CHAPTER 6

URBAN DEVELOPMENT PLAN IN NORTH DHAKA

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6.1 Introduction

Since becoming the national capitol after Bangladesh's independence in 1971, Dhaka City has grown rapidly and the population in metropolitan area now exceedings eight million. In connection with the growth of Dhaka, the GOB has been tackling increasinly complicating policy issues; rapid urbanization and the diffusion of urbanization, and effective management of large metropolitan area. It has been recognized by those concerned that previous experiences on these issues show that the urbanization is not a simple demographic phenomenon, rather it is the result of many complex social and economic changes. In other words, the urbanization is inevitable and the process of irreversible.

In late May 1997, the first edition of the "Dhaka Metropolitan Development Plan " (DMDP) was published by RAJUK under the project "Preparation of Structure Plan, Master Plan and Detailed Area Plans for Dhaka: (BGD/88/052)" as one of the UNDP's aided projects implemented in cooperation with UNCHS/HABITAT in Dhaka.

The main objective of the DMDP preparation was to develop multi-sectoral development plans which form a framework of development planning, preparation of sectoral master plans and feasibility studies for metropolitan infrastructure elements lacking development policies and investment programs.

The DMDP consists of two components: the "Dhaka Structure Plan (1995-2015)" and the "Dhaka Urban Area Plan (1995-2005)". Policies and strategies for urban development, such as range of DMDP plans, the nature, functions, form, contents and strategic basis, are mainly presented in the Dhaka Structure Plan. The Dhaka Urban Area Plan, on the other hand, provides a mid-term strategy for the next ten years for the development of urban area and defines the geographic boundaries of the extent of area that will cover during the interim plan period.

As to the "Detailed Area Plan", which is intended to delineate the detailed zone planning of urban development for each of 19 "Strategic Planning Zone (hereinafter referred to as "SPZ") in Dhaka city and its suburbs, only two SPZs have been completed as model studies by RAJUK. The remaining 17 SPZs are expected to be prepared in the next few years.

6.2 Dhaka Metropolitan Development Plan (DMDP)

6.2.1 Standpoints, Roles and Limitations of the DMDP

The Structure Plan declares standpoints, roles and limitations of the DMDP that:
"The Structure Plan can be distinguished from more formal planning processes, such as development and master plans, in that it accepts and recognizes the uncertainty of future events by concentrating on fundamentals and leaving more detailed problems for resolution nearer the time they occur. In this way, it is to a certain extent open-ended, providing a broad policy framework for action plans and development programs which because of their shorter time scale can be formulated in greater detail.

An urban development strategy should be subject to regular review, but, because of its concentration on central issues rather than details, should not become as rapidly outdated as the more traditional master plan. This form of planning is particularly appropriate for metropolitan Dhaka where the growth of population and economic development cannot be determined with any degree of precision.

A strategy, as opposed to a plan, recognizes that the future is not certain, and that it is not possible to predict with confidence the future circumstances of the city"

It also says the nature of structure planning that:
"Equally it is not possible to foresee the appropriate physical form of urban development areas beyond the medium term. The detailed design of development should not therefore be attempted until the development of an area is likely within the succeeding five or ten year period. This approach means that certain decisions affecting the development of the city in the medium and long term cannot be built into the strategy immediately. One purpose of the strategy should be to identify those decisions which cannot be taken immediately, to suggest the approximate date at which decisions will be necessary, and to recommend the trends which must be kept under review to allow decision points to be identified more accurately at a later date.

Uncertainties about the future must not be used as an excuse for avoiding immediate action. The purpose of a strategy is to lessen collective uncertainty about short term action, and to provide a coordinated basis for development agencies to proceed knowing that they are all working to a common goal."

Along with the above mentioned overview on the theDMDP preparation, RAJUK has introduced, interpreted, organized and recommended policies and strategies for DMDP in view of:

- describing national and regional context in the backdrop of growth of Dhaka and dealing with features of the spatial development strategies,
- elaborating the impact of the Dhaka spatial development pattern, plan phasing, and sequencing including plan flexibility and provisional decisions, and
- introducing sub-areas of the Structure Plan and types of thereof and finally highlighting sectoral plans, policies and proposals.

6.2.2 Features of Spatial Development Strategy

The DMDP disclosed the features which influenced the proposed development strategy outlined in the Structure Plan as quoted below.

Quote:

* The DMDP research and past planning studies have recognized the constraints imposed on Dhaka's urban land resources by flood risk. The DMDP further acknowledges the associated serious problem of water logging resulting from urban encroachment on natural depressions and khals (canals);

* The options to reduce and minimize these major constraints rests with utilizing and optimizing naturally floor-free land and carrying out major flood protection works and protecting existing natural depressions and khals;

* Whilst previous plans opted for the former, there are now only minimal supplies of flood-free land south of the Tongi Khal, some 20 km north of the city center;

* The flood protection projects now underway (FAP-8B), and expected developments related with the Eastern Bypass for (FAP-8A), will result in a supply of flood-free land in strategically attractive locations much closer to the heart of the city and its support systems;

* In order to optimize the full potential of existing and potential new development land areas, the areas designated as retention ponds in natural depressions and the city's existing natural drainage system and khals must be protected at all costs;

* The potential sources of affordable flood-free land, with secure tenure in the areas referred to above, will take time before they can begin to accommodate significant proportions of Dhaka's predicted population growth; although the opened up near fringe in the DND triangle and South East may see faster development;

* Acknowledgment of the above facts, in the face of continuing high rates of population growth, the majority of whom will be poor, and development trends which seek to capitalize on the advantages of centrality, leads to the key principle of the proposed strategy. That is, the adoption of an incremental approach towards achieving spatial change in the structure and pattern of Dhaka's urban development.

Unquote.

6.2.3 Policies and Strategies Adopted in the DMDP

A set of policies and strategies has been prescribed in the DMDP Structure Plan to seek for well organized inter-agency and inter-sector coordination and investment thereof towards the realization of orderly and controlled urban development in the Metropolitan Dhaka.

A list of policies is shown in Table 6.2.1 by sector/field and summary descriptions are presented hereunder.

(1) Rural and Special Area Policies

* Lands within the green belt have positive and sustainable uses; and
* These uses can be maintained and protected via effective land-use controls and their enforcement.

The DMDP says that:

- the policies pertaining to these non-urban areas relate to function and development treatment,
- the policies with respect to development treatment are essentially ones of conservation, whereby the function performed by the area requires a degree of protection from urban impacts via policies and some basic rules and regulations,
- the urban development strategies seek to optimize land resources and curtail the inefficient, and at times inequitable, conversion of new, mostly rural land, via a range of positive initiatives,

Table 6.2.1 List of Policies Adopted in DMDP

Sector/Field		Policy (ID & Name)	
1.	**Rural and Special Area Policies**		
1.1	Areas of High Agricultural Value	RS/1	Areas of High Agricultural Value
1.2	Flood Control, Drainage and Irrigation Project Areas	RS/2	Flood Control, Drainage and Irrigation (FCD) Project Areas
1.3	Flood Plains, rivers and Water Bodies	RS/3	Flood-Flow Zones
		RS/4	River Pollution Control
		RS/5	Flood Retention Ponds
1.4	Special Areas	RS/6	Special Areas
2.	**Urban Area Policies**		
2.1	Established pre-1983 Urban Area	UA/1	Land Resource Optimization
		UA/2	Infrastructure Consolidation
		UA/3	Community-Based Development Initiatives
		UA/4	Urban Neighborhood Action Programs
2.2	Existing Near Urban Fringe	UA/5	Urban Fringe Development Acceleration
2.3	New Urban Land	UA/6	New Urban Land Growth Promotion
		UA/7	Infrastructure Initiatives
2.4	Peripheral Urban Development Areas	UA/8	Priority Peripheral Urban Development Areas (Tongi/Gazipur & Savar/Dhamsona)
3.	**Economic Development**		
3.1	Economic Development Manufacturing Industry	SE/1	Incentive
		SE/2	Industrial Estates, Tejgaon and Tongi
		SE/3	Foot-loose Industries
		SE/4	Polluting Industries
		SE/5	Informal Sector Activities
3.2	Public Administration	SE/6	Institutions and Public Administration
3.3	Commerce	SE/7	Dispersal of commercial Activity
		SE/8	Improved Access to and within the CBD (Central Business District)
3.4	Health and Hygiene	SE/9	Data Dissemination
3.5	Recreation and Open Space	SE/10	Augmenting City Open Space
		SE/11	Securing Future Open Space
4.	**Infrastructures**		
4.1	Road Development	IN/1	Eastern Bypass
		IN/2	Incremental Network Development
4.2	Development of Public Transport Service	IN/3	Bus Service
		IN/4	Commuter Rail Network
5.	**Flood Control and Drainage**		
5.1	Prioritization of FCD Projects - Approach and Criteria	IN/5	Incremental Flood Protection

- the observe of these strategies is to protect the non-urban areas from haphazard and unplanned incursions.

1) Areas of High Agricultural Value

Policy RS/1 - Areas of High Agricultural Value

Three areas of high quality agricultural land within the market catchment area of Dhaka will be conserved and promoted as areas of high intensity food production.

Reason:

To ensure a base for urban food supplies in close proximity to the city and to improve income levels within the agricultural sector of the metropolitan area's economy.

2) Flood Control, Drainage and Irrigation Project Areas

Policy RS/2 - Flood Control, Drainage and Irrigation (FCDI) Project Areas

The expansion of winter cropping and culture fisheries will be promoted within the identified Narayanganj-Narsingdi Project Area via appropriate measures of flood control, drainage and irrigation.

Reason:

By improvements in the hydrologic regime it will be possible to extend the cultivation of high yielding and high value crops within the area of impact. As well as affording protection to homesteads and infrastructure from flood damage, improved all-weather road communication and proximity of the project area to Dhaka City will make marketing of agricultural products easier and more efficient.

3) Flood Plains, Rivers and Water Bodies

Policy RS/3 - Flood-Flow Zones

Land development, within the designated flood plain areas of the DMDP Structure Plan, will be controlled in order to avoid obstructions to flood flow, which might otherwise result in adverse hydraulic effects as, for example, the rise of flood water levels and changes in flow direction.

Main flood flow zone:

Land development for residential, commercial and industrial development, including raising the level of land, via land filling, will be strictly prohibited.

Permitted uses, provided that they cause no adverse hydraulic effect will be:

- agriculture,
- dry season recreation facilities,

- ferry terminals, and
- excavation of mineral deposits, including dry season brick works.

Causeways for roads or railways will be permitted, subject to detailed geological surveys being undertaken and on condition that they are built with culverts sufficient to allow for unimpeded flood flow.

Sub flood flow zone:

Development compatible with the rural nature of these mainly rice growing areas, will be permitted on condition that:

- the structures are built on stilts, or on land raised above design flood water level;
- the alignment of structures and raised land to be designed so as not to disturb flood flow.

Reason:

To minimize adverse hydraulic effects, the risk to human life and economic damage.

Policy RS/4 - River Pollution Control

Environmental protection measures will be taken to prevent pollution of the Lakhya River and its tributary, the Balu River, in order to ensure that it remains a viable, long-term source of potable water for Dhaka City.

Reason:

To establish a feasible and alternative water source to the existing and dwindling artesian supply system, for the future health and prosperity of the nation's capital.

Policy RS/5 - Flood Retention Ponds

Control will be maintained over the areas designated in the DMDP Structure Plan for flood retention ponds in order to ensure that they remain capable of fulfilling their primary function of water storage at times of flooding.

The use of the land within designated retention pond areas to be restricted to the following activities:

- agriculture,
- fish cultivation, and
- recreation.

No land filling or permanent structures will be permitted within the designated retention pond areas. Where uses other than those listed above already exist, these will be discontinued and the owners compensated by the government, either in the form of compensation, or equivalent land swap.

Reason:

The flood retention ponds will be designed to reduce the intensity of local flooding within the protected areas and to reduce pumping requirements, and as such, are an integral part of the proposed flood protection schemes. Their location should be the subject of detailed geological survey to ensure that the city's natural drainage system is not compromised and that the effects of water logging are minimized.

4) Special Areas

Policy RS/6 - Special Areas

Existing special area uses included within the DMDP Structure Plan are:

- National Mausoleum Site,
- Savar Cantonment, and
- Government High Security Industrial Park, north of Gazipur (outside of the RAJUK area).

The DMDP Structure Plan proposes the following special area uses:

- Lalbagh Fort in Old City,
- Biswa Estema - a new permanent site is proposed west of Tongi,
- Tannery industry - to be relocated away from Hazaribag, to a site adjacent to the Dhalesawari River, south of Savar. However the environmental impact of the new site will have to be analyzed.
- ZIA International Airport.

Reason:

The national or metropolitan importance and/or security of the functions of the Special Area designated sites requires that they be accorded special consideration, both in respect of prospective land use within their immediate vicinity and of future land requirements to sustain their particular function.

(2) Urban Area Policies

1) Established pre-1983 Urban Area

Policy UA/1 - Land Resource Optimization

To mitigate the impact of densification, the Municipal Planning Authority (MPA) will seek to optimize land resources within the defined established urban area by encouraging the in-filling of vacant, under utilized land, by allowing vertical development up to four or six floors and by the redevelopment or re-subdivision of land within lower-density communities. The optimization needs to be supported with a strong effort to rehabilitate and upgrade the infrastructure facilities and services, including roads, to appropriate and affordable levels and to consolidate these levels in accordance with the density levels that may be expected in the coming years.

Reason:

Given the expected increase of population and the need to none-the-less maintain and develop a healthy and stimulating urban living environment, it will be necessary to optimize the use of and more effectively utilize the existing largely flood-free areas of, urbanized land, to maximize investment in the ongoing FAP-8B flood protection facilities, and to inhabit, and where necessary restrict, peripheral growth ahead of infrastructure supply.

Policy UA/2 - Infrastructure Consolidation

At the level of the DMDP Urban Area Plan, and particularly in the course of the DMDP Detailed Area Plan preparation, the MPA will ensure that densification targets at the community level are accompanied by infrastructure consolidation programs which are both feasible, affordable and adhere to acceptable minimum standards of provision. The community, through their active participation in the decision making process, community-based organizations (CBOs) and NGOs will all be consulted to determine priorities, standards and what role they might play in the implementation of these programs.

Reason:

To ensure that adverse impacts in the form of environmental degradation, increased congestion and declining levels of social and community services provision are not a necessary or long-term consequence of densification.

Policy UA/3 - Community-Based Development Initiatives

The MPA recognizes the increasing importance of community-led initiatives and participation in the land development process and commits itself to the application of community-based land delivery mechanisms which give priority to meet the basic needs of the urban poor, and in mobilizing the efforts and resources of the informal private sector.

Reason:

To enhance access to land with secure tenure, and to affordable and appropriate levels of infrastructure and social community services provision for an increasing majority of the population.

Policy UA/4 - Urban Neighborhood Action Programs

The MPA also recognizes the increasing importance of community-led initiatives and participation in the rehabilitation and upgrading of infrastructure services provision in existing informal and unplanned areas and densely populated inner urban areas and will facilitate and support indigenous processes and actions in the rehabilitation of these areas. The approach and methodology recommended is based on the premise that support for physical rehabilitation will have limited impact unless accompanied by attention to the social and institutional structures that will guide and manage the process of upgrading and rehabilitation and enhance political support and commitment at the local level.

Reason:

To enhance access to affordable, appropriate and improved levels of infrastructure and social and community services provision for an increasing majority of Dhaka's population, and to build on initiatives already being promoted by the DCC, with support from LGED, UNICEF and other agencies.

2) Existing Near Urban Fringe

This is the area of land which was converted to urban use in the 1980's. It is widely scattered around most of Dhaka's established urban area and with its about 1,200 ha (3,000 acres), it comprises one tenth of the 1991 urban area and supports almost 0.54 million people. However the development has taken place in a spontaneous, but haphazard way, leaving little way for an appropriate road network nor for basic infrastructure facilities and services.

Policy UA/5 - Urban Fringe Development Acceleration

The MPA will initiate and coordinate a range of measures aimed at stimulating reorganization and re-subdivision of the urban fringe area.

Reason:

To accelerate the utilization of land converted to urban use in the 1980's and to see to the development of appropriate and affordable levels of infrastructure and road provision.

3) New Urban Land

Policy UA/6 - New Urban Land Growth Promotion

The MPA will initiate and coordinate a range of measures aimed at stimulating the rate of development in the designated areas of the urban fringe.

Reason:

To optimize the utilization of land converted to urban use in the 1980's and early 1990's and to promote planned development.

Policy UA/7 - Infrastructure Initiatives

The MPA will seek to promote, through the DMDP Structure Plan, an orderly sequence of new area development by means of mutually reinforcing and coordinated public sector investment programs, spearheaded by drainage, flood protection and transport development.

Reason:

To optimize the benefits of limited public sector resources and to establish for the private sector, clear indicators as to where and when their own investments, great or small will be supported and reinforced.

4) Peripheral Urban Development Areas

In line with the spatial strategy of gradual change, major investment in satellite or new towns is accorded very low priority in the time-frame of the DMDP Structure Plan. This development option capitalizes least on existing and presently committed urban infrastructure investments, and fails to address the shelter needs and priorities of the urban majority, including the urban poor, and the existing low mobility levels of this group and its need for close proximity to employment opportunities.

Policy UA/8 - Priority Peripheral Urban Development Areas (Tongi/Gazipur and Savar/ Dhamsona)

The MPA will promote Tongi/Gazipur and Savar/Dhamsona in the north and north-west of the DMDP Plan area as the first priority locations for dispersed town development, but only in the latter half of the plan's period, and not before 2010.

Reason:

To reinforce existing growth trends, particularly where prior private and public sector investment in economic activity will act as a spur development.

(3) Economic Development

1) Manufacturing Industry

Policy SE/1 - Incentives

The MPA will seek to achieve changes to the fiscal incentive boundary, to assure inside RAJUK's control area boundary, showing **Least Development Status**. Following on from this change, the MPA will seek to designate specific targeted locations within RAJUK's control area boundary as Special Incentive Zones. The locations identified in the DMDP Structure Plan are Tongi, Dhamsona, Savar and Narayanganj. In the case of Narayanganj, the area should be designated a Special Rehabilitation Incentive Zone.

Reason:

To attract to these specific locations a broad range of manufacturing industries in order to help stimulate and develop a sound economic base in support of population dispersal, particularly towards the end of the DMDP Structure Plan period, and in the case of Narayanganj to help offset declines in its traditional economic base dominated by textiles and aid the process of regenerating its declining economic base its urban fabric and infrastructure and services provision.

Policy SE/2 - Industrial Estates, Tejigaon and Tongi

The MPA will initiate a major review of these two government areas, in particular their management, with a view to improving their operational procedures and cost effectiveness. Further, that the MPA will not designate any new general industrial areas for development in the DMDP Structure Plan period to 2015, or until the Tejgaon and Tongi Industrial Estates are operating at full and optimum capacity, whichever is the sooner.

Reason:

To effectively capitalize on the substantial public sector investments already made, to improve cost recovery on government-owned land, now extremely valuable on the open market, and ensure that similar future public sector investments are demand-related.

Policy SE/3 - Foot-Loose Industries

The MPA will encourage foot-loose industries to establish themselves in Metropolitan Dhaka within the special designated zone proposed in the DMDP Structure Plan.

Reason:

In recognition of proven locational preferences and market forces and in support of the long-term strategy of reinforcing areas with potential for growth at a minimum of public sector investment in land acquisition and provision of infrastructure and other public services provision.

Policy SE/4 - Polluting Industries

The MPA will commit itself to an integrated policy of the incremental environmental upgrading and relocation, where necessary, of Dhaka's existing polluting industries, in a manner commensurate with sound environmental practice and cost-effectiveness.

Reason:

To improve urban living conditions, particularly for the urban poor, safeguard the quality of groundwater reserves and to do so in a manner which is cognizant of the financial constraints of private sector interests and operators.

Policy SE/5 - Informal Sector Activities

The MPA will actively seek to encourage informal private sector economic activities by means of relaxing those regulations which tend to stifle these initiatives, and providing opportunities to enhance conditions and productivity.

Reason:

To stimulate and promote economic activity and the proliferation of informal sector work opportunities, particularly among the lower income groups.

2) Public Administration

Policy SE/6 - Institutions and Public Administration

The MPA will support and actively encourage the dispersal of public administration and government institutions to the growth areas proposed in the DMDP Structure Plan.

Reason:

To spread employment opportunities more evenly within the metropolitan area, reduce congestion at the city center and help establish a sustainable economic base in the proposed new development areas, and the areas designated as Special Incentive Zones towards the latter half of the DMDP Structure Plan period to 2015.

3) Commerce

Policy SE/7 - Dispersal of Commercial Activity

In recognition of the prevailing low mobility levels of the majority of Dhaka's workforce the MPA will seek to promote the gradual dispersal of commercial activity to the existing suburbs and new growth areas proposed in the DMDP Structure Plan.

Reason:

To increase the range and choice of job opportunities at locations removed from the Central Area, thereby enhancing the choice of living area, particularly to the lower income, less mobile groups of Dhaka's population, the majority of the urban population.

Policy SE/8 - Improved Access to and within the CBD

In the Central Business District, including old Dhaka, the MPA will seek to improve overall accessibility via the promotion of those measures deemed necessary to upgrade transport services to and within the area as a whole. Further, the MPA will not, at least in the short-term period of the DMDP Structure Plan to 2000, improve constraints on the private commercial sector operations in excess of those already in force.

Reason:

To allow a period of grace in which proposed short-term transport upgrading measures would be aiming to extract measurable improvement from the CBD's already existing transport infrastructure.

4) Health and Education

Policy SE/9 - Data Dissemination

The MPA will maintain close liaison with the Ministries of Education and health and their implementing line agencies to ensure that they have the most relevant and up-to-date available information on population distribution and its planned build-up, in line with the DMDP Structure Plan proposals.

Reason:

To allow the responsible Ministries to coordinate their own development priories and programs with that the overall DMDP Structure Plan Spatial Development Strategy. In so doing, social and community infrastructure service provision will augment the Spatial Development Strategy by: (a) affording priority of provision to the established built-up area and (b) rationing additional provision in favor of the priority growth areas.

5) Recreation and Open Space

Policy SE/10 - Augmenting City Open Space

The MPA will seek to augment the city's existing stock of major recreational facilities by means of exploiting the resource of vacant and/or under-utilized government land within the established urban area.

Reason:

To prevent further impoverishment of the city's supply of such facilities, and its environment in general, by increasing public access to publicly-owned government land and minimize costs of land acquisition.

Policy SE/11 - Securing Future Open Space

It is the MPA's intention to identify and secure sites for major recreational use in the DMDP Structure Plan's all priority new development areas, but especially the DND Triangle and Harirampur (north of Mirpur).

Reason:

These two areas, following the medium term infrastructure development initiatives will be the fastest growing flood-protected areas in the second half of the DMDP Structure Plan period. By 2015, these areas should both be well established exten-

sions to the existing urban area with populations meriting their own high order social facilities and open space.

(4) Infrastructures

1) Road Development

Policy IN/1 - Eastern Bypass

The MPA will afford high priority to the development of a limited access Eastern Bypass to become a key link in the emerging national network of arterial roads and to relief the existing urban network.

Reason:

It provides an arterial road through the Metropolitan Area as a key link between an upgraded Chittagong Highway and communications to the north-west of the country via Tangail and the new Jamuna Bridge.

Policy IN/2 - Incremental Network Development

In pursuance of the proposed long-term road transport network, the MPA will seek to promote an incremental approach to its overall development, as a means of conserving resources and being responsive o proven demand for the service being offered.

Reason:

It will utilize limited resources in the most cost-effective manner over a sustained period of time.

2) Development of Public Transport Services

Policy IN/3 - Bus Services

The MPA will seek to support and promote the expansion of Dhaka's bus services on the routes proposed in the Immediate Action Plan of Greater Dhaka Metropolitan Area Integrated Transport Study (DITS).

Reason:

This is the most appropriate and cost-effective means of upgrading the City's public transport services in the first half of the DMDP Structure Plan period.

Policy IN/4 - Commuter Rail Network

The DMDP will support and promote the development of a long-term commuter rail network, to serve the high density sections of the main urbanized area.

Reason:

It will ensure that Dhaka, at the end of the DMDP Structure Plan period of 2015, with a likely population of some 15 million, has the beginning of a mass transit system capable of easing the pressures on a road network which will experience inevitable and growing congestion throughout the DMDP Structure Plan period.

(5) Flood Control and Drainage

1) Existing Feasibility Studies, FAP-8A and FAP-8B

The DMDP Structure Plan only draws out the strategic issues of drainage and flood protection which are otherwise covered in considerable detail in Sector Feasibility Studies and the DMDP Drainage Component, Component 2B, dated September 1993.

Whilst planning and implementation of Flood Control and Drainage (FCD) works in Greater Dhaka is shared between the FPCO, BWDB and DWASA, their integration within the overall spatial development strategy espoused in the DMDP Structure Plan is essential. As with road development, the DMDP Structure Plan sees FCD works as being key factors in the shaping of Dhaka's future pattern of urban development. Nonetheless, they should serve rather than pre-determine a pattern of urban development selected on a broad cross-section of socio-economic criteria. This priority was recognized by JICA in their Final Report.

As recorded earlier in this Report, the MPA will support early completion of FCD works under the FAP-8B, Phase 2 program and promote actions necessary to accelerate funding for a phased development of FAP-8A **in accordance with the area priorities proposed in the DMDP Structure Plan.**

2) Prioritization of FCD Projects - Approach and Criteria

Whilst the FCD works to be undertaken under FAP-8B are now agreed and in process, according to the terms of the ADB loan, the FAP-8A proposals have already been worked up to a high level of detail and are expected to the subject of an ADB feasibility study, linked to proposals to study the feasibility of improving the National Highway between the Jamura Bridge and Chittagong. Subject to the findings of

this study, GOB needs to fulfill certain pre-conditions, and Policy UA/6 sets down the main issues which need addressing in order to achieve this.

FAP-8A proposals therefore, and particularly the phasing of works, as indicated by JICA itself are far from being a "fait accompli". In consideration of how to best utilize the (prospective) works of FAP-8A in support of a preferred long-term growth strategy the DMDP Study Team were particularly cognizant of policy recommendations of the DMDP Component 2B Drainage Team, chief amongst these being that:

- FCD works should be implemented on an incremental, rather than a widespread basis, with zones being defined beforehand on the basis of planned use and demand;
- for reasons of security and project longevity, land-filling should be preferred to empoldering where there exists an economic choice.

Policy IN/5 - Incremental Flood Protection

The MPA will seek to employ means of implementation of components of FAP-8A which will spread costs over time and capture benefits for other development sectors.

Reason:

It will optimize overall cash flow and fund availability and will be a means of increasing benefits.

6.3 Other Relevant Development Plans

6.3.1 Residential Estate Development Plan

The ongoing residential estate development project is seen at the Uttara Model Town. It has initiated by RAJUK for about 75 ha in the western area of the town. Although site development including internal road network and power supply is almost completed, water supply, drainage and sewerage services are not commenced yet.

In some other areas, private sector has been developing housing area including apartment type building and individual housing at Uttara Khan and Baridhara, but their scope of work and magnitude are not clear to date.

6.3.2 Industrial Estate Development Plan

The DMDP Structure Plan as described in its Policy SE/1 has identified Tongi, Dhamsona, Savar and Narayanganj as Special Incentive Zones. Narayanganj is further considered to be designated as a Special Rehabilitation Incentive Zone. This is to attract to these specific locations a broad range of manufacturing industries in order to help stimulate and develop a sound economic base in support of population dispersal, particularly towards the end of the DMDP Structure Plan period. In the case of Narayanganj, it is to help offset declines in its traditional economic base dominated by textiles and aid the process of regenerating its declining economic base, its urban fabric and infrastructure and services provision.

In Tongi and Tejgaon, there are government's initiated industrial estates. The DMDP Structure Plan put special policies to these industrial estates that:

- The MPA will initiate a major review of these two government areas, in particular their management, with a view to improving their operational procedures and cost effectiveness.
- The MPA will, further, not designate any new general industrial areas for development in the DMDP Structure Plan period to 2015, or until the Tejgaon and Tongi Industrial Estates are operating at full and optimum capacity, whichever is the sooner.

In addition to the above, the DMDP Structure Plan introduced Policy Se/4 - Polluting Industries that the MPA will commit itself to an integrated policy of the incremental environmental upgrading and relocation, where necessary, of Dhaka's existing polluting industries, in a manner commensurate with sound environmental practice and cost-effectiveness.

This particular policy will, when implemented, contribute to a remarkable improvement at the Tongi Industrial Estates since none of presently operating factories have wastewater treatment facilities and consequently discharge untreated wastewater into the Tongi Rover through the surrounding swampy fields.

Under the above mentioned circumstances, RAJUK does not have any particular plan to establish any new industrial estates within the Study Area, except for the relocation and rehabilitation of existing ones.

CHAPTER 7

PLANNING FUNDAMENTALS

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7.1 General

In this Chapter, fundamental conditions and requirements as well as limitations and assumptions are clarified and pre-determined prior to proceed with the master plan preparation of the Study, referring to the policy and strategy which are currently enforced or planned to apply for urban development in the Study Area.

Among others, the RAJUK's "Dhaka Metropolitan Development Plan (DMDP)," particularly its "Structure Plan," is regarded as a principal guide for future urban development and sector planning. Policy and strategy adopted in the DMDP Structure Plan were carefully reviewed and reflected on the master planning of sanitation/sewerage provision.

Physical framework of master planning, such as setting up of planning horizon/target year, target area for master planning, future population, was paid due consideration for keeping up of appropriate consistency with that of the DMDP Structure Plan.

Absence or insufficiency of reference data or plans/programs was supplemented by past experiences on similar projects in the Study Area.

7.2 Policy and Strategy for Sanitation/Sewerage Provision

7.2.1 Policy for Sanitation/Sewerage Provision

The RAJUK's DMDP Structure Plan (1995-2015) is primarily referred to, as the latest supreme plan for urban development of Dhaka City and its prospective suburban areas, in delineating the target area for master plan preparation with the planning horizon of 2020 in this Study. The overview of the DMDP Structure Plan in its target year of 2015 is shown in Figure 7.1.1.

The DMDP Structure Plan provides policies of relevant sector developments, such as land use, economy, transportation and flood control, but no clear policy for provision of sanitation and sewerage service is included. Some policies relevant to sanitation/sewerage sector are picked up in the fields of pollution control and infrastructures from the DMDP Structure Plan.

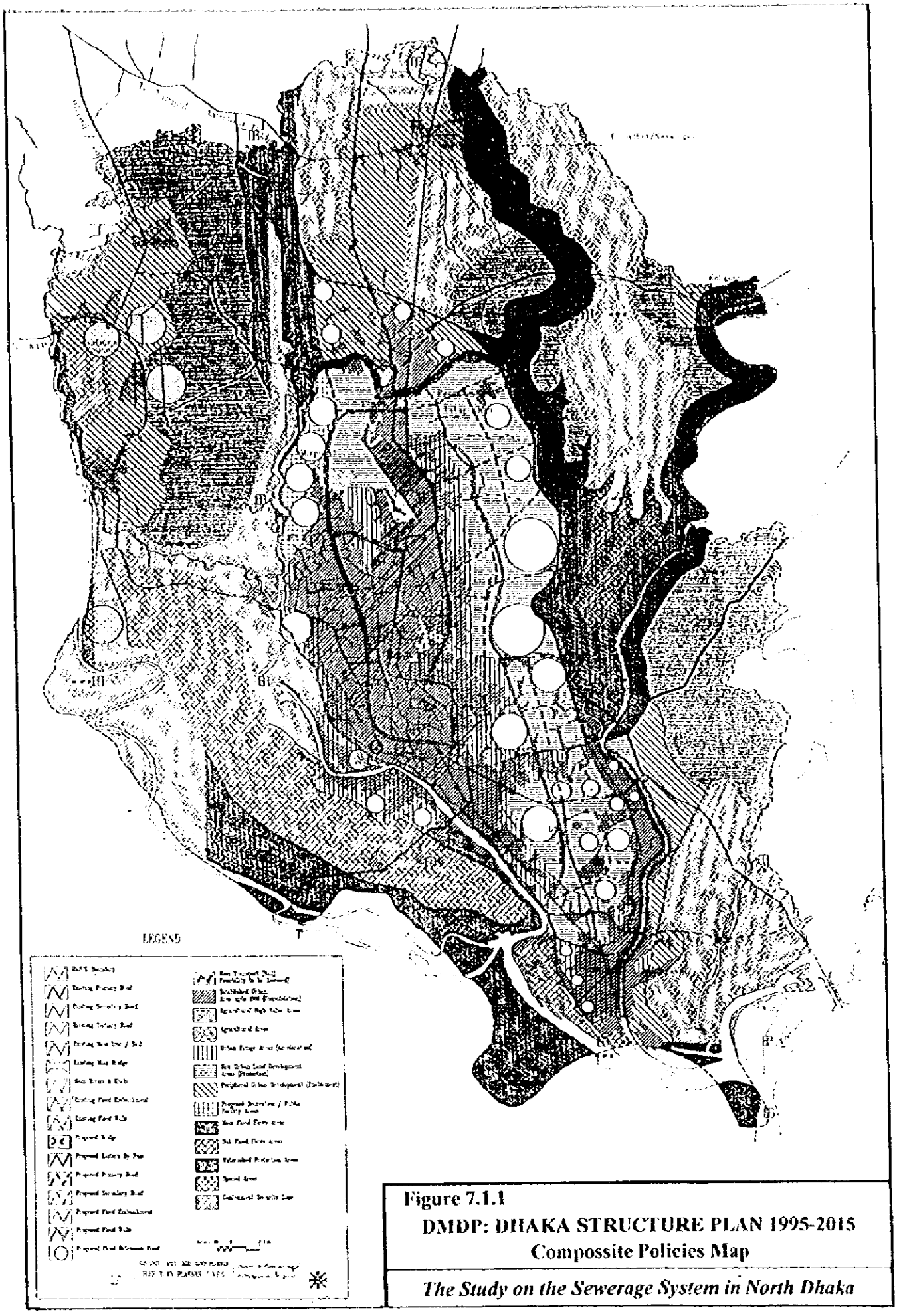


Figure 7.1.1
DMDP: DHAKA STRUCTURE PLAN 1995-2015
Compossite Policies Map

The Study on the Sewerage System in North Dhaka

Essential points of these policies and relationships to the Study are summarized below.

Policy RS/4 - River Pollution Control,

Essence of policy:

- Environmental protection measures will be taken to prevent pollution of the Lakhya River and its tributary, and the Balu River, in order to ensure that it remains a viable, long-term source of potable water for Dhaka City.

Relationship to the Study:

- When proposed sewage treatment plant is located within the catchment area of these rivers, the discharge point of treated effluent may have to be located in the down-stream to avoid unnecessary pollution of surface water source for drinking water supply.
- The on-going Saidabad Water Supply Project (the World Bank financial assistance) has a plan to locate its raw water intake along the Balu River.

Policy UA/2 - Infrastructure Consolidation

Essence of policy:

- In the DMDP Detailed Area Plan preparation, the Government will ensure that densification targets at community level are accompanied by infrastructure consolidation programs which are both feasible, affordable and adhere to acceptable minimum standards of provision.

Relationship to the Study:

- Service level of sanitation/sewerage facility and its tariff schedule will have to reflect affordability and civil-minimum requirement for urban residents.

Policy UA/5 - Urban Fringe Development Acceleration

Essence of policy:

- The Government will initiate and coordinate a range of measures aimed at stimulating reorganization and re-subdivision of the urban fringe area, to accelerate the utilization of land converted to urban use in the 1980's and to see to the development of appropriate and affordable levels of infrastructure.

Relationship to the Study:

- Same as Policy UA/2.

Policy SE/2 - Industrial Estate, Tejgaon and Tongi

Essence of policy:

- The Government will initiate a major review of these two government areas, particularly in their management, with a view to improving their operational procedures and cost effectiveness.
- The Government will not designate any new general industrial areas for development in the DMDP Structure Plan period to 2015, or until the Tejgaon and Tongi Industrial Estates are operating at full and optimum capacity, whichever is the sooner.

Relationship to the Study:

- Tongi Industrial Estate forms an integrated and independent zone wherein no industrial wastewater treatment is taken up to date.
- Possibility to accept industrial wastewater into public sewerage system will be studied during the master plan preparation in the Study.

Policy SE/4 - Polluting Industries

Essence of policy:

- The Government will commit to an integrated policy of the incremental environmental upgrading and relocation, where necessary, of Dhaka's existing polluting industries, in a manner commensurate with sound environmental practice and cost-effectiveness.

Relationship to the Study:

- In case industrial wastewater is to be accepted to the sewerage system, provision of primary treatment at respective factories will be required.

7.2.2 Strategy for Sanitation/Sewerage Provision

(1) Coverage of master plan

The master plan for sanitation/sewerage service provision will be focused on the domestic wastewater and stormwater disposal will be excluded from the master plan activities, as stipulated in the Scope of Work for the Study and in consideration of presence of plans

for flood control and stormwater disposal.

(2) Strategies to delineate service area boundary for provision of sanitation and sewerage service are prepared in due consideration and interpretation of the aforementioned policies adopted in the DMDP Structure Plan.

These strategies consist of:

1) Designation of target area for master plan preparation,
2) Application of different service levels by area, and
3) Exclusion of wastewater being discharged from Tongi Industrial Estate and other polluting industries.

1) Designation of target area for master plan preparation

Target area for master planning is considered to coincide with the urban area boundary in 2015 as adopted in the DMDP Structure Plan. This means that the proposed urban area for 2015 under the said Structure Plan will remain unchanged through the future until the target year 2020 of this Study.

This strategic decision is based on the uncertainty of long-term framework as admitted in the course of DMDP preparation and on the importance to maintain consistency with the supreme plan, the DMDP Structure Plan, within the reasonable timeframe. Another reason underlying this decision is that an expansion of water supply service to the future urban area of the DMDP Structure Plan is not yet visible state at this moment.

It shall be noted that, in view of the above, the target area of this master plan is subject to periodical review and update corresponding to the implementation progress of relevant infrastructure projects and of the DMDP Urban Area Plan.

2) Application of different service levels by area

There are several implications for provision of public sewerage service:

a. Cost and time requirement

An implementation of sewerage system to achieve the proposed service coverage of the master plan generally requires a considerable period and a large amount of capital investment.

b. Accountability of executing agency

Attainment of sound accountability of the executing agency is subject to thorough restructuring of its institutional and financial set-up in view of financial cash-flow, debt service ratio, cost recovery, and human resource development.

c. Affordability of beneficiaries

Beneficiaries are belonging to different levels of income group and financial affordability in connection with per capita water consumption and payment to water/sewerage service charges and they may stay at more or less similar situation during the master plan period.

d. Different states of urbanization by area

Although the DMDP Structure Plan has been issued as an overall guideline of policy and strategy, the Detailed Area Plan by Strategic Planning Zone are still at the stage of commencement and various legislative arrangements are subject to inter-agency coordination and approval of the Government. While, private sectors keep on running investment at different magnitudes and different fields.

When the above mentioned circumstances and the size of master plan target area are taken into account, there will appear different states of urbanization with different population densities.

Although provision of sewerage service to all over the urban area is idealistic, but not realistic when aforementioned implications are fully taken into account. An application of different service levels by area is therefore deemed the most practical approach as an intermediate measure toward the realization and fulfillment of public sewerage service through the future.

This master plan has introduced a categorization of target area;

- Core area for sewerage service,
- Transitional area from on-site treatment to sewerage service, and
- On-site treatment area.

A conceptual diagram of sanitation/sewerage provision is drawn in Figure 7.2.1 and its itemized explanation of area categorization is provided in Table 7.2.1, respectively.

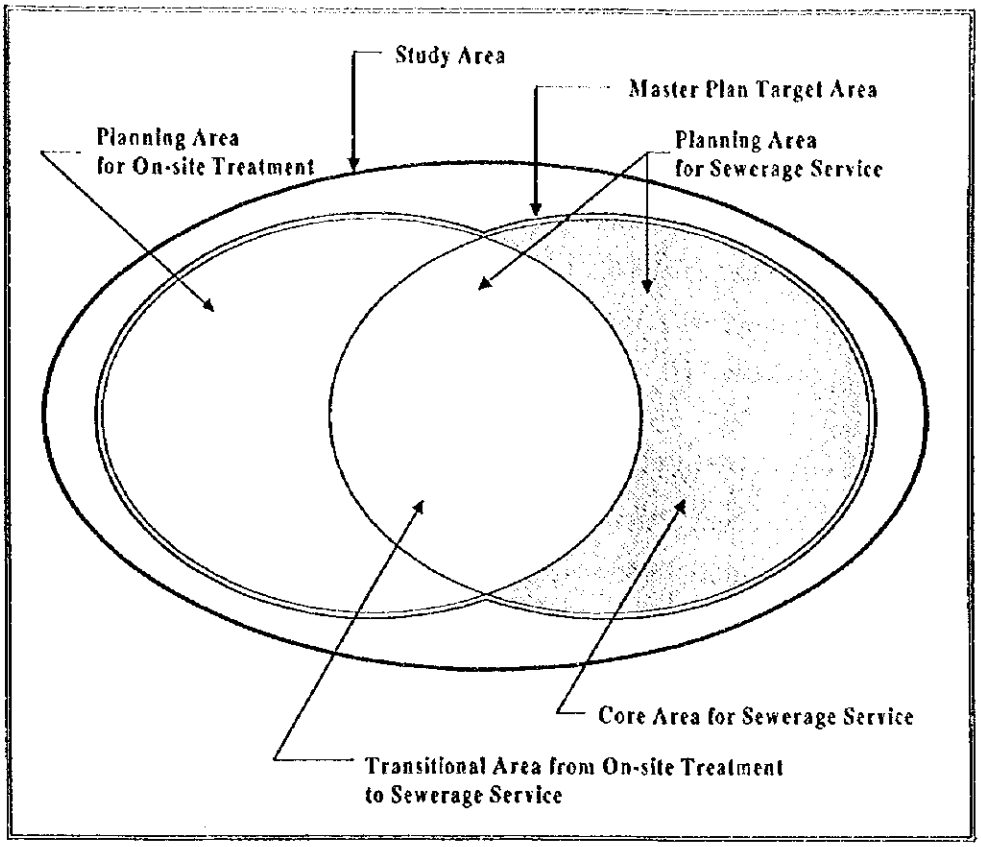


Figure 7.2.1 Conceptual Diagram of Sanitation/Sewerage Provision

Table 7.2.1 Explanation of Conceptual Diagram

Area	Description
Study Area (North Dhaka)	・Dhaka City (Uttara, Mirpur, Mohammadpur, Cantonment, Banani, Badda, Gulshan, Baridhara) ・Tongi Pourashava (Municipality)
Outside the Target Area for Master Plan	Areas outside of the Target Area for Master Plan are rivers, canals, swamps, agricultural area and open space.
Target Area for Master Plan	Master Plan area for sanitation/sewerage provision.
Planning Area for **Sewerage Service**	Areas where sewerage services will be provided by the target year of 2020 under this Master Plan.
Planning Area for **On-site Treatment**	Areas where the existing on-site treatment methods, i.e. septic tank, will be utilized through the future within this Master Plan framework.
Transitional Area from On-site Treatment to Sewerage Service	Areas where the sewage will be treated by sewerage system by shifting from the existing septic tank during the Master Plan period to 2020.
Core Area for Sewerage Service	Existing urbanized areas having relevant infrastructures (water supply and road network) for implementing sewerage project.

3) Exclusion of industrial wastewater from sewerage service

Within the master plan target area, there is the Tongi Industrial Estate which is an integrated industrial complex mostly consisting of textile dying and poultry, followed by pharmaceuticals, dry battery cells, and synthetic detergents. None of these factories has wastewater treatment facilities and their untreated "colorful" wastewater are discharged into the Tongi River via swamp area. This industrial estate is now subject to thorough review of their management with a view of operating procedures and cost effectiveness under Policy SE/2 of the DMDP Structure Plan.

Another typical polluting industry is tannery which discharges toxic wastewater containing Chromium Hexavalent. Most of tannery factories are small scale and located in Hazaribag area of Dhanmondhi in South Dhaka. These factories are subject to relocation to a site adjacent to the Dhaleswari River, south of Savar.

In line with the policy adopted by the DMDP Structure Plan, this master plan of the Study shall take standpoints that:

- Polluting industries shall primarily obey the "Polluters Pay Principle" to safeguard not only the quality of public environment, but also the sewer network and biological treatment process of the sewerage system.
- To realize the above principal approach, such industries shall introduce their own industrial treatment facilities within their factory compound or joint treatment facilities with neighboring factories at their cost, and treat their wastewater prior to discharge into public water body so as to comply with the environmental quality standards.

The Tongi Industrial Estate shall have their integrated industrial wastewater treatment plant, since combined treatment with domestic sewage will have greater risk of environmental degradation. This is because of biological concentration of toxic substances into the sewerage sludge and disposal of such excess sludge will lead to secondary environmental pollution by leachete. Thus, the Tongi Industrial Estate is excluded from the master plan preparation of this Study.

When accepting industrial wastewater into the public sewerage system, each factory shall have primary treatment facilities for their wastewater. Relevant studies on this extent are conducted and presented in the succeeding Chapter, for future reference.

7.3 Target Year

Target year of the North Dhaka Sewerage Master Plan was set forth in 2020 as per the Scope of Work of the Study agreed between the JICA and the Government of Bangladesh (the Ministry of Finance, the Ministry of Local Government, Rural Development and Co-operatives, and the Dhaka WASA) on November 25, 1996.

For the Feasibility Study of Priority Project/s, the target year was determined to be 2005 in consideration of the reasonable time frame for project implementation and the importance to maintain consistency with the DMDP Urban Area Plan which has the same target year.

This target year was also agreed between the Study Team and the DWASA at the 1st Progress Review Meeting on June 25, 1997.

7.4 Identification of Service Level by Area

7.4.1 Identification of Target Area for Master Plan Preparation

(1) Master plan target area consistent with the DMDP Structure Plan

Target year of master planning in this Study was designated to 2020, while that of long term development in the DMDP Structure Plan was set forth to the year 2015.

For the five-year gap of these target years, due attention is given to maintain consistency of this master plan with the DMDP Structure Plan. In this respect, it is assumed that the 2015 urbanized area as proposed in the DMDP Structure Plan will remain unchanged through the future up to 2020 of the master plan target year. This planning assumption is made in view of:

- unavoidable uncertainty principally involved in the long term planning of urban development as admitted by the DMDP in the course of its planning process,
- absence of any other rational plan/program for urban development beyond 2015 at this moment, and
- importance to maintain consistency of framework with the DMDP as the supreme plan for sewerage sector.

(2) Identification of master plan target area

The target area of master plan was then identified focusing on to the future urban area in 2015 of the DMDP Structure Plan. The identification process of target area boundary is described below and its outcome is shown in Figure 7.4.1.

1) Strategic Planning Zone of the DMDP

"Ward" and "Mauza" are commonly used to delineate sub-divisional administrative boundary under municipal level. Its size varies from dozens of hectares to several hundred hectares.

A planning approach employed in the DMDP was to establish "Strategic Planning Zone" (hereinafter referred to as "SPZ") as the principal minimum planning unit by grouping several wards for application of its policy and strategy for urban development.

Each SPZ was likewise characterized by respective features of land development/usage and future population. Areas other than urban development purpose were planned to be strategically used for flood control and recreational purposes.

In respect to the above, future urbanized areas with their sizes and associated population of SPZs are primarily reflected on the framework of master plan preparation in this Study.

2) Sub-classification of SPZs and area measurement

In the DMDP Structure Plan, future population was projected by sub-dividing each SPZ into the existing urbanized area defined as "Established Urban Area" as of 1991, the future urban area such as "Urban Fringe Area" to the existing urbanized area, and "New Urban Land Development Area."

These sub-classifications of SPZs are only exhibited on the SPZ Location Map in the DMDP, but not reflected on the Composite Policies Map which shows overall land use type with boundary. To visualize boundaries of urban area and SPZs, the SPZ Location Map was projected on the Composite Policies Map by the Study Team. Areas of sub-classified SPZs were then measured on the map with the use of digital planimeter.

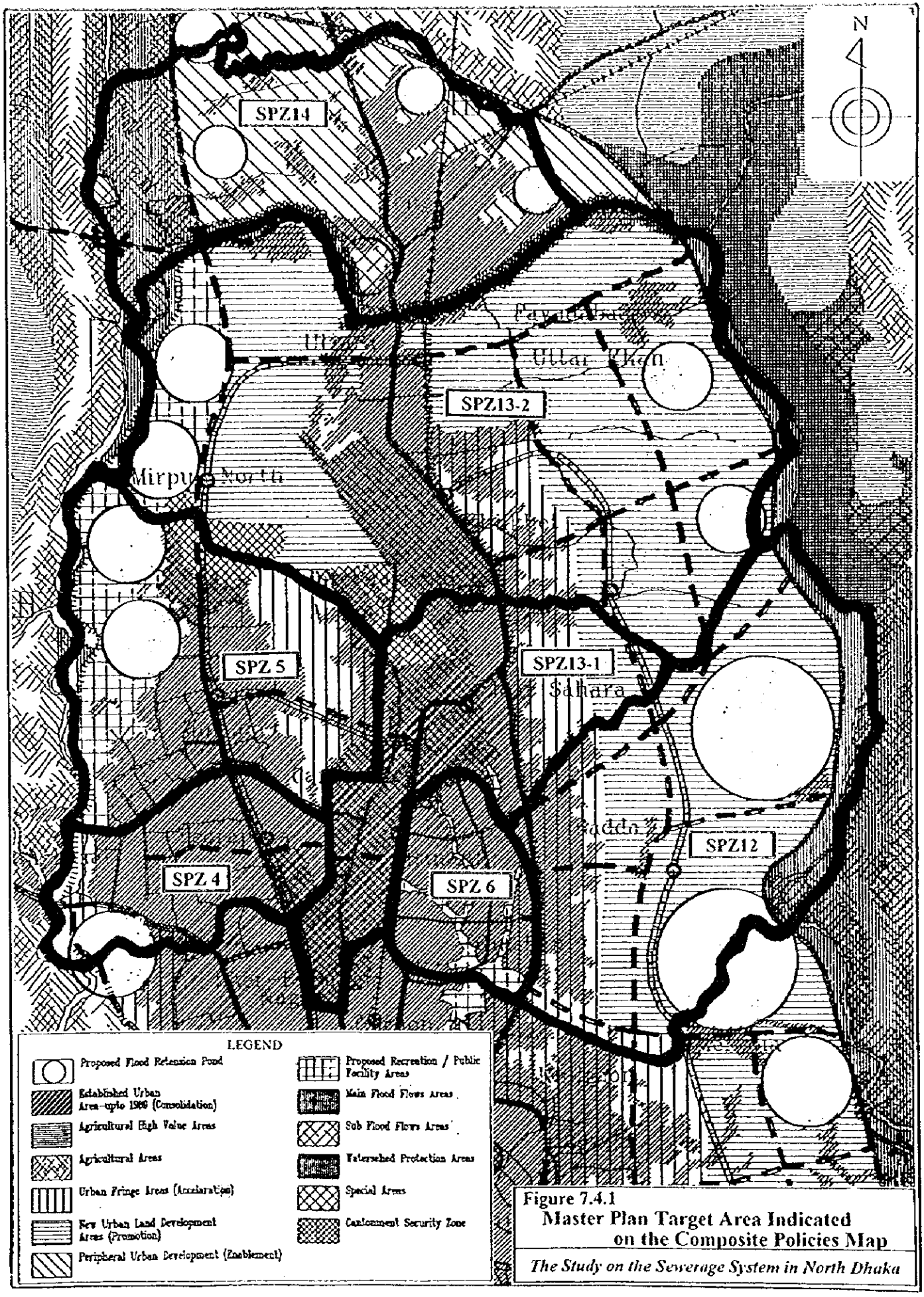


Figure 7.4.1
Master Plan Target Area Indicated on the Composite Policies Map

The Study on the Sewerage System in North Dhaka

Study Area

The Study Area consists of SPZ Nos. 5, 6, 13-1, 13-2, 14 and parts of SPZ Nos. 4 and 12. The total measured area is 20,850 ha.

Master Plan Target Area

The master plan target area is confined to cover residential, commercial and institutional uses which are included in:

- Established Urban Area,
- Urban Fringe Area,
- Peripheral Urban Development Area, and
- New Urban Development Area.

The total area of the master plan target area measured on the map is 14,140 ha which is equivalent to about 68% of the Study Area.

The following areas specified in the DMDP Structure Plan are excluded from the master plan target area:

- Proposed Flood Retention Pond,
- Proposed Recreation Area, and
- Tongi Industrial Estate as Special Area.

7.4.2 Service Level by Area

(1) Methodology for identifying service level by area

Principal methodology to identify target area for sanitation/sewerage planning is to refer:

- Strategy for sanitation/sewerage service provision as discussed in Section 7.2, and
- Land development/usage proposed in the DMDP.

Two service levels are considered in this master plan; sewerage service and on-site treatment. The sewerage service is further subdivided into:

- Core area for sewerage service provision, and
- Transitional area from on-site treatment to sewerage service during the master plan period to 2020.

On-site treatment area is considered to remain unserved by the sewerage service during the master plan period. This area will have septic tank or any other appropriate sanitation measures including the intermediate method, such as small bore communal sanitation system for a cluster of individual housing, small scale community sewerage system for apartment type housing, etc.

Schematic diagram of the composition of target area is shown in Figure 7.4.2. Identified areas by service level are shown in Table 7.4.1 and Figure 7.4.3, respectively.

Figure 7.4.2 Schematic Diagram of the Composition of Master Plan Target Area

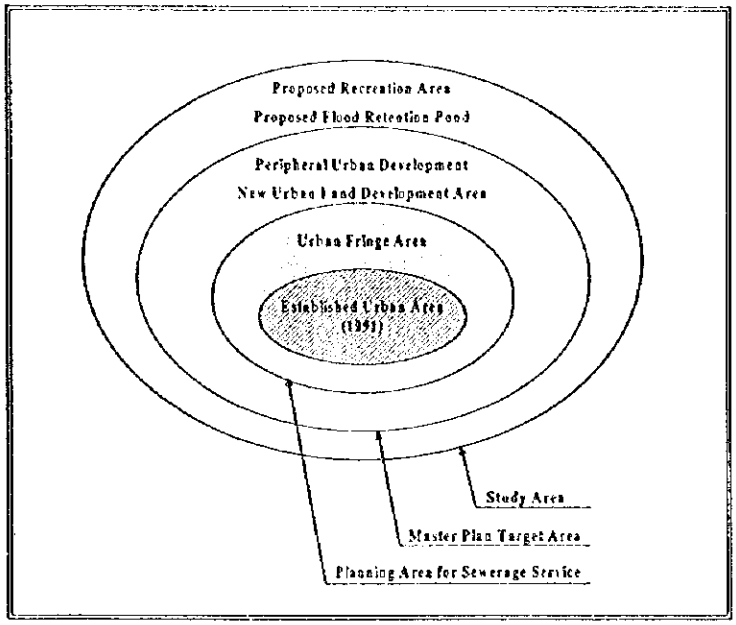
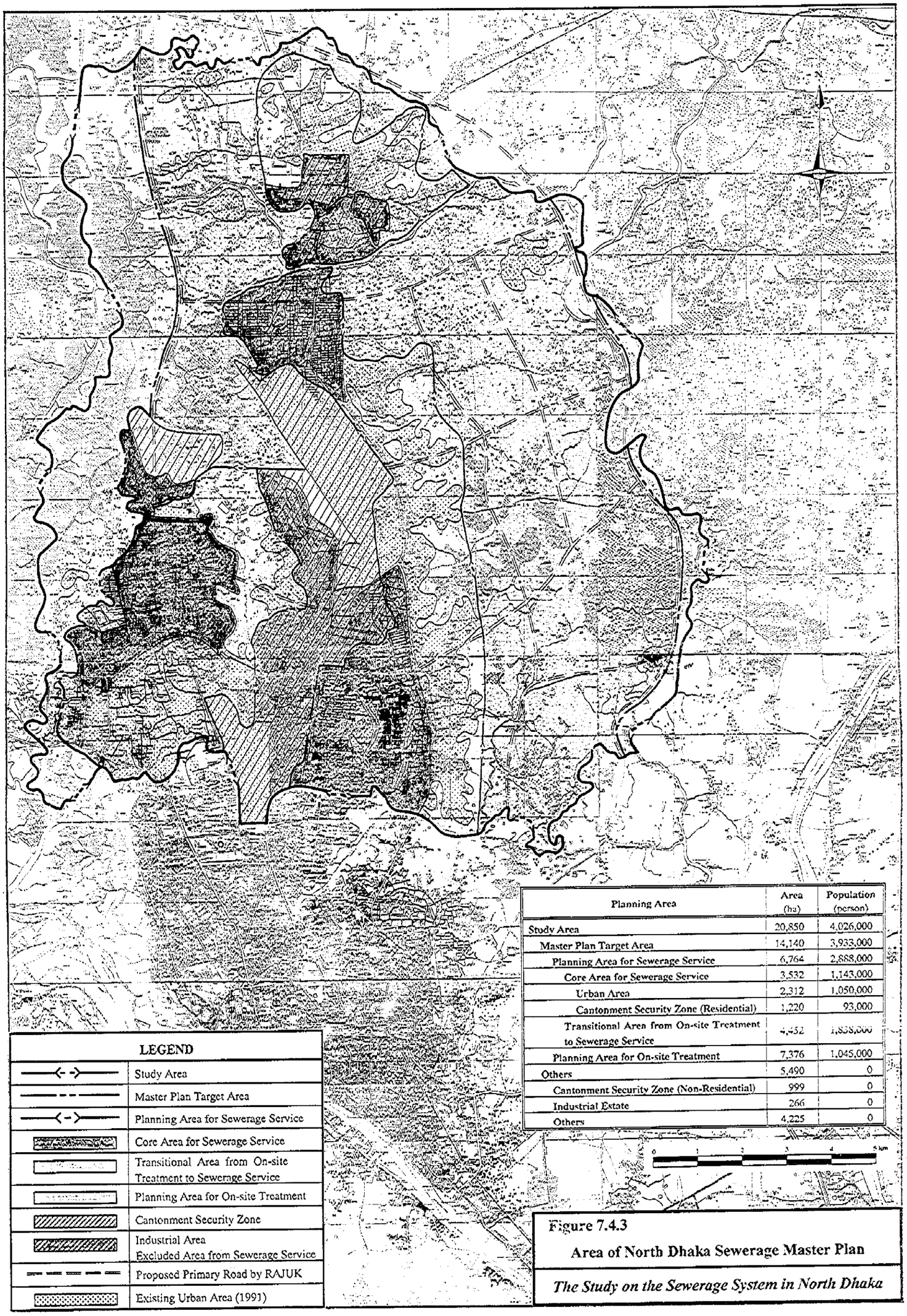


Table 7.4.1 Area of North Dhaka Sewerage Master Plan

Unit: ha

SPZ No.	Stydy Area										
	Master Plan Target Area						Others*1				Grand Total
	Sewerage Service Area				On-site Treatment Area	Total	Cantoment (Non-Residential)	Industrial Estate	Flood Control, etc.	Total	
	Core Area		Transitional Area	Sub-Total							
	Urban Area	Cantoment (Residential)									
4	55	0	992	1,047	0	1,047	63	0	163	226	1,273
5	734	232	685	1,651	10	1,661	115	0	849	964	2,625
6	732	68	0	800	0	800	0	0	132	132	932
12	0	0	712	712	1,624	2,336	0	0	1,323	1,323	3,659
13-1	136	855	547	1,538	261	1,799	338	0	0	338	2,137
13-2	504	65	624	1,193	4,714	5,907	483	0	608	1,091	6,998
14	151	0	892	1,043	767	1,810	0	266	1,150	1,416	3,226
Total	2,312	1,220	4,452	7,984	7,376	15,360	999	266	4,225	5,490	20,850

Note: *1- Others in Study Area include Flood Flow Area, Flood Retention Pond, Watershed,etc.



Planning Area	Area (ha)	Population (person)
Study Area	20,850	4,026,000
Master Plan Target Area	14,140	3,933,000
Planning Area for Sewerage Service	6,764	2,888,000
Core Area for Sewerage Service	3,532	1,143,000
Urban Area	2,312	1,050,000
Cantonment Security Zone (Residential)	1,220	93,000
Transitional Area from On-site Treatment to Sewerage Service	4,452	1,838,000
Planning Area for On-site Treatment	7,376	1,045,000
Others	5,490	0
Cantonment Security Zone (Non-Residential)	999	0
Industrial Estate	266	0
Others	4,225	0

Figure 7.4.3

Area of North Dhaka Sewerage Master Plan

The Study on the Sewerage System in North Dhaka

7.5 Design Population

7.5.1 Methodology to Set Up Future Population in DMDP

The future population for master plan preparation of this Study is principally referred to the DMDP population framework, but minor modification is introduced to population breakdown by SPZ in order to maintain the consistency with the overall figure of the DMDP.

The DMDP projected the future population for 2005 and 2015 by different methods due to considerable uncertainty in the long term planning of urban development.

(1) Categorization of planning area for population projection

The DMDP subdivided the Metropolitan Dhaka area into the following three categories in its population projection:

- Established Urban Area in 1983,
- Established Urban Area in 1991, and
- Additional New Area.

"Additional New Area" mentioned in the above denotes a comprehensive naming to cover "Urban Fringe Area," "Peripheral Urban Development Area," and "New Urban Land Development Area."

(2) Population projection for the year 2005

In principle, the DMDP projected future population of each SPZ in 2005 based on the population growth rate from 1983 to 1991 (Population Census data).

Future population in 2005 as exhibited in Figure 7.5.1 is projected based on the following method in the DMDP:

1) Established Urban Area in 1983
   a. Adopt the 1991 Population Census data as the base figure.
   b. Establish population growth rates of each SPZ in accordance with the respective urban development policies/strategies.
   c. Estimate the future population of each SPZ based on the base population figure and the population growth rates.

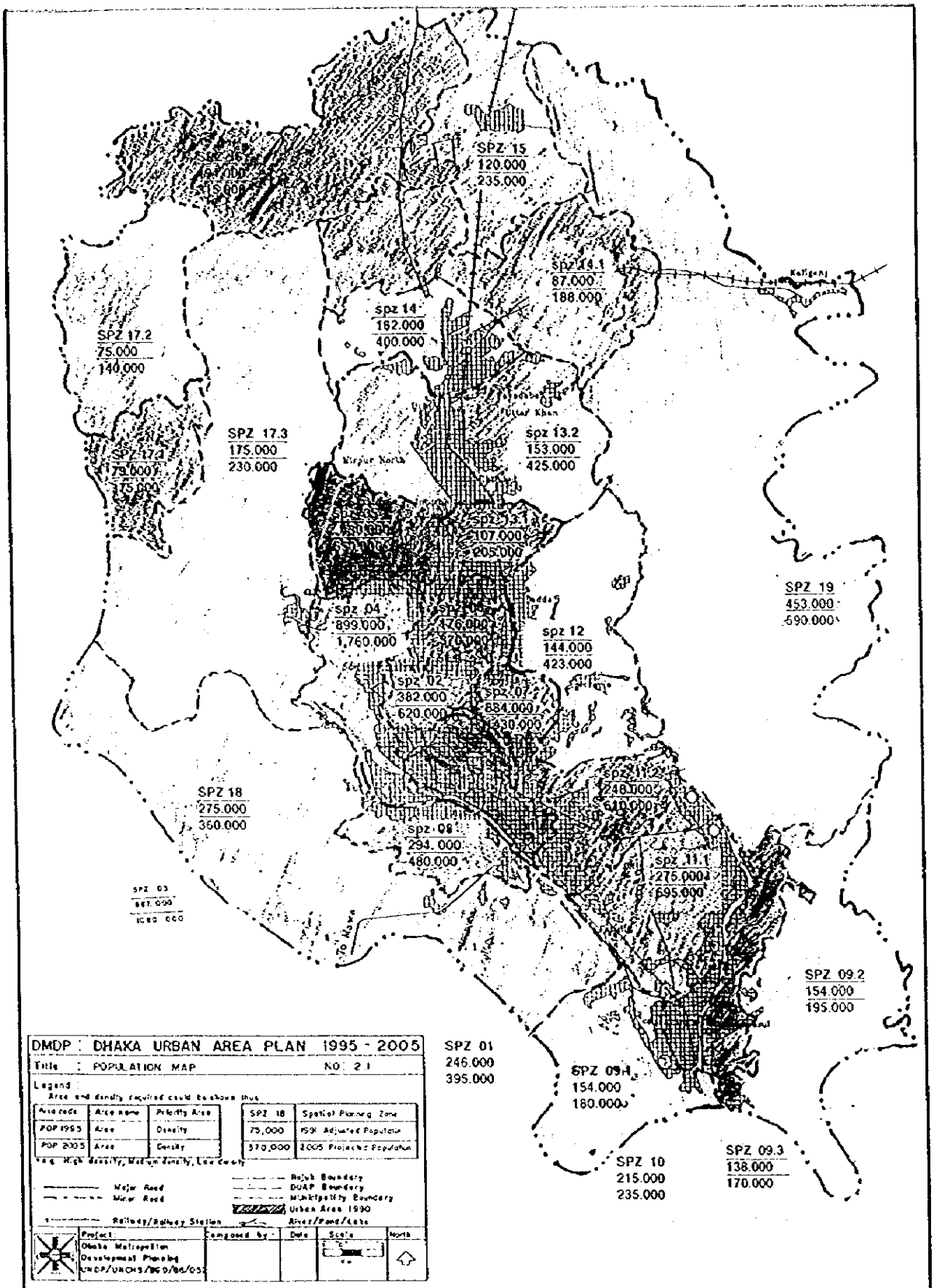


Figure 7.5.1

Population Map

The Study on the Sewerage System in North Dhaka

2) Established Urban Area in 1991

a. Estimate the population density of the Established Urban Area in 1983

b. Determine the size (area) of the Established Urban Area in 1991.

c. Estimate the future population of each SPZ based on the above population density and area.

3) Additional New Area

a. Determine the size (area) of the Additional New Area.

b. Establish the future population density by SPZ.

c. Estimate the future population based on the above population density and area.

(3) Population projection for the year 2015

For the population projection in 2015, conditions and assumptions for SPZs as introduced in the 2005 population projection are not taken up. The DMDP shows the total population in the planning area and a breakdown by year of urbanization as shown in Table 7.5.1.

Table 7.5.1 Future Population Projected in the DMDP

Unit: person

Area	2005 (1)	Target of Growth Distribution (2)	2015* (3) = (1) + (2)
Established Urban Area in 1983	9,431,000	590,000	10,021,000
Established Urban Area in 1991	698,000	590,000	1,288,000
Additional New Area	2,490,000	1,770,000	4,260,000
Total	12,619,000	2,950,000	15,569,000

Note: Population in 2015 includes outside of the Study Area.

7.5.2 Design Population for the Study

(1) Methodology to establish design population

Although the population framework of the DMDP is primary reference figure, it can not be applied directly to the planning work in this Study due to its roughness in areal project.

In this master plan, the following methodology is taken up:

1) Area by year of urbanization by SPZ is measured.
2) The DMDP 2015 population is reallocated by year of urbanization (Established Urban Area in 1983 & 1991, and Additional Urban Area) in each SPZ.
3) The population density in 2015 is estimated by year of urbanization by SPZ.
4) Future population in target year of 2020 (2015 in DMDP) is estimated by multiplying area in 1) and population density in 3).

(2) Design population

Future population by SPZ in the Study Area are estimated based on the aforementioned method and its results are shown in Table 7.5.2.

As shown on the above, the total population of the master plan target area is estimated to reach 3.05 million in 2005 consisting of 2.16 million in the Established Urban Area and 0.89 million in the Additional New Area. The 2005 population will likewise increase 2.1 times of the 1991 population (1.43 million) in the 14 years period from 1991 to 2005.

Consequently, the future population in the target year 2020 will continuously increase to 4.03 million which is equivalent to 1.3 times of the 2005 population and 2.8 times of the 1991 population, respectively. These projected trends of population development are exhibited in Figure 7.5.2.

For reference, the future population adopted in "the Dhaka City Emergency Water supply Project" is also indicated in Table 7.5.2 and Figure 7.5.3, respectively. It is clearly observed that the trend of population development since 1991 toward the year 2020 are quite similar to each other. For instance, the DMDP adopts future population of 4,026,000 in 2015, while "the Dhaka City Emergency Water Supply Project" shows 4,566,974 in the same year. Since this master plan study assumes that the 2015 DMDP population will remain unchanged up to the target year of 2020, the difference of future population between the Study and "the Dhaka City Emergency Water Supply Project" will be about 10% in 2020.

Table 7.5.2 Design Population by SPZ in 2020

Unit: person

Year	SPZ No.	Established Urban Area	Additional New Area	Total	Remark *1
1991	4	337,000	0	337,000	
	5	430,000	0	430,000	1991:
	6	176,000	0	176,000	1,249,489
	12	67,000	0	67,000	
	13-1	107,000	0	107,000	1995:
	13-2	153,000	0	153,000	1,562,294
	14	162,000	0	162,000	
	Total	1,432,000	0	1,432,000	2000:
2005	4	589,000	93,000	682,000	2,005,586
	5	654,000	0	654,000	
	6	295,000	75,000	370,000	2010:
	12	136,000	183,000	319,000	3,098,901
	13-1	126,000	80,000	206,000	
	13-2	173,000	250,000	423,000	2020:
	14	190,000	210,000	400,000	4,566,974
	Total	2,163,000	891,000	3,054,000	
2015	4	695,000	159,000	854,000	
	5	791,000	0	791,000	
	6	345,000	128,000	473,000	
	12	149,000	313,000	462,000	
	13-1	131,000	137,000	268,000	
	13-2	179,000	428,000	607,000	
	14	212,000	359,000	571,000	
	Total	2,502,000	1,524,000	4,026,000	

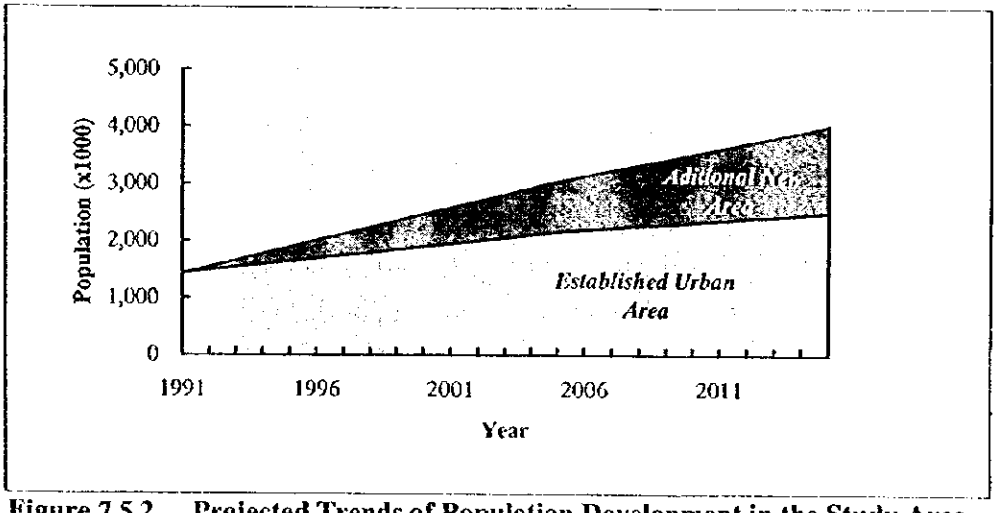


Figure 7.5.2 Projected Trends of Population Development in the Study Area

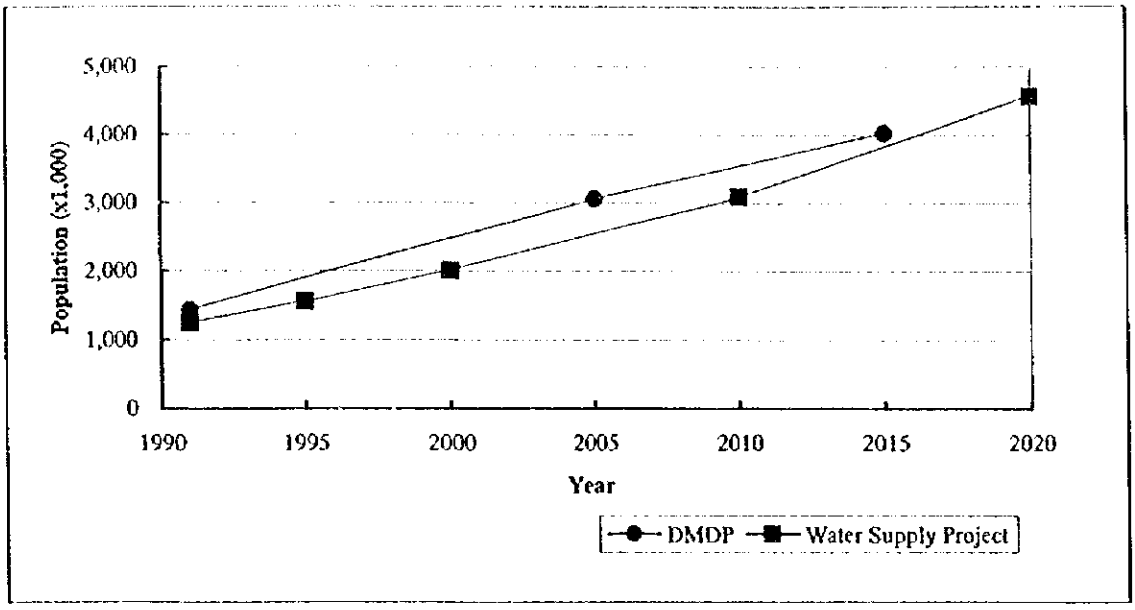


Figure 7.5.3 Comparison of Future Population of DMDP and Dhaka City Emergency Water supply Project

(3) Estimation of population density

SPZ includes several different category of urban area by its planned urbanization. Therefore, population density of each SPZ varies by composition of the urban area.

The population density is estimated as follows:

1) Measurement of urban area (Established Urban Area and Additional New Area) on the Composite Policies Map of the DMDP Structure Plan.
2) Allocation of the future population estimated in the previous sub-section to the areas measured on the above.
3) Estimation of the population density by SPZ.

It shall be noted that the areas designated in the Composite Policies Map of the DMDP Structure Plan and the areas referred in estimating the future population are matched as shown in Table 7.5.3.

Table 7.5.3 Correspondence of Areas between the Composite Policies Map and the Population Projection

Areas on the Composite Policies Map	Allocation of Future Population
Established Urban Area (EUA)	Established Urban Area
Urban Fringe Area New Urban Land Development Area Peripheral Urban Development Area	Additional New Area
Cantonment Security Zone-residential	Population Density: 76 person/ha (from SPZ 13-1: 65,000 person/855ha)
Cantonment Security Zone-non-residential	No resident

The estimated population density by SPZ are shown in Tables 7.5.4.

Table 7.5.4 Population Density by SPZ in the Study Area (2020)

SPZ	Type of Area / Description		Established Urban Area	Additional New Area	Cantonment Security Zone (Residential)	Total
4	Area	(ha)	945	102	0	1,047
	Population	(person)	695,000	159,000	0	854,000
	Density	(person/ha)	735	1,559	0	816
5	Area	(ha)	992	437	232	1,661
	Population	(person)	773,000		18,000	791,000
	Density	(person/ha)	541	541	76	476
6	Area	(ha)	732		68	800
	Population	(person)	335,000	128,000	5,000	468,000
	Density	(person/ha)	639		76	585
12	Area	(ha)	457	1,879	0	2,336
	Population	(person)	149,000	313,000	0	462,000
	Density	(person/ha)	326	167	0	198
13-1	Area	(ha)	473	471	855	1,799
	Population	(person)	66,000	137,000	65,000	268,000
	Density	(person/ha)	140	291	76	149
13-2	Area	(ha)	903	4,939	65	5,907
	Population	(person)	174,000	428,000	5,000	607,000
	Density	(person/ha)	193	87	76	103
14	Area	(ha)	832	978	0	1,810
	Population	(person)	212,000	359,000	0	571,000
	Density	(person/ha)	255	367	0	315
Total	Area	(ha)	14,140		1,220	15,360
	Population	(person)	3,928,000		93,000	4,021,000
	Density	(person/ha)	278		76	262

Note 1) The fgures in SPZ4 and SPZ12 correspond to the study areas within these zones.
2) SPZ5 : While Urban Fring Area was established, Additional New Area was not iden in DMDP. Thus, the population density was calculated by allocating some portion of population in Established Urban Area to Additional New Area.
3) SPZ6 : Though the population of Additional New Area was planned in DMDP, its a was not projected. Accordingly, that population was included in that of in Established Urban Area and the population density was calculated.

(4) Establishment of future population for the Study

1) Future population in the Study Area

The future population in the Study Area is estimated multiplying the areas measured on the Composite Policies Map and the corresponding population density.

Table 7.5.5 shows the future population and the population density by target year together with base figure in 1991 classified into subject area for planing purpose. The population composition in the master plan target area in 2020 is shown in Figure 7.5.4.

Table 7.5.5 Future Population in the Study Area

Items	Study Area										
	Master Plan Target Area						Others				Grand Total
	Sewerage Service Area				On-site Treatment Area	Total	Cantonment (Non-Residential)	Industrial Estate	Flood Control, etc.	Total	
	Core Area		Transitional Area	Sub-Total							
	Urban Area	Cantonment (Residential)									
Area (ha)	2,312	1,220	4,452	7,984	7,376	15,360	999	266	4,225	5,490	20,850
Density	454	76	413	373	142	262	0	0	0	0	193
Population	1,050,000	93,000	1,838,000	2,981,000	1,045,000	4,026,000	0	0	0	0	4,026,000

Note: Density-Person/ha; Population-person
Urban Area is Established Urban Area and Additional New Area
Flood Control, etc include Flood Flow Area, Flood Retention Pond, Watershed, etc.

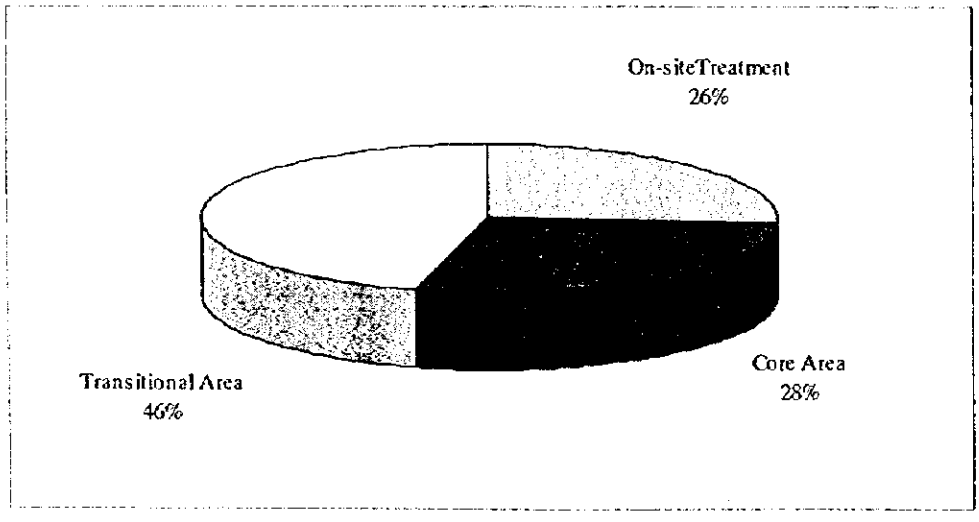


Figure 7.5.4 Population Composition of the Master Plan Target Area in 2020

As shown in the figure, about 74% of the urban population or some 2.98 million people will be the target population for the sewerage master plan, while 26% or some

1.05 million people will remain in the on-site treatment area in the target year of 2020 of this master plan. A group of 93,000 people to be contained in the "Cantonment Security Zone" as classified in "Others" is not included in this master plan.

2) Future population in the sewerage planning zone

The future population in the master plan target year 2020 has been established mainly based on SPZs. This future population is hereby subdivided into sewerage planning zones for the purpose of sewerage master plan preparation.

In zoning of the sewerage planning area, following conditions are due considered:

- Geographical and topographic conditions of "Core Area,"
- Compactness and areal configuration of each zone for sewerage service, and
- Road network proposed in the DMDP Structure Plan.

Four zones are considered for planning the sewerage system in North Dhaka as shown in Table 7.5.6.

Table 7.5.6 Zoning for Sewerage System Planning in North Dhaka

Sewerage Zone	SPZ	Municipality/Ward
Tongi	SPZ14	Tongi
Uttara	SPZ13-2	Uttara
North Dhaka East	SPZ5, SPZ6, SPZ12, SPZ13-1, SPZ13-2	Badda, Banani, Baridhara, Gulshan, Cantonment
North Dhaka West	SPZ4, SPZ5	Mirpur, Mohammadpur, Cantonment

Based on the above zoning, future population, population density and area by SPZ by sewerage zone are finally established for the target year of 2020.

Table 7.5.7 Planned Area, Population Density and Population by Sewerage Zone in North Dhaka

Unit: Area - ha; Population density - person/ha; Population - person

Sewerage Zone	SPZ	Item	Sewage Service Area								
			Core Area					Transitional Area			Total
			Established Urban Area	Additional New Area	Sub-Total	Cantonment (Residential)	Total	Established Urban Area	Additional New Area	Sub-Total	
Tongi	14	Area	151	0	151	0	151	549	343	892	1,043
		Density	255	0	255	0	255	255	367	297	291
		Population	39,000	0	39,000	0	39,000	139,000	126,000	265,000	304,000
Uttara	13-2	Area	399	105	504	0	504	288	224	512	1,016
		Density	193	87	171	0	171	193	87	146	158
		Population	77,000	9,000	86,000	0	86,000	56,000	19,000	75,000	161,000
North Dhaka East	5	Area	0	0	0	102	102	0	0	0	102
		Density	0	0	0	76	76	0	0	0	78
		Population	0	0	0	8,000	8,000	0	0	0	8,000
	6	Area	732	0	732	68	800	0	0	0	800
		Density	639	0	639	76	591	0	0	0	591
		Population	468,000	0	468,000	5,000	473,000	0	0	0	473,000
	12	Area	0	0	0	0	0	457	255	712	712
		Density	0	0	0	0	0	326	167	270	270
		Population	0	0	0	0	0	149,000	43,000	192,000	192,000
	13-1	Area	136	0	136	855	991	337	210	547	1,538
		Density	140	0	140	76	85	140	291	197	125
		Population	19,000	0	19,000	65,000	84,000	47,000	61,000	108,000	192,000
	13-2	Area	0	0	0	65	65	44	68	112	177
		Density	0	0	0	76	76	193	87	125	107
		Population	0	0	0	5,000	5,000	8,000	6,000	14,000	19,000
	Total	Area	868	0	868	1,090	1,958	838	533	1,371	3,329
		Density	561	0	561	76	291	243	206	229	266
		Population	487,000	0	487,000	83,000	570,000	204,000	110,000	314,000	884,000
North Dhaka West	4	Area	55	0	55	0	55	890	102	992	1,047
		Density	735	0	735	0	735	735	1,559	816	816
		Population	40,000	0	40,000	0	40,000	655,000	159,000	814,000	854,000
	5	Area	734	0	734	130	864	248	437	685	1,549
		Density	541	0	541	76	472	541	541	540	502
		Population	398,000	0	398,000	10,000	408,000	134,000	236,000	370,000	778,000
	Total	Area	789	0	789	130	919	1,138	539	1,677	2,596
		Density	555	0	555	76	487	693	733	706	629
		Population	438,000	0	438,000	10,000	448,000	789,000	395,000	1,184,000	1,632,000
Total		Area	2,207	105	2,312	1,220	3,532	2,813	1,639	4,452	7,984
		Density	472	86	454	76	324	422	397	413	373
		Population	1,041,000	9,000	1,050,000	93,000	1,143,000	1,188,000	650,000	1,838,000	2,981,000

7.6 Collection System

There are two different types of sewer system; separate system is to drain sanitary sewage and stormwater by different sewer lines, combined system drains these two water in the same sewer line.

Since the separate system is to convey only the sanitary sewage into the sewage treatment plant, it does not spill out sanitary sewage into the public water body during the raining period and therefore it is advantageous for conservation of aquatic environment.

When the target area is relatively well equipped with stormwater drainage system, the separate sewer system can be implemented economically with the use of existing drainage system for stormwater disposal. The separate system has, however, following potential disadvantages that:

- Considerable amount of pollutants accumulated the road surface will be washed out at the beginning of rainfall and discharged into the public water body through storm sewer.
- Installation work of both sanitary and storm sewers becomes difficult, when there exist other underground utilities in the built-up area.
- Installation depth of sanitary sewer becomes deeper than the combined sewer, owing to its smaller diameter and steeper gradient of vertical alignment.

The combined sewer system is, on the other hand, advantageous for the areas where the inundation occurs frequently or the provision of the stormwater drainage facility is insufficient. The sewer pipe installation of this system is easier than that of the separate system. The combined sewer system has also certain disadvantages on the conservation of aquatic environment when:

- Flushing of sediments in sewer lines causes to happen shock load to the sewage treatment plant at the beginning of rainfall.
- Stormwater overflow chamber discharges the diluted sewage exceeding the design intercepting capacity of sewer lines during the rainfall.

For the North Dhaka sewerage master plan, the separate sewer system is adopted paying due attentions to that:

- The existing sewerage system employs the separate sewer system.
- The Study aims at the prevention of water pollution in the public water body through the provision of sewerage system including sewage treatment plant.
- The comprehensive flood protection and stormwater drainage plan has been developed including the Study Area.

7.7 Design Sewage Flow

The design average daily, maximum daily and maximum hourly sewage flows are set for the target year 2020 taking into account the current status and future plan of water supply, and the existing sewerage plan for South Dhaka.

7.7.1 Per Capita Sewage Flow

(1) Present status of water supply

As to the present status of water supply, the actual performance of water supply was investigated from the clients' ledger for water supply in DWASA Zone V, within the Master Plan Target Area. Among the 80 collected data, 27 were extracted considering the reliability of actual figure and composition of the relevant data to calculate the per capita water consumption. The results are shown in Appendix 7.7.1. In accordance to the results, the present per capita water consumption was figured out as 93 lpcd, approximately.

(2) Results of field survey

A sewage quantity survey was carried out to grasp the present status of the domestic sewage flow rate. Selecting three (3) different types of housing, namely independent houses, apartment house and slum housing, the survey was conducted six (6) times a day at four (4) hour intervals during both the rainy season (July 1997) and dry the season (December 1992). The daily domestic sewage flow was calculated using the average of the six (6) measurements.

The number of houses within the survey area was also investigated by type of housing, as mentioned above, and was used to estimate the per capita domestic sewage flow. The population of the area was estimated by multiplying the number of housing units and the average number of family members, which was obtained from the results of the Questionnaire Survey on Residents' Awareness on Environmental Sanitation. The per capita domestic sewage flow is summarised in Table 7.7.1.

Table 7.7.1 Per Capita Domestic Flow by Sewage Quantity Survey

Item		Independent House	Apartment House	Slum Housing	Total/ *Average
No. of Houses		30	35	55	120
Family Size		5.9	6.4	5.3	5.8
Population		180	220	290	690
Flow Rate (l/day)	Rainy Season	84,000	54,800	72,200	211,000
	Dry Season	467	249	249	333
Per Capita Flow Rate (lpcd)	Rainy Season	72,000	67,200	134,400	342
	Dry Season	400	305	463	397

Note: Date of Survey; Rainy Season -June 1997
Dry Season -December, 1997

* Per capita flow rate

Compared with the water consumption and design per capita sewage flow in the existing sewerage service area, the estimated per capita domestic sewage flow determined in this sewage quantity survey was rather large; the reasons for this large figure were as follows:

- In the rainy season, rainwater and stagnant water were deemed to flow into the sewer lines. It is relating to the fact that the BOD and T-N are relatively low, while the SS was relatively high, which indicated that the domestic sewage was diluted by rain water, etc. and the SS contents was supplied from soils, etc.
- In the dry season, sewage flow from apartment housing and slum housing was larger than that of the dry season, while sewage from the independent housing decreased. These facts also indicate that the domestic sewage was mixed with other sources of water in the sewer lines.

Based on the above survey evaluation, the survey results were utilised as reference data in establishing the per capita sewage flow.

(3) Existing sewerage service area

Table 7.7.2 shows the design per capita sewage flow in the existing sewerage service area in South Dhaka.

Table 7.7.2 Design Per Capita Sewage Flow of Existing Sewerage System

Item	Design Population (Person)	Design Sewage Flow (cu.m/day)	Per Capita Sewage Flow (lpcd)
Design Average Daily Flow	1,880,000	146,000	80
Design Maximum Daily Flow		183,000	100
Design Maximum Hourly Flow		232,000	125

(4) Plans for water supply

The basis for the Fourth Dhaka Water Supply Project presented in the World Bank's Staff Appraisal Report (1996) is given in Table 7.7.3, from which the per capita water consumption was estimated at 137 lpcd for the target year 2020 as shown in Table 7.7.4 and Figure 7.7.1. The values of dry season daily peak and physical losses adopted in this estimation are the same as those that used in the estimation of water requirements in the Dhaka City Emergency City Water Supply Project (1992).

Tongi is not included in the DWASA water supply service area, however, its per capita water consumption is assumed to be the same as that in the DWASA service area, since

Tongi adjoins Dhaka City and there is no significant difference in living style. Although the per capita water consumption of 137 lpcd is the average of the overall DWASA service area and does not represent the Study Area, it is also applied to the Study Area, because the EUZs 1 to 13 out of the 36 Elementary Urban Zones used in the Dhaka City Emergency Water Supply Project (1992) approximately correspond to the Study Area excluding Tongi and Cantonment and have no significant difference in the per capita water consumption with the overall average as shown in Appendix 7.7.2.

Table 7.7.3 Total Water Requirement, Capacity and Deficit Projections

	Total Water Requirements			
	Current	2000	2010	2020
cu.m/day	1,192,178	1,370,745	1,762,428	2,480,522
IMGD	262	302	388	546
MGY	95,630	110,230	141,620	199,210
	Production Capacity (IMGD)			
	Current	2000	2010	2020
Groundwater	173	197	217	234
Chandnigat	10	10	10	10
Narayanganj	9	9	9	9
Phase 1 Treatment Plant	-	50	50	50
Phase 2 Treatment Plant	-	-	100	100
Phase 3 Treatment Plant	-	-	-	100
Total	192	266	386	503
	Projected Water Shortage (IMGD)			
	Current	2000	2010	2020
Total DWASA Capacity	189	266	386	503
Production	166	256	375	491
Total Requirements	262	302	388	546
Water Shortage	96	46	13	55

Source: "Fourth Dhaka Water Supply Project (1995)"

Table 7.7.4 Calculation of Per Capita Water Supply

Item		Unit	1995	2000	2010	2020
Population	a	person	5,647,991	6,778,340	9,261,394	12,618,842
Water Requirement	b	IMGD	262	302	388	546
Production Capacity	c	IMGD	192	266	386	503
Production	d	IMGD	166	256	375	491
Dry Season Daily Peak	e	%	10	10	10	10
Physical Losses	f	%	31	28	20	15
Actual Water Supply	g	IMGD	104	168	273	379
Per Capita Water Supply	h	lpcd	84	113	134	137

Note: Source:"Dhaka City Emergency Water Supply Project" and "Fourth Dhaka Water Supply Project"
Calculation: g = d * (1 + e/100) / (1 - f/100)

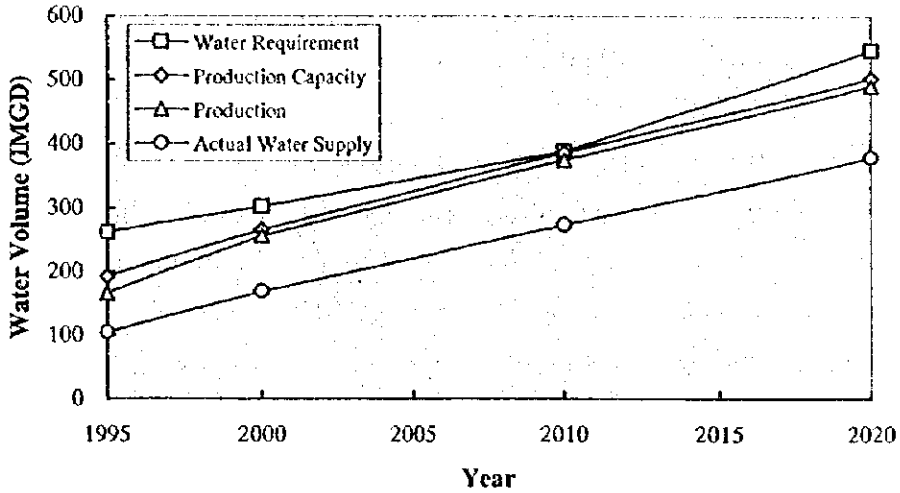


Figure 7.7.1 Water Supply Project of DWASA

It should be noted that the above per capita water consumption is composed of those for residential, industrial and urban service purposes. In this connection, the Dhaka City Emergency City Water Supply Project (1992) assumed that the present percentages of these water uses will not change in the future, namely 81.15% for residential, 4.66% for industrial and 14.19% for urban service as presented in Table 7.7.5. Although the study team carried out the investigation on the actual water consumption by water use to compare the above rate to the actual ratio, such data were not available.

Table 7.7.5 Per Capita Water Supply and Sewage Flow

Unit: lpcd

Item	Ratio (%)	1995	2000	2010	2020
Per Capita Water Supply	100.00	84.0	113.0	134.0	137.0
Domestic	81.15	68.0	92.0	109.0	112.0
Industry	4.66	4.0	5.0	6.0	6.0
Urban Service	14.19	12.0	16.0	19.0	19.0
Per Capita Water Supply for Sewerage Plan		80.0	108.0	128.0	131.0
Per Capita Sewage Flow		56	76	90	92

As in the Study, industrial wastewater is not accepted to a sewerage system in principle, the per capita water consumption will be 131 lpcd deducted 6 lpcd for industrial use from 137 lpcd is the basis for estimating the per capita sewage flow for the target year 2020 as shown in Table 7.7.5. Given that 70% of the per capita water consumption will enter into the sewerage system,. then the per capita sewage flow is 92 lpcd.

In general, daily and hourly maximum flow can be estimated by actual water consumption and hourly fluctuation of incoming sewage rate to the sewage treatment plant. However, no data were available on actual water consumption in the study area and hourly fluctuation of incoming sewage rate in Pagla STP will not be appropriate since the sewage was conveyed from plural Lift Stations and actual sewage flow fluctuation will be equalized at L/Ss. Accordingly, daily and hourly maximum per capita sewage flow was calculated adopting the general values, shown in Table 7.7.6, assuming the groundwater infiltration is10% of the maximum daily flow.

Table 7.7.6 Per Capita Sewage Flow

Item	Sewage Flow (lpcd)	Groundwater Infiltration (lpcd)	Total (lpcd)
Design Average Daily Flow	92	10	100
Design Maximum Daily Flow	115		125
Design Maximum Hourly Flow	150		160

(5) Design sewage flow

Per capita sewage flow up to the target year of 2020 was established by the comprehensive study on future water supply plan, the results of actual water consumption and sewage quantity survey and design criteria of the existing sewerage service area. Please refer Table 7.7.7.

Table 7.7.7 Per Capita Sewage Flow by Year

Unit: lpcd

Item	2000	2005	2010	2015	2020
Design Average Daily Flow	85	95	100	100	100
Design Maximum Daily Flow	105	115	125	125	125
Design Maximum Hourly Flow	135	145	160	160	160

7.7.2 Per Capita Pollution Load

Among others, BOD (Biochemical Oxygen Demand) and SS (Suspended Solids) are the most important water quality parameters in planning and designing of the sewage treatment plant. BOD, in particular, plays a role of key parameter in the determination of the required capacity of the sewage treatment plant.

Three methods are commonly used to determine BOD of the sewage. The first method is the estimation of BOD with the use of the unit BOD pollution load at per capita per day and the sewage volume. The second method is, of course, the estimation of BOD based on the result of water quality examination of actual sewage sampled from the Study Area.

A series of water sampling and water quality examination was repeatedly carried out during the course of field work of the Study. These analysis results will be referred to in establishing the planned sewage quality.

(1) Examination of sewage quality

BOD value will be estimated with the use of actual data in other countries and compared to the analysis results of water samples collected in this field work.

There are some report on the study of unit BOD pollution load of domestic sewage stemmed from field investigations. The following are the findings and study results:

1) Japan (in 1990)

Unit: g/capita/day

Water Quality Parameter	Nightsoil	Gray Water	Total
BOD	18	39	57
COD_{Mn}	10	18	28
SS	20	23	43
T-N	9	3	12
T-P	0.9	0.3	1.2

2) United States

Unit: g/capita/day

Water Quality Parameter	Nightsoil	Gray Water	Total
BOD	23	55	78

3) Tropical countries

Unit: g/capita/day

Water Quality Parameter	Nightsoil	Gray Water	Total
BOD	22	18	40

4) Other countries

Unit: g/capita/day

Name of Country	BOD-Total
United Kingdom	50 - 59
France (rural area)	23 - 34
Brazil	44

Source: "Urban Drainage and Sewage Treatment in Developing Countries" by the Ministry of Construction of Japan.

As shown on the above, there are wide range of the unit BOD pollution load reflecting differences of living standard, life style, etc. The WHO, however, recommends to apply 45 g/capita/day when no data is available.

Using 45 g/capita/day, the unit BOD pollution load is calculated as follows:

- BOD load: 45 g/capita/day
- Discharged sewage volume: 100 l/capita/day
- BOD = (45 g-BOD/capita/day) / (100 l/capita/day) = 450 mg/l

(2) Results of water quality examination

Table 7.7.8 shows the per capita pollution load, in terms of BOD and SS, as calculated in the sewage quality surveys that were conducted to determine the status of domestic sewage during both the dry and rainy seasons. The surveys were carried out at the same site as the sewage quantity survey and the sampling was also done in same manner; six (6) times a day, every four (4) hours. The daily pollution load was calculated by the average of (sewage flow) x (sewage quality) of six (6) samples per day. Then, the per capita pollution load was calculated by dividing the daily pollution load by the population. The results of the water quality survey and the daily pollution load calculations are shown in Appendix 14.5.1.

Table 7.7.8 Per Capita Pollution Load by Sewage Quality Survey

Item			Individual House	Apartment House	Slum Housing	Average
Population (person)			180	220	290	690
Rainy Season (Jun., 1997)	Flow Rate (l/day)		84,000	54,800	72,200	211,000
	Water Quality (mg/l)	BOD	17	33	24	23
		SS	155	62	65	100
	Pollution Load (g/day)	BOD	1,400	1,800	1,700	4,900
		SS	13,000	3,400	4,700	21,100
	Per Capita Pollution Load (gpcd)	BOD	7.8	8.2	5.9	7.1
		SS	72	15	16	31
Dry Season (Dec., 1997)	Flow Rate (l/day)		72,000	67,200	134,400	273,600
	Water Quality (mg/l)	BOD	203	186	313	253
		SS	232	317	98	187
	Pollution Load (g/day)	BOD	14,600	12,500	42,000	4,900
		SS	16,700	21,300	13,200	51,200
	Per Capita Pollution Load (gpcd)	BOD	81	57	145	100
		SS	93	97	46	74

The investigated sewage was comprised of wastewater from kitchen, washing, shower and septic tank effluent, excluding nightsoil. The average per capita pollution load of three (3) types of housing was as follows:

BOD : 7.1 g/capita/day

SS : 31 g/capita/day

The above BOD load corresponds to 40% of the samples from tropical countries (18 g/capita/day) and 20% of the Japanese example (39 g/capita/day); the SS load is 1.4 times of the Japanese example (23 g/capita/day).

Just as in the case of the sewage quantity survey, it can be assumed that stormwater intrusion in the sewer lines affected the survey results, since the results of the BOD and SS analyses were quite different.

The obvious imbalance among the BOD and SS unit pollution loads are deemed to be caused by such data being obtained during the rainy season. The data obtained during the same survey, in the dry season, also showed the following impractical results:

BOD : 100 g/capita/day

SS : 74 g/capita/day

Due to inflow of wastewater other than domestic sewage, per capita pollution load estimated from the field survey results is utilised as reference information in establishing the design per capita pollution load.

(3) Water quality examination of wastewater influent at the existing STP

Monthly average BOD and SS of influent sewage at Pagla STP is shown in Table 7.7.10. By these existing sewage quality analysis data, yearly average figures in 1995 were calculated as 216 mg/l of BOD and 224 mg/l of SS.

Table 7.7.9 Monthly Average of BOD and SS of Influent Sewage in Pagla STP

Month/Year	BOD (mg/l)	SS (mg/l)
Nov. 1994	213	211
Dec.	202	221
Jan. 1995	238	243
Feb.	225	225
Mar.	222	243
Apr.	211	225
May	211	233
Jun.	222	226
Jul.	205	205
Aug.	216	215
Sep.	213	217
Oct.	218	219
Annual Average	216	224
Jul. 1997	214	300
Dec. 1997	206	356
Average	210	328
Overall Average	213	276

Note: Water quality examination on July and December 1997 was carried out by JICA Study Team.

The average figures of BOD and SS examined by the Study Team in rainy season and dry season of 1997 are 210 mg/l and 328 mg/l, respectively. These figures are obtained as an average of two seasons and data of each season are also average figures calculated from analysis results of 6 samples collected in a day, excluding unrealistic analysis results. BOD figure is more or less similar to previous data, while SS is about 1.5 times higher than the previous data.

The overall average of previous data and analysis results of the Study Team are 213 mg/l of BOD and 276 mg/l of SS.

(4) Planned sewage quality

The design sewage quality is determined upon comprehensive evaluation of the sewage quality survey results, reference data collected during the Stage 1 domestic work and influent sewage quality survey at the existing STP (Pagla). Planned sewage qualities estimated by different sources are shown in Table 7.7.11. As shown in the table, there are large fluctuation among the figures, planned sewage quality was therefore established in due consideration of sewage quality survey in Pagla Sewage Treatment Plant as the most realistic data.

Table 7.7.10 Estimated Planned Sewage Quality

Items	BOD (mg/l)	SS (mg/l)
Reference Data	450	-
Domestic Sewage Quality Survey	30	97
Projected Sewage Quality based on the Survey	78	320
Influent Sewage Quality Surveyed at Pagla STP	213	276

The target sewage for the proposed sewerage system is domestic sewage and industrial sewage is excluded. Therefore, the planned sewage quality is assumed to be in low concentration compared with the influent sewage quality at Pagla STP (please refer Chapter 3, 3.4.4). Thus, the planned sewage quality was estimated as follows, based on the inflow sewage quality of Pagla STP.

BOD : 200 mg/l

SS : 200 mg/l

7.8 Sanitation Facilities

7.8.1 Objectives of the Study

On-site wastewater treatment/disposal is an important mean, not only for small rural communities, but also for urban/semi-urban households unserved by the public sewerage system.

The study of on-site treatment/disposal was hereby taken up draw several options from the view points of low cost sanitation and technical alternatives corresponding to different and sizes and localities of beneficiaries, such as a cluster of individual households, an apartment type housings and an independent households. The study was also intended to look into technical options as an intermediate countermeasure for those unserved households situated in the transitional area from the on-site treatment to the public sewerage service.

Field inspections on the existing facilities, such as individual septic tanks and small bore community sewerage system were carried out during the Stage 1 Field Work. Water sampling from various points in the Study Area and their laboratory examination were also implemented.

A brief discussion of the data available at this stage of study are presented hereunder. A further review of the collected data and information and an in depth study was conducted during the Stage 1 Domestic Work in Japan. The study results will indicate the above outcomes as well as recommendations on associated problems to help maintain public hygiene and living environment at desirable level and were incorporated in the Feasibility Study on the Priority Project.

Reference is made to the "Appropriate Technology for Treatment of Wastewater for Small Rural Communities" (Lyon, 1982, EURO Reports and Studies, WHO Regional Office for Europe).

7.8.2 Septic Tank with Infiltration as Typical Method

Systems with septic tanks are the most commonly applied method. After in a septic tank, the effluent is usually disposed into the soil. However, the design and size of the infiltration units/facilities play an important role in the satisfactory performance of this technical option.

This method is practically suitable for treatment of domestic wastewater of single household, institution and small communities (or apartment type housing accommodating more than 5 households).

(1) Design of septic tank

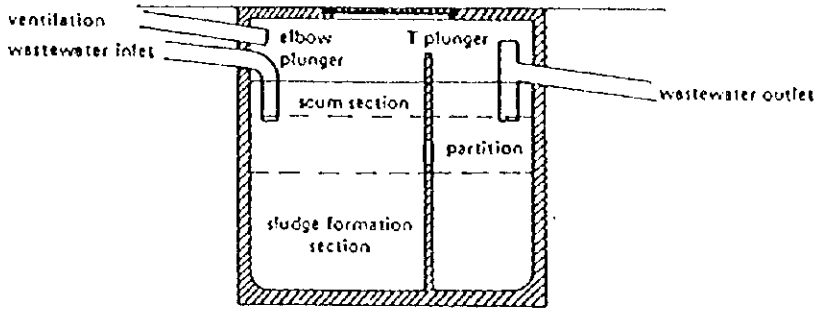
Septic tanks shall be constructed with the use of watertight materials and composed of two compartments as shown in Figure 7.8.1.

Domestic wastewater (both sullage and fecal wastewater) is carried into the first compartment of the septic tank. In this compartment, solid wastes settle to form a sludge layer and are anaerobically digested. Further sedimentation, as well as sedimentation of the sludge that has been re-suspended by peak flow, takes place in the second compartment, which is generally half the size of the first compartment.

The treatment performance largely depends on climatic conditions (particularly temperature). BOD may be reduced by 30-50%, while the total suspended solids (TSS) by 50-70%. The physico-chemical characteristics of treated effluent generally restrict direct disposal to surface water body or an aquifer (cesspool, fissured subsoil, etc.).

Figure 7.8.1 Typical Design of Septic Tank

(To be copied from Fig. 3 Design of a septic tank with footnote)



Source: L'assainissement individuel - principes et techniques actuelles. Paris. Ministère de l'Environnement et de Cadre de Vie et Agence de Bassin Loire-Bretagne. 1980.

The required size of septic tank depends on the following design conditions:

1) Influent wastewater flow

   Attention shall be paid to reduce water consumption for economical sizing of septic tank; such as replacement of conventional flush toilets by water-saving designs (pour flush, etc.).

2) Retention time required for effective sedimentation of solid wastes

   The required retention time for solid sedimentation depends on the number of users.

3) Sludge accumulation rate

   The sludge accumulation rate varies considerably depending on climatic conditions, ranging from 30 liters/person/year in southern Europe to 70 liters/person/year in the north.

4) Frequency of desludging

   The frequency of desludging depends on the rate of sludge accumulation and the cost of its removal. In different European countries, the desludging frequency varies from

twice a year to once every four years, although yearly or twice-yearly intervals are usually recommended.

(2) Disposal of treated effluent

There are several technical options for the disposal of treated effluent, such as soak pits, subsurface irrigation systems, and sand filters. The selection of these technical options largely depends on land availability and the volume of treated effluent. However, septic tanks with irrigation systems are becoming popular for both individual household and community sanitation (for up to 1,000 people in some European countries).

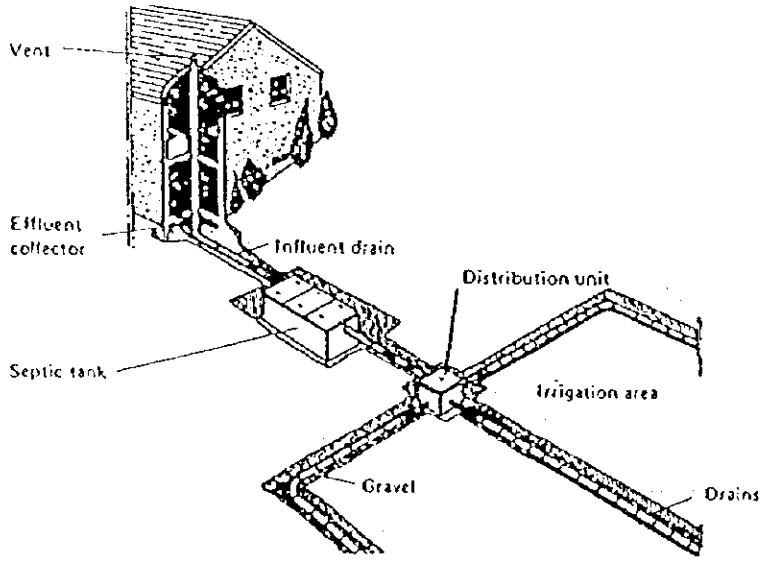
1) Subsurface irrigation system

This system disposes the treated effluent of the septic tank by infiltration into the soil through drains embedded in filtering media. The principal design of this system is exhibited in Figure 7.8.2.

Additional options to this system are to include:

- Pre-filter upstream of the distribution unit to serve as a precaution against silting of the drains as it is an indicator of the functioning of the septic tank.
- Flushing cistern to ensure better distribution of wastewater in the treatment unit.

Figure 7.8.2 Principal Design of Shallow Subsurface Irrigation System



Source: *L'assainissement individuel-principles et techniques actuelles.* Paris, Ministère de l'Environnement et du Cadre de Vie et Agence de Bassin Loire-Bretagne. 1980

A subsurface filtration system consists of a series of narrow (0.5 to 1 m) leaching trenches or one or more sand filters. The choice between trenches or filters depends

on the nature of the soil and the land immediately surrounding the system, as shown in Figure 7.8.3.

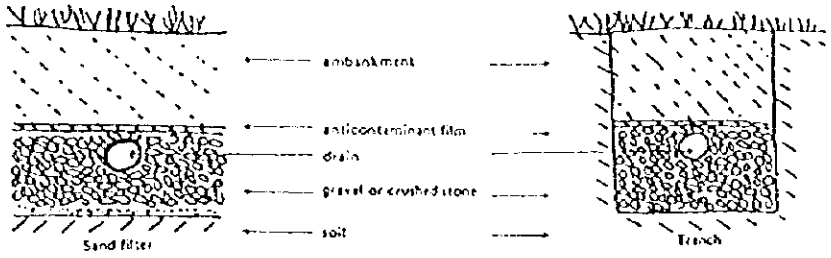
a. Trenches

Trenches are suitable for the locality where the soil is not permeable enough and is difficult to work on. Trenches can accommodate certain storage of the effluent, since the walls of trenches play a useful role in the infiltration process.

b. Sand filters

Sand filters are more compact and are particularly suitable when the soil is permeable, and when the site does not present any topographical problems or difficulties due to the presence of impermeable strata.

Figure 7.8.3 Subsurface Filtration System (Trench & Sand Filter)



Source: *L'épandage des eaux usées domestiques.* Tude prèalable de l'aptitude des sols et règles de dimensionnement des installations. Paris, CTGRF. Etude No. 50, 1980.

2) Alternative measures of subsurface filtration

More costly alternative measures are available for subsurface filtration, when the environmental conditions restrict the application of the above mentioned methods, particularly:

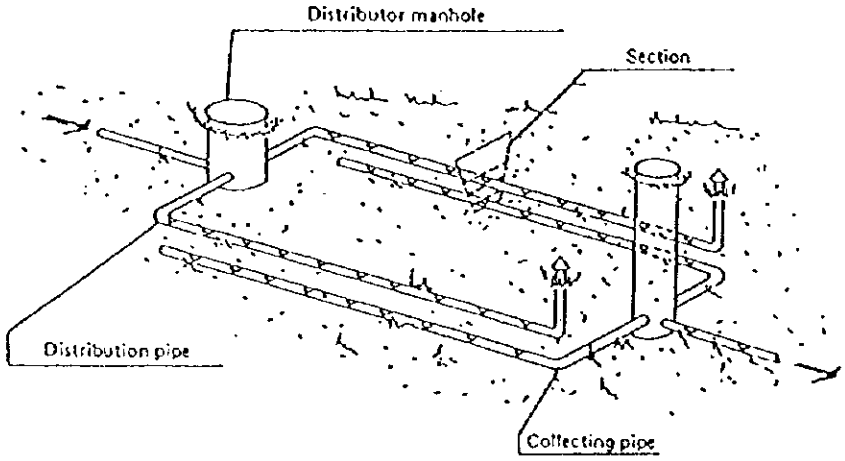
- when unprotected groundwater is located near the surface; and
- when the soil stratum is not sufficiently thick.

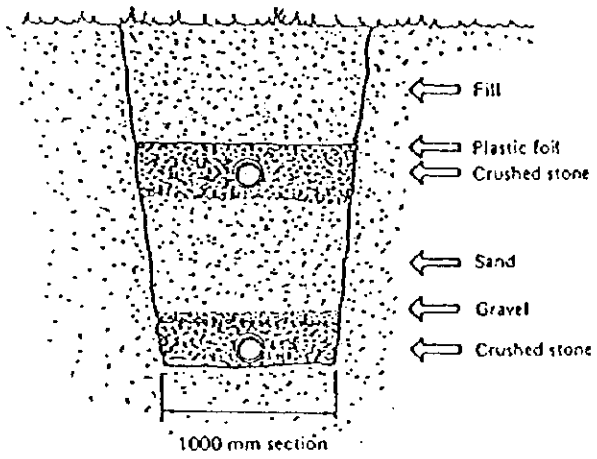
Three alternative measures are considered as follows:

a. Drained sand filter

This method is useful when the permeability of soil is too poor or when ground-water table is too shallow (0.5 to 1 m). This method shall be used only in case where the effluent can be discharged into surface environment, as shown in Figure 7.8.4.

Figure 7.8.4 Drained Sand Filter for a Single Household

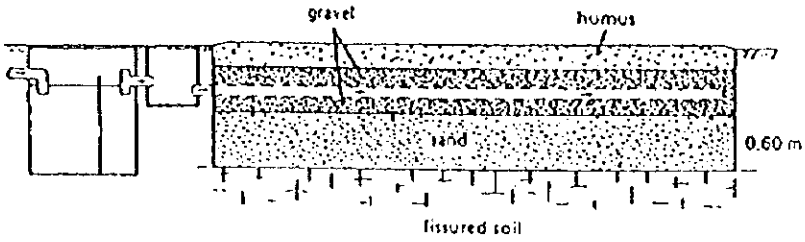




b. Undrained sand filter

This is a modified method of the above mentioned drained sand filter and applicable when the soil stratum is not sufficiently hick, but does allow infiltration of effluent after treatment (fissured substratum), as shown in Figure 7.8.5.

Figure 7.8.5 Undrained Sand Filter

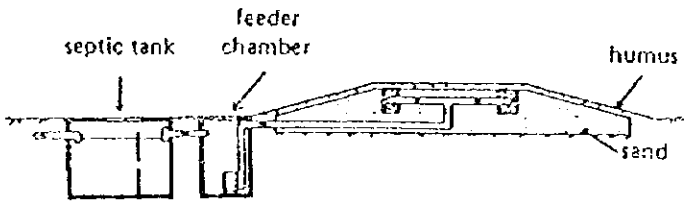


Source: *L'assainissement individuel-principles et techniques actuelles.* Paris, Ministère de l'Environnement et du Cadre de Vie et Agence de Bassin Loire-Bretagne. 1980

c. Raised sand filter

This sand filter is installed in a mound (approximately 1 m) of sand placed on the natural ground surface after leveling. This method is applicable if an aquifer is close to the surface (0.5 to 1 m depth) and if the effluent cannot be discharged into the environment. In application of this method, the soil must be sufficiently permeable, as shown in Figure 7.8.6.

Figure 7.8.6 Raised Sand Filter



Source: *L'assainissement individuel-principles et techniques actuelles.* Paris, Ministère de l'Environnement et du Cadre de Vie et Agence de Bassin Loire-Bretagne. 1980

7.8.3 Compact Aerobic Domestic Sewage Treatment Module

Septic tank associated with infiltration system has several limitations on its application that:

- It is applicable to rural and suburban areas where necessary open space is available to construct infiltration system,
- It is applicable to the area where soil conditions are favorable for infiltrating effluent from septic tank.

In other word, when the houses are located in densely populated area and the sufficient open space to construct infiltration system is not available, and/or soil conditions are impermeable, the said treatment/disposal method of domestic sewage is not suitable.

To meet with the above mentioned restrictions on locality, there is an technical option among the on-site treatment/disposal methods which is so called the compact aerobic domestic sewage treatment module.

This compact treatment module employs a biological contact treatment method with diffuser of compressed air. It enables reduction of required space to more or less equivalent to septic tank by increased treatment efficiency and does not require infiltration system.

This compact treatment module has two different types in its application; one for only night-soil treatment and the other for both nightsoil and other domestic sewage. Generally, this compact module achieves treatment efficiency of at least 30 mg/l of BOD in its treated effluent. It requires, however, removal of excess sludge to be accumulated in the module at an interval of twice a year.

Different treatment capacity is available corresponding to sizes of households or apartment. Provision of equalization tank is recommended for the facilities having service population of more than 200 persons, to offset flow rate fluctuation of raw sewage. A typical design of compact aerobic domestic sewage treatment module is shown in Figure 7.8.7.

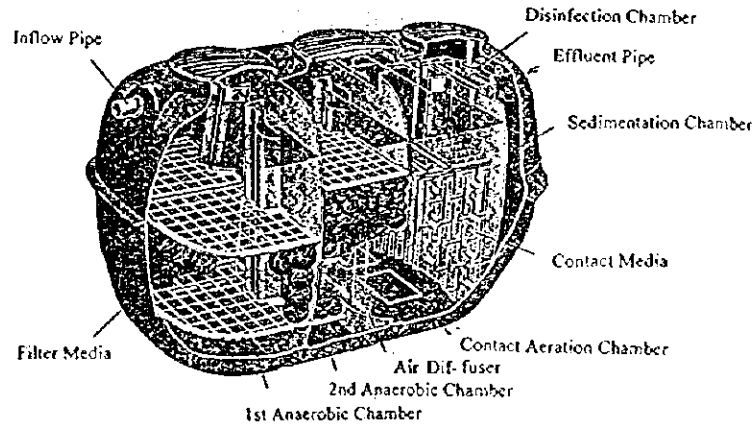
When the future urban development in the Study Area is taken into account, this compact treatment module shall be considered for those apartment type housing to be constructed in the suburban area where the public sewerage system is not planned.

Figure 7.8.7 Typical Design of Compact Aerobic Domestic Sewage Treatment Module

Inflow Pipe Disinfection Chamber Effluent Pipe Sedimentation Chamber

Filter Media 1st Anaerobic Chamber 2nd Anaerobic Chamber Air Diffuser

Contact Media Contact Aeration Chamber



7.8.4 Standardization of On-Site Treatment and its Application

In application of on-site treatment method to the individual households and other large scale facilities such as commercial establishments and apartment type buildings, certain technical standardization and legislative arrangement are deemed indispensable in achieving better sanitation practices, smooth and easy O&M, and environmental soundness.

(1) Technical standardization

Majority of existing septic tanks have following characteristics:

- The size/capacity of septic tanks is not determined based on the sound technical criteria.
- Septic tanks are simply constructed with the use of bricks and mortar and have effluent outlet with regardless to surrounding environmental conditions.
- Septic tanks are usually located at the back of houses away from the streets.
- Future conversion from septic tank to sewerage system is not considered.
- Due to lack of inappropriate timing of desludging, considerable number of septic tanks seem to be full of septage and therefore discharge untreated sewage.

- Removed septage is dumped into rivers, ponds, canals and sewer manholes, resulting further deterioration of living environment.

To attain environmental soundness both for residents and surrounding environment, the following technical set ups are necessary:

- Soak pit shall be attached to the septic tank where effluent disposal to nearby drainage is not available and/or surrounding environment does not allow such disposal, such as densely populated area.
- Combined treatment of nightsoil and gray water shall be introduced for apartment type housing and other large scale facilities, i.e. commercial establishments, public facilities.

(2) Legislative arrangement

Deficiencies and/or inappropriateness of the existing on-site treatment facilities largely owe to lack of proper legislative arrangements and their implementation. In this Master Plan, septage removed from respective septic tanks is planned to be accepted at the sewage treatment plant to reduce pollution load to the surrounding environment both at users and public water bodies.

The following legislative and administrative arrangements are hereby pointed out to realize the improvement of application of on-site treatment:

- Building permission either new house/building or renovation/improvement of existing one shall be granted to applicants when appropriate installation plan of septic tank or equivalent facility including location and plumbing schedule for disposal of effluent is submitted and approved by the authorized technical standards.

- DWASA shall have option to reject services of water supply and acceptance of septage for treatment against any applicant when the house/building is violating the above mentioned building permission.

- House/building owner shall be obliged to enter into contract for desludging from septic tank with public corporation or private entity registered to DWASA and subject to approval of pertinent authority.

- Penalty clause shall be provided in the pertinent regulation to restrict building without appropriate domestic sewage treatment facility and inadequate removal of

septage. Negligence to remove septage may be subject to penalty in a form of holding tax or any other measure, such as closure of business or termination of water supply.

- Financial assistance, i.e. soft loan facility, partial subsidy, shall be considered for smooth and accelerated implementation of proper sanitation measures.

- Accreditation of house/building conforming to sanitation requirement to be issued by pertinent authority is another option to notify it to the purchasing public. By this means, private developers will be led to follow appropriate sanitation practices.

- Health and hygiene education to the public shall also be initiated by authorities concerned to enhance an importance of public hygiene practice and community participation.