	5	4	4	4	3	1	4	4	4	2	2	66
BANGLA MOTOR	1	1	1		1	1	2	2	3	2	2	1	2	2	1	2	5	4	4	3	3	1	4	4	4	2	2	60
MOGHBAZAR	1	1	1		1	1	3	1	1	2	2	1	3	4	2	4	5	4	4	4	3	2	4	4	4	2	1	65
MOUCHAK	2	5	3		4	1	3	1	1	2	2	2	3	4	1	3	5	4	4	4	3	2	4	4	4	2	5	78
KAKRAIL	1	4	3		3	2	3	2	5	3	3	1	3	4	2	2	5	4	4	4	3	2	4	4	4	2	4	81
TOPKHANA	1	2	2		3	1	4	2	4	3	3	1	3	4	1	3	5	4	4	4	3	2	4	4	4	2	4	77
MALIBAGH	2	5	3		4	1	4	1	1	2	3	2	3	4	2	2	5	4	4	4	3	3	4	4	4	2	3	79
FAKIRAPOOL	1	5	4		4	2	4	2	5	2	2	1	3	4	1	3	5	4	4	4	3	2	4	4	4	2	4	83
SHAPLA CHATTAR	3	5	4		5	4	5	3	4	3	2	1	4	4	2	4	5	4	4	4	3	3	4	4	4	3	5	96
RAJAR BAGH	3	5	5		5	1	5	2	5	3	1	2	3	2	1	2	5	4	4	4	3	1	4	4	4	2	4	84
ITTEFAQ	3	4	3		4	2	3	2	4	2	1	2	2	2	1	3	5	4	4	4	3	1	4	4	4	2	4	77
SAIDABAD	1	1	1		1	2	3	1	1	2	1	1	2	2	1	3	5	4	4	4	3	2	4	4	4	2	5	64
KHILGAON	3	5	4		5	1	3	1	4	2	2	1	4	1	1	2	5	4	4	4	3	2	4	4	4	2	1	76
JATRABARI FLY-OVER SITE	1	1	3		2	3	2	2	2	2	2	1	2	3	1	3	5	4	4	4	3	1	4	4	4	3	2	68
BIJOY NAGAR	1	5	3		2	1	4	2	5	3	2	1	3	1	1	2	5	4	4	4	3	1	4	4	4	3	1	73
KADAM CHATTAR	2	5	3		4	2	5	3	5	3	3	2	4	3	1	4	5	4	4	4	3	1	4	4	4	3	5	90
SONAR GAON FLY-OVER SITE	1	2	2		1	1	2	3	1	3	1	2	2	2	2	2	5	4	4	3	3	1	4	4	4	3	1	63
																												1891

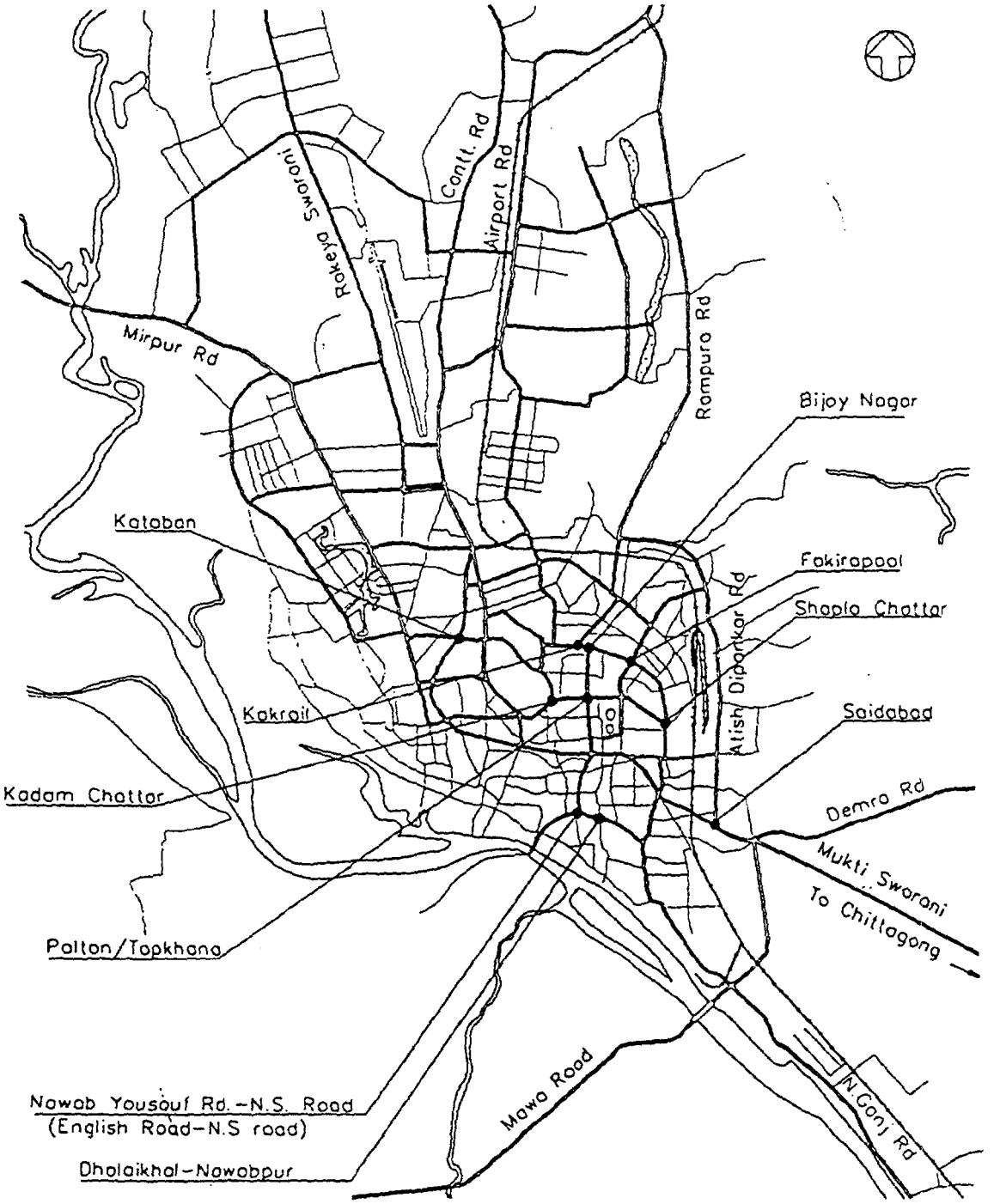
ANNEXURE E: **Location Maps**
(Showing Project Components)

1. Location of Flyovers
2. Location of 10 Intersections
3. Location of 10 Intersections
4. Location of Footpatrh Construction
5. Location of NMT Links
6. Location of Foot-Bridges
7. Location of Inter-District Bus Terminals
8. Location of 2 Underpasses

ocations of Flyovers
:ontract : C-1

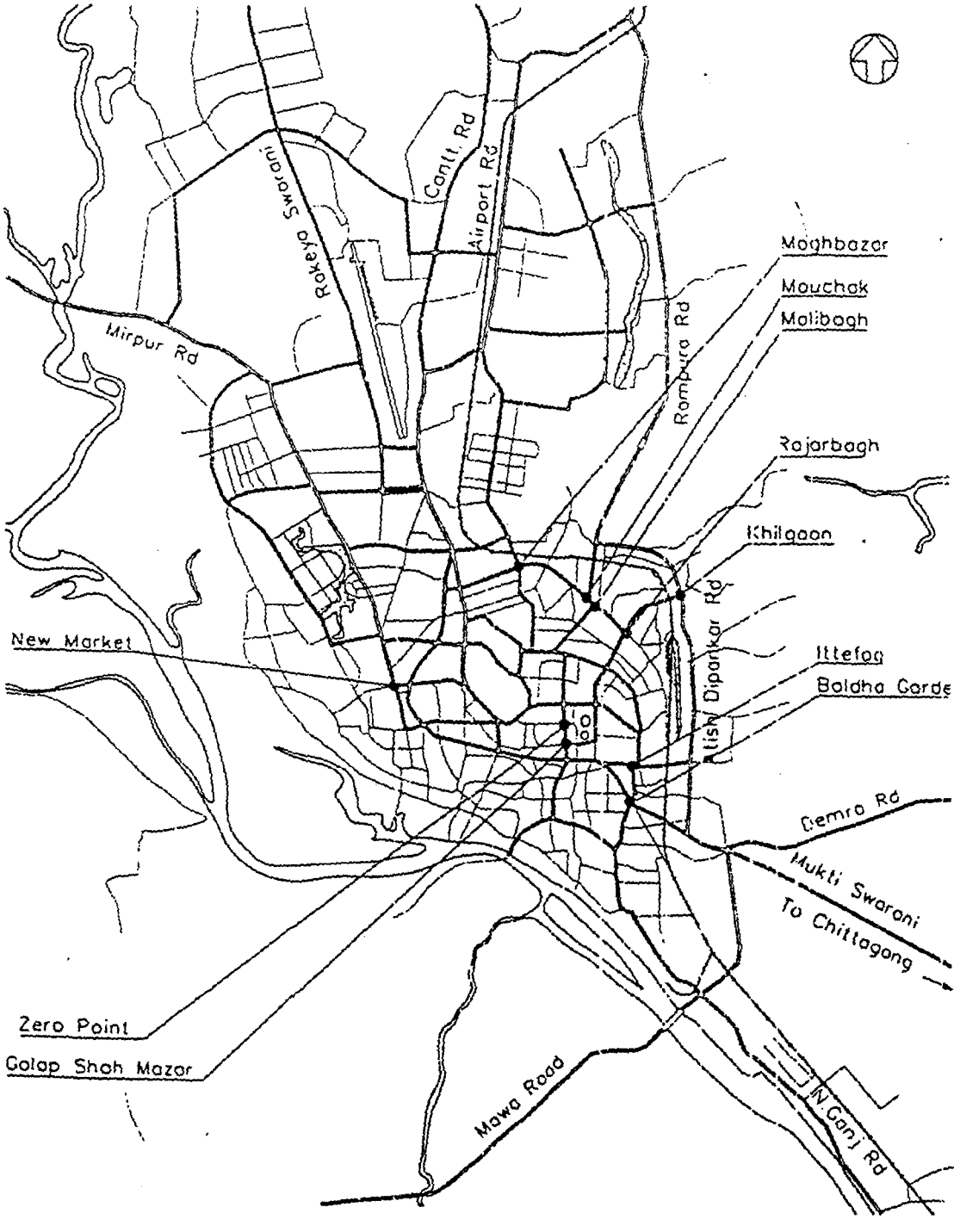


Location of 10 Intersection
Contract : C-2



PPK

Location of 10 Intersection
Contract : C-3



PPK

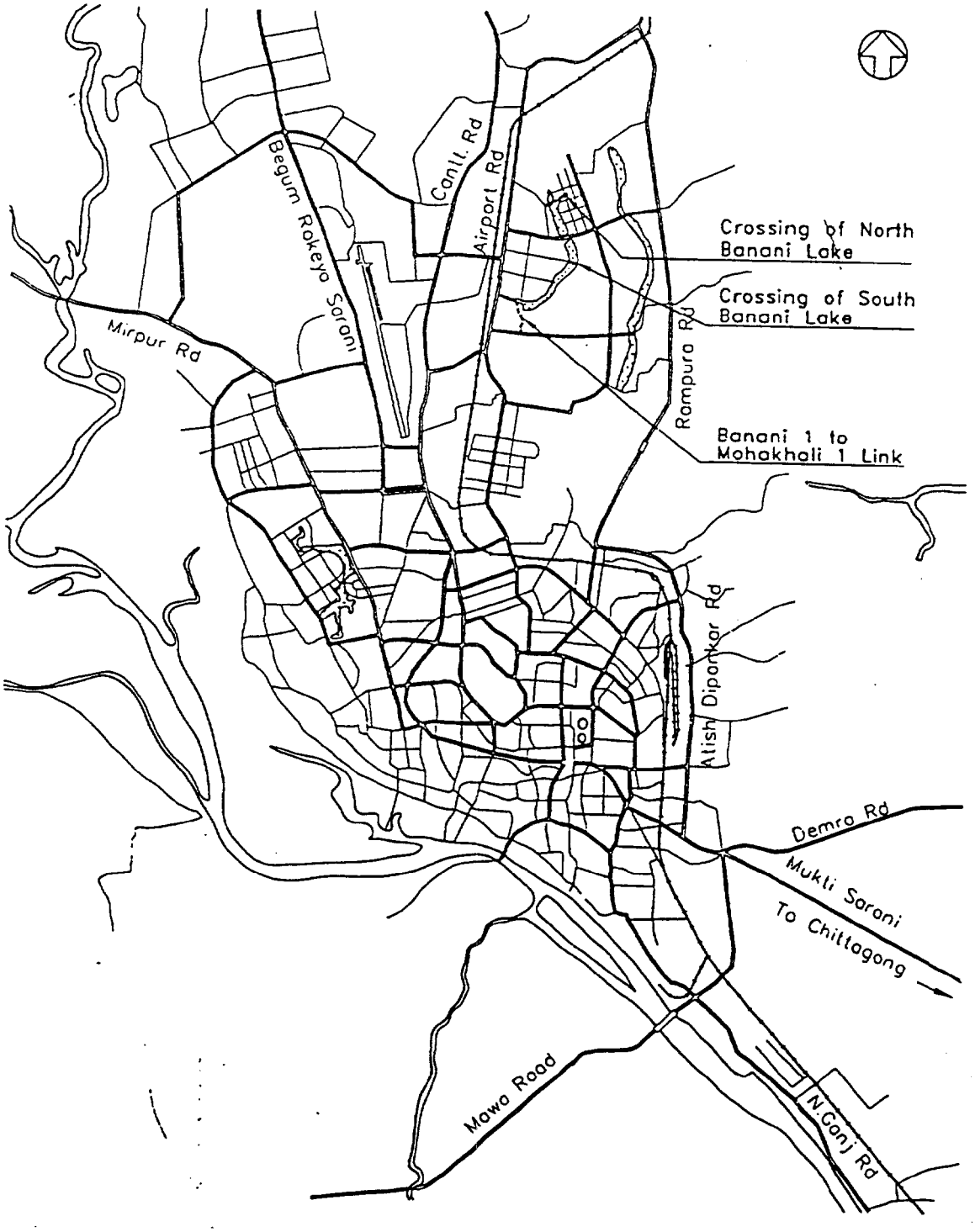
Location of Footpath Construction
Contract : C-4

Legend:

------ Proposed Footpath

PPK

Location of NMT Links
Contract : C-4

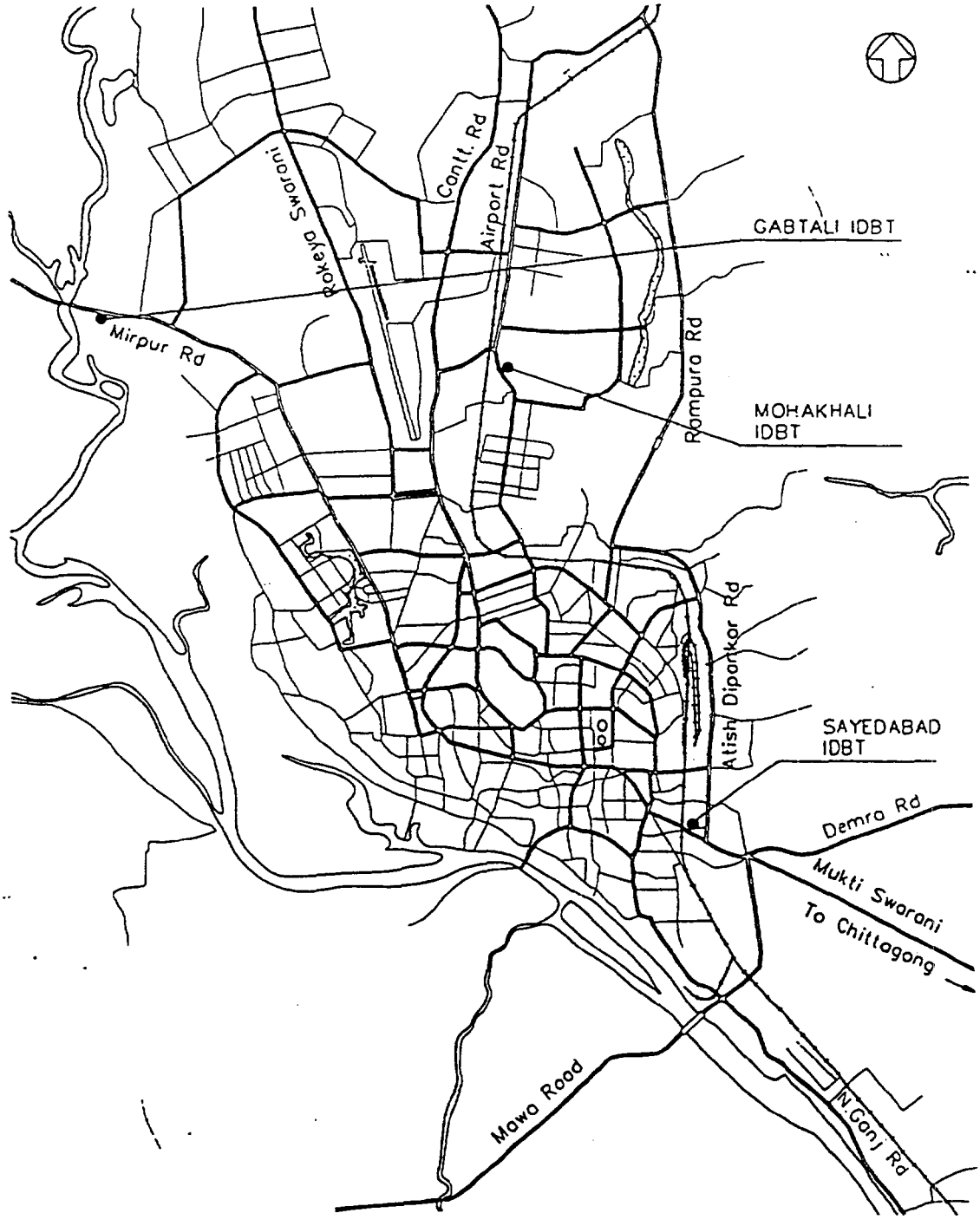


Legend:

--- Proposed NMT Links

PPK

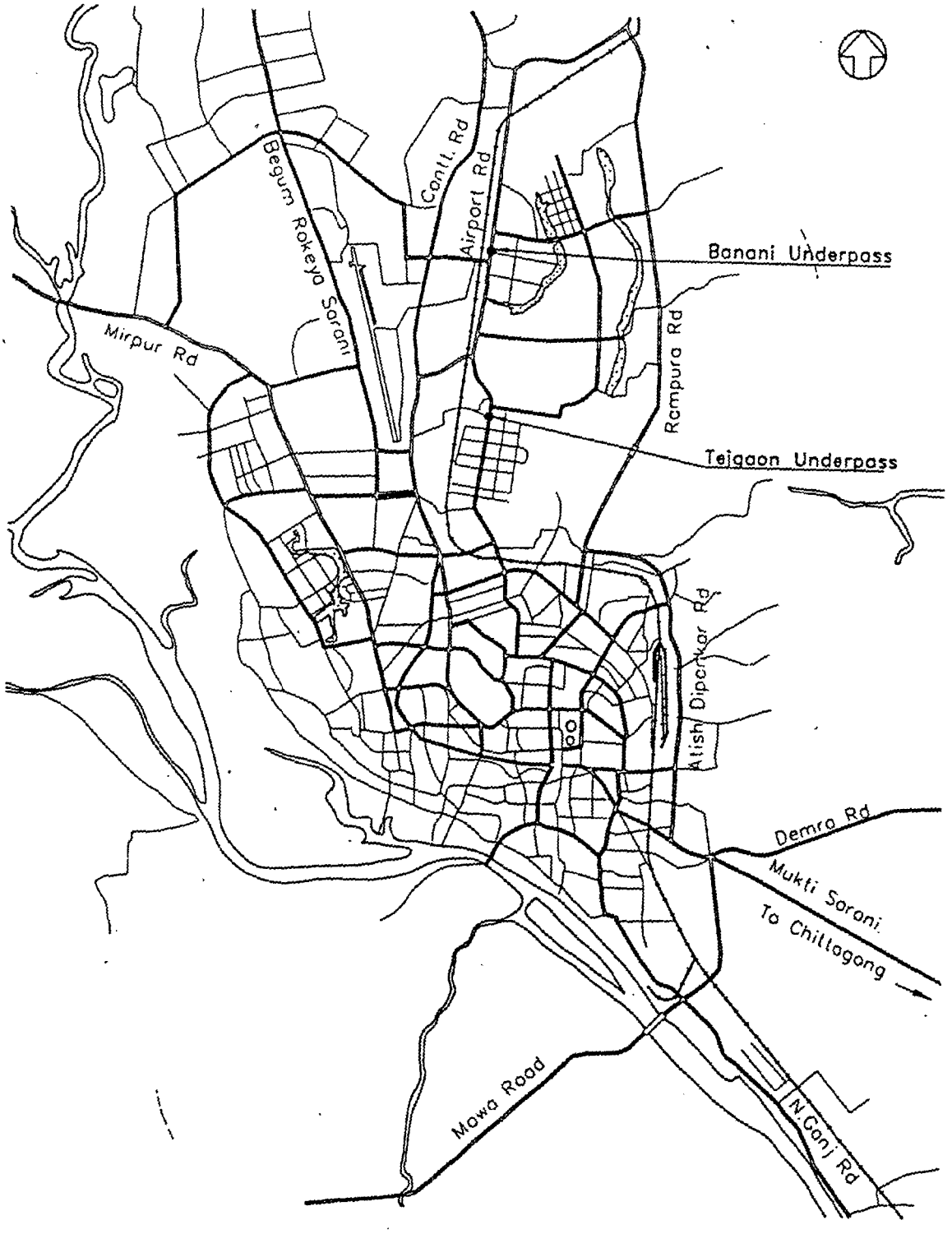
Location of Inter-District Bus Terminal
Contract : C-5



PPK

...on of 2-Underpasses

Contract : C-6



Legend:

- - - Proposed NMT Links

PPK

ANNEXURE F:

List of Tables:

ANNEXURE G:

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ANNEXURE H:

Abbreviation and Acronyms

-	BRTA	Bangladesh Road Transport Authority
-	BRTC	Bangladesh Road Transport Corporation .
-	BBS	Bangladesh Bureau of Statistics
-	CO	Carbon Monoxide
-	CNG	Compressed Natural Gas
-	DOE	Department of Environment
-	dBA	Decibel (Measure of sound)
-	DITS	Dhaka Integrated Transport Studies
-	DUTP-II	Dhaka Urban Transport Project- Phase-II
-	DCC	Dhaka City Corporation
-	EAP	Environmental Action Plan
-	ECE	United Nation's Economic Commission for Europe
-	EE	Environmental Evaluation
-	EIA	Environmental Impact Assessment
-	EIV	Environmental Impact Values
-	EQS	Environmental Quality Standard
-	EU	Environmental Unit
-	HC	Hydro-carbon
-	HDV	Heavy Duty Vehicle
-	IAP	Immediate Action Plan
-	LDV	Light Duty Vehicle
-	LPG	Liquefied Petroleum Gas
-	MV	Motorized Vehicle
-	MT	Motorized Transport
-	µg	Microgram (10^{-6} gram)
-	µg/m^3	Microgram/meter cube
-	mg	Milligram (10^{-3} gram)
-	NGO	Non Government Organization
-	NMT	Non-motorized Vehicles
-	NO_x	Nitrogen Oxides
-	NMV	Non Motorized Vehicles
-	O&M	Operation and Maintenance
-	O_3	Ozone
-	Pb	Lead Compounds
-	PAP	Project Affected People
-	PIU	Project Implementation Unit
-	PM_{10}	Particulate Matter of size 10 microns or less.

-	RAJUK	Rajdhani Unnayan Katripakha (Capital Development Authority)
-	R&H	Roads & Highways
-	SPM	Suspended Particular Matters
-	SAARC	South Asian Association for Regional Co-operation
	SO_2	Sulfur-dioxide
-	TOR	Terms of Reference
-	TSP	Total Suspended Particles
-	USA	United States of America
-	USAID	United States Agency for International Development
-	UNEPA	United Nations Environment protection Agency
-	VOC	Volatile Organic Compounds
-	WHO	World Health Organization