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APPENDIX

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ABBREVIATIONS

AC	Asbestos Cement
AF	Anaerobic Filter
AFF	Anaerobic Fixed Film
AIDS	Acquired Immune Deficiency Syndrome
AMF	Automatic Mains Failure
ASP	Activated Sludge Process
AWPF	Advanced Water Purification Facility
BIOFOR	Biological Filtration and Oxygenated Reactor
BIS	Bureau of Indian Standards
BOD	Biochemical Oxygen Demand
BSUP	Basic Services to Urban Poor
BWSSB	Bangalore Water Supply and Sewerage Board
CAA	Constitutional Amendment Act
CB	Circuit Breaker
CBO	Community Based Organization
CC	Cement Concrete
CFD	Computational Fluid Dynamics
CI	Cast Iron
CMP	City Master Plan
CMWSS	Chennai Metropolitan Water Supply and Sewerage
CMWSSB	Chennai Metropolitan Water Supply and Sewerage Board
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
CPCL	Chennai Petroleum Corporation Ltd.
CPHEEO	Central Public Health and Environmental Engineering Organisation
CPM	Critical Path Method
CSP	City Sanitation Plan
CSS	Centralized Sewerage System
CT	Community Toilet
CTE	Consent to Establish
CTO	Consent to Operate
CWMS	Centralized Wastewater Management System
DAF	Dissolved Air Flotation
DALY	Disability-Adjusted-Life-Years
DC	Direct Current
DEWATS	Decentralized Wastewater Treatment System
DI	Ductile Iron
DMF	Dual Media Filter
DO	Dissolved Oxygen
DOF	Drop Out Fuses
DOL	Direct on Line
DPR	Detailed Project Report
DSMS	Decentralized Sewage Management System
DWCPE	Double Walled Corrugated Polyethylene
DWF	Dry Weather Flow

DWMS	Decentralized Wastewater Management System
EB	Expanded Bed
EBB	Eco Bio Block
EBOD	Effective Biochemical Oxygen Demand
EC	Electrical Conductivity
EDC	Endocrine Disruptor Chemicals
EIA	Environmental Impact Assessment
EMI	Equated Monthly Instalments
EN	European Standards
ES	Effective Size
EUS	Epizootic Ulcerative Disease
EWC	European Water Closet
EWS	Economically Weaker Section
F/M	Food to Microorganism ratio
FAB	Fluidized Aerobic Bed
FAR	Floor Area Ratio
FBAS	Fixed Bed Biofilm Activated Sludge Process
FFR	Fixed Film Reactors
FLC	Full Load Current
FRP	Fibre Glass Reinforced Plastic Pipes
FS	Faecal Sludge
FSI	Floor Space Index
GDP	Gross Domestic Product
GFRP	Glass Fibre Reinforced Plastics
GI	Galvanized Iron
GIS	Geographical Information Systems
GL	Ground Level
GOS	Group Operating Switches
GRP	Glass Fibre Reinforced Plastic
GWRS	Groundwater Replenishment System
HDPE	High Density Polyethylene
HETP	Health Effects Testing Program
HIA	Health Impact Assessment
HIV	Human Immunodeficiency Virus
HRT	Hydraulic Retention Time
HUDCO	Housing and Urban Development Corporation Limited
HWL	High Water Level
ID	Internal Diameter
IDWSSD	International Drinking Water Supply and Sanitation Decade
IEC	Information, Education and Communication
IIT	Indian Institute of Technology
IJS	Intermediate Jacking Stations
INR	Indian Rupees
IPR	Indirect Potable Reuse
IS	Indian Standards
ISO	International Organization for Standardization
JICA	Japan International Cooperation Agency
JnNURM,JNNURM	Jawaharlal Nehru National Urban Renewal Mission
JWWA	Japan Water Works Association
LD	Low Density

LDPE	Low Density Polyethylene
LIC	Life Insurance Corporation of India
LLDPE	Linear Low Density Polyethylene
lpcd	Litres per capita per day
LPD	Litres Per Day
LPM	Litres Per Minute
LWL	Low Water Level
M&E	Monitoring & Evaluation
MAP	Magnesium Ammonium Phosphate
MBBR	Moving Bed Biofilm Reactor
mg/l, mg/L	Milligrams per litre
MBR	Membrane Bio Reactor
MD	Medium Density
MDG	Millennium Development Goal
MF	Microfiltration
MFL	Maximum Flood Level
MFL	Madras Fertilizers Ltd.
ML	Million Litres
MLD, mld	Million Litres per Day
MLE	Modified Ludzck Ettinger
MLSS	Mixed Liquor Suspended Solids
MLVSS	Mixed Liquor Volatile Suspended Solids
MNRE	Ministry of New and Renewable Energy
MOEF, MoEF	Ministry of Environment and Forests
MOP	Manual of Practice
MOUD, MoUD	Ministry of Urban Development
MPN	Most Probable Number
MS	Mild Steel
MSL	Mean Sea Level
NB	Nominal Bore
NEERI	National Environmental Engineering Research Institute
NF	Nanofiltration
NGO	Non-Governmental Organization
NPK	Nitrogen, Phosphorus, Potassium
NPS	Nominal Pipe Size
NPSH	Net Positive Suction Head
NRCD	National River Conservation Directorate
NS	Nominal Size
NUSP	National Urban Sanitation Policy
O&M	Operation and Maintenance
OCWD	Orange County Water District
OD	Outside Diameter
OD	Oxidation Ditch
ODF	Open Defecation Free
PCB	Pollution Control Boards
PCC	Precast cement concrete
PERT	Program Evaluation Review Technique
PHE	Public Health Engineering
PHED	Public Health Engineering Department
PLC	Programmable Logic Controller

PP	Poly Propylene
PPP	Public Private Partnership
PSS	Percent Soluble Sodium
PUB	Public Board of Utility
PVC	Polyvinyl Chloride
PWD	Public Works Department
RAS	Return Activated Sludge
RBC	Rotating Biological Contactor
RC	Reinforced Concrete
RCC	Reinforced Cement Concrete
RCP	Retention Cum Polishing
RO	Reverse Osmosis
RSC	Residual Sodium Carbonate
RTU	Remote Terminal Unit
SAFF	Submerged Aeration Fixed Film
SAMP	Sampling and Monitoring Program
SAR	Sodium Absorption Ratio
SBR	Sequencing Batch Reactor
SCADA	Supervisory Control and Data Acquisition
SD	Standard Deviation
SDI	Silt Density Index
SF	Safely Factor
SFBR	Submerged Fixed Bed Reactor
SFRC	Steel Fibre Reinforced Concrete
SLB	Service Level Benchmarks
SLD	Single Line Diagram
SOR	Surface Overflow Rate
SRT	Sludge Retention Time
SS	Standard Steel
SS	Suspended Solids
STP	Sewage Treatment Plant
SVI	Sludge Volume Index
SWD	Side Water Depth
SWP	Structured Wall Pipes
TBM	Tunnel Boring Machine
TCPO	Town and Country Planning Organization
TDS	Total Dissolved Solids
TFC	Thirteenth Finance Commission
TKN	Total Kjeldahl Nitrogen
TMG	Tokyo Metropolitan Government
TMP	Trans Membrane Pressure
TN	Total Nitrogen
TOR	Terms of Reference
TP	Total Phosphorus
TS	Total Solids
TSS	Total Suspended Solids
TVS	Total Volatile Solids
TWAD	Tamil Nadu Water Supply and Drainage Board
UF	Ultrafiltration
UIDSSMT	Urban Infrastructure Development Schemes for Small and

	Medium Towns
ULB	Urban Local Body
UNDP	United Nations Development Programme
UNICEF	United Nations International Children Emergency Fund
UP	Uttar Pradesh
UPS	Uninterruptible Power Supply
UPVC	Unplasticized Polyvinyl Chloride
US EPA, USEPA	United States Environmental Protection Agency
UV	Ultraviolet
UWSS	Urban Water Supply and Sanitation
VFD	Variable Frequency Drive
VS	Volatile Solids
VSS	Volatile Suspended Solids
WC	Water Closet
WEF	Water Environment Federation
WF21	Water Factory 21
WHO	World Health Organization
WS & S	Water Supply and Sanitation
WSP	Water and Sanitation Program
WSP	Waste Stabilization Pond
WTP	Water Treatment Plant
ZDTS	Zero Discharge Toilet System
ZLD	Zero Liquid Discharge

CHAPTER 1 INTRODUCTION

Perhaps we need to be reminded what Gandhiji said "For India, Sanitation is more important than Independence".

1.1 PREAMBLE

Over the years, there has been continuous migration of people from rural and semi-urban areas to cities and towns. The proportion of population residing in urban areas has increased from 27.8% in 2001 to 31.80% in 2011. The number of towns has increased from 5,161 in 2001 to 7,935 in 2011. The uncontrolled growth in urban areas has left many Indian cities deficient in infrastructural services as water supply, sewerage, storm water drainage, and solid waste management.

Most urban areas inhabited by slums in the country are plagued by acute problems related to indiscriminate disposal of sewage. Due to deficient efforts by town/city authorities, sewage and its management has become a tenacious problem and this is notwithstanding the fact that the large part of the municipal expenditure is allotted to it. It is not uncommon to find that substantially a large portion of resources is being utilized on manning sewerage system by Urban Local Bodies (ULBs) for their operation and maintenance. Despite this, there has been a progressive decline in the standard of services with respect to collection, transportation, treatment and safe disposal of treated sewage as well as measures for ensuring safeguard of public health & hygiene and environment. In many cities and towns in the country, a large quantity of sewage remains unattended giving rise to insanitary conditions in especially densely populated slums which in turn results in an increase in morbidity especially due to pathogens, parasitic infections and infestations in all segment of population particularly with the urban slum dwellers.

Sewerage and sewage treatment is a part of public health and sanitation, and according to the Indian Constitution, falls within the purview of the State List. Since this is non-exclusive and essential, the responsibility for providing the services lies within the public domain. The activity being of a local nature is entrusted to the ULBs, which undertake the task of sewerage and sewage treatment service delivery, with its own staff, equipment and funds. In a few cases, part of the said work is contracted out to private enterprises.

Cities and towns which have sewerage and sewage treatment facilities are unable to cope-up with the increased burden of providing such facilities efficiently to the desired level. Issues and constraints that are encountered by the ULBs responsible for providing sewerage and sanitation facilities are compounded due to various reasons. The main cause of water pollution is the unintended disposal of untreated, partly treated and non-point sources of sewage and more important is its effect on human health and environment.

The reasons for the above cited position are:

1. Almost all local bodies not being financially resourceful to self-generate the required capital funds and looking up to the State and Central Governments for outright grant assistance.
2. Lack of institutional arrangements and capacity building to conceive planning, implementation, procurement of materials, operate and maintain the sewerage system and sewage treatment plants at desired level of efficiency.
3. The fact that the collected sewage terminates far away beyond the boundaries of the ULB and is a "out of sight, out of mind" syndrome.

4. The high cost of infrastructure investment, continual replacement and on-going O&M costs of centralized sewerage system (CSS) facilities take these systems beyond the financial grasp of almost any ULB in the country.

5. It is also necessary to recognize that the practice of piped sewer collection is basically an inheritance from advanced countries with high water usages, which ensures adequate flushing velocities in their high per capita water supply rates and do not result in night-soil lumps settling down in pipes and do not result in choking and sulphide gas generation whereas in the Indian scenario, the per capita supply is low and inequitable in many cities and that too intermittent and this results in settling down of night-soil, choking, gasification etc., which necessitates very often the extreme remedies of cutting open the roads to access and break open the pipes for rectification, etc.

While the conventional sewerage may be an effective system for sewage collection and transportation and treatment, it also remains as a highly resource-inefficient technology. Consequentially, high capital cost and continuing significant costs for operation and maintenance of this system prohibit its widespread adoption in all sizes of urban areas in the country.

There has been no major effort to create community awareness either about the likely perils due to poor sewage management or the simple steps that every citizen can take which will help in reducing sewage generation and promote effective management of its generation and treatment. The degree of community sensitization and public awareness is low. There is no system of segregation of black water (from toilets) and grey water (other liquid wastes) at household level. In most of cities and towns no proper service connections have been provided to the toilets connecting to sewer collection system.

1.1.1 Need for Safe Sanitation System

Sanitation can be perceived as the conditions and processes relating to people's health, especially the systems that supply water and deal with human waste. Such a task would logically cover other matters such as, solid wastes industrial and other special/hazardous wastes and storm water drainage. However, the most potent of these pollutants is the sewage.

When untreated sewage accumulates and is allowed to become septic, the decomposition of its organic matter leads to nuisance conditions including the production of malodorous gases. In addition, untreated sewage contains numerous pathogens that dwell in the human intestine tract. Sewage also contains nutrients, which can stimulate the growth of aquatic plants, and may contain toxic compounds or compounds that are potentially mutagenic or carcinogenic. For these reasons, the immediate and nuisance-free removal of sewage from its sources of generation, followed by treatment, reuse, or dispersal into the environment in an eco-friendly manner is necessary to protect public health and environment.

1.1.2 Present Scenario of Urban Sanitation in India

The problem of sanitation is much worse in urban areas due to increasing congestion and density in cities. Indeed, the environmental and health implications of the very poor sanitary conditions are a major cause for concern. The study of Water and Sanitation Program (WSP) of World Bank observes that when mortality impact is excluded, the economic impact for the weaker section of the society accounting 20% of the households is the highest. The National Urban Sanitation Policy (NUSP) of 2008 has laid down the framework for addressing the challenges of city sanitation. The Policy emphasizes the need for spreading awareness about sanitation through an integrated city-wide approach, assigning institutional responsibilities and due regard for demand and supply considerations, with special focus on the urban poor.

As per 2011 Census, the households having latrine facility within premises is 81.4% which includes 72.6% households having water closets and 7.1% households having pit latrines and 1.70% households having other latrines (connected to open drains, night soil removed by human etc., which are unsafe). Out of 72.6% households, 32.70% households are having water closets with piped sewer system, 38.20% households are having water closets with septic tank and 1.70% households are having water closets with pit latrines (ventilated improved pit/open pit etc.). The remaining 18.60% household are both sharing public latrines (6%) and defecating in open (12.60%).

According to the report on the Status of Wastewater Generation and Treatment in Class-I Cities and Class-II towns of India, December 2009 published by Central Pollution Control Board, the estimated sewage generation from 498 Class-I cities and 410 Class-II towns (Population estimated for 2008 based on 2001 census) together is 38,524 MLD, out of which only 11,787 MLD (35%) is being treated with a capacity gap of 26,467 MLD.

Sewer networks for collection and transportation of sewage from each and every household in cities and towns are too inadequate to carry sewage up to the treatment plants. Treatment plants capacities are also woefully inadequate due to many reasons such as poor planning and implementation of sewerage and sewage treatment plants and other appropriate sanitation facilities by ULBs due to inadequate financial resources and lack of adequate capacity of ULBs in the country.

This imposes significant public health and environmental costs to urban areas that contribute more than 60% of the country's GDP. Impacts of poor sanitation are especially significant for the urban poor (22% of total urban population), women, children and the elderly. The loss due to diseases caused by poor sanitation for children under 14 years alone in urban areas amounts to Rs. 500 crores at 2001 prices (Planning Commission-United Nations International Children Emergency Fund (UNICEF), 2006). Inadequate discharge of untreated domestic/municipal wastewater has resulted in contamination of more than 75% of all surface water across India.

1.1.3 Basic Philosophy of Sewage Treatment

Sewage when collected from communities can be perceived as a "water conveyor belt". Its treatment can be perceived as "unloading the conveyor belt" to make the belt useable again. The crucial issue is water in the conveyor belt. Thus, treated sewage must ultimately return to receiving water bodies or on to the land or might be reused for specific purposes after proper treatment specified for the purpose. The complex question faced by the design and practicing engineers is: What levels of treatment must be achieved in a given type of treatment – beyond those prescribed by discharge standards – to ensure protection of the health of the community and the environment? The answer to this question requires detailed analyses of local conditions and needs, application of scientific knowledge and engineering judgment based on past experience, and consideration of central, state, and local regulations. In some cases, a detailed assessment is required. The reuse and disposal of sludge are vexing problems for some ULBs and need careful consideration.

1.1.4 Sewerage and Sewage Treatment Technology

Sewerage and Sewage treatment technology is the branch of environmental engineering in which the basic principles of engineering are applied to solve the issues associated with the collection, those of biochemistry are applied to the treatment and environmental issues are applied in the disposal, and reuse of treated sewage. The ultimate goal is the protection of public health in a manner commensurate with environmental, economic, social, and political concerns. To protect public health and environment, it is necessary to have knowledge of:

1. constituents of concern in sewage,

2. impacts of these constituents when sewage is dispersed into the environment,

3. the transformation and long-term fate of these constituents in treatment processes,

4. treatment methods which can be used to remove or modify the constituents found in sewage, and

5. methods for beneficial use or disposal of solids generated by the treatment systems.

To provide an initial perspective on the field of sewerage and sewage treatment technology, common terminology is first defined followed by:

1. a discussion of the issues that need to be addressed in the planning and design of sewerage management systems, and

2. the current status and new directions in sewerage and sewage treatment technology.

1.1.5 Efforts of Concerned Agencies in Retrospect

Till late seventies sewerage and sanitation was not accorded due priority by ULBs. The impetus of International Drinking Water Supply and Sanitation Decade (IDWSSD), 1981-90, had produced considerable efforts in urban areas in the country to improve health by investment in water supply and sanitation programmes. These often comprise, in sewerage and sanitation sub-sector, construction of sewers, on-site sanitation facilities using various types of latrines. Under certain hydrological conditions, unsewered sanitation can cause severe groundwater contamination by pathogens and nitrate, which may largely negate the expected health benefits of such programs. In some circumstances, therefore, the low-cost-technologies may be incompatible.

Though the targets fixed for sewerage and sanitation coverage during the decade at the beginning of the IDWSSD were laudable, but could not be achieved due to resource constraints and other impending reasons. Due to these reasons, condition of sanitation has gone from bad to worse.

1.2 LOSS TO THE NATION DUE TO POOR SANITATION

1.2.1 Time and Money Loss in terms of DALYs

The Disability-Adjusted-Life-Years (DALY) is a measure of overall disease burden, expressed as the number of years lost due to ill-health, disability or early death. Originally developed by the WHO, it is becoming increasingly common in the field of public health and health impact assessment (HIA). It extends the concept of potential years of life lost due to premature death – to include equivalent years of 'healthy' life lost by virtue of being in states of poor health or disability. In doing so, mortality and morbidity are combined into a single common-matrix.

As per the WHO report, 80% of the diseases in human being are water-borne and water-related. It is mainly due to water pollution or water contamination and water logging. Though water logging may be location and weather specific but water pollution and contamination is a common phenomenon which can occur at any place at any point of time if community is not careful about adverse impact of indiscriminate disposal of sewage. The indiscriminate disposal of human excreta or sewage from habitations may contain hazardous micro-organisms (pathogens) for water pollution and harbouring vectors which act as carriers of pathogens.

Names of diseases mentioned in the Table 1.1 might appear to be conventional which occur in many parts of the country. The occurrence of such diseases depends upon various factors relating to illiteracy, personal hygiene, standard of living, malnutrition, adulteration of food items, lack of community awareness among all stakeholders, and many other factors related to

environmental pollution. No doubts that these factors play important role in occurrence of diseases but unsafe disposal of untreated or partially treated sewage plays a vital role in aggravating the chances of occurrence of these communicable diseases.

Table 1.1 Burden of Water Related Diseases in India, 1990

(In millions of DALYs)

Diseases	Female	Male	Total
Diarrheal Diseases	14.39	13.64	28.03
Intestinal Helminthes	1.00	1.06	2.06
Trachoma	0.07	0.04	0.11
Hepatitis	0.17	0.14	0.31
Total – water-borne and water-related Diseases	15.63	14.88	30.51

Source: World Development Report – World Bank, 1993

If we merely consider the economic value of life year at the average per capita income of $ 300 per year, the annual loss of 30.51 million DALYs is worth of 30.51 × 300 = $ 9.153 billion. (Exchange rate during 1993, $1 = INR 40). Improvements in water supply and sanitation including management of municipal solid waste can substantially reduce the incidences and severity of these diseases, as well as infant mortality associated with diarrhoea as shown in the following box:

Reduction in morbidity from better water supply and sanitation including safe disposal of municipal solid waste is estimated to be 26% for diarrhoea, 27% for trachoma, 29% for ascaris, 77% for schistosomiasis, and 78% for dracunculiasis. Mean reduction in diarrhoea-specific mortality can be 65%, while overall child mortality can be reduced by 55%.

Source: Esrey et. al. 1991

From the above statements and Table, it is evident that environmental pollution by liquid and solid wastes adversely affects the environment and human health directly or indirectly resulting in loss of life and heavy financial burden on exchequers.

1.2.2 Poor Sanitation Costs India $54 Billion

It has been reported from "The Economic Impact of Inadequate Sanitation in India" a report released by the Water and Sanitation Program (WSP), a global partnership administered by the World Bank that inadequate sanitation cost India almost $54 billion or 6.4% of country's GDP in 2006. Over 70% of this economic impact or about $38.5 billion was health-related with diarrhoea followed by acute lower respiratory infections accounting for 12% of the health-related impacts.

It is the poorest who bear the greatest cost due to inadequate sanitation. The poorest fifth of the urban population bears the highest per capita economic impact of $ 37.75, much more than the national average per capita loss due to inadequate sanitation, which is $ 21.35. Health impacts, accounting for the bulk of the economic impacts, are followed by the economic losses due to the time spent in obtaining piped water supply and sanitation facilities, about $15 billion, and about $0.5 billion of potential tourism revenue loss due to India's reputation for poor sanitation, the report says. Following Table 1.2 gives a glimpse of '**How much we lose**'.

Table 1.2 Poor sanitation cost to India

Sl. No.	Impact	Loss ($ billion)
1.	Heath	38.5
2.	Access time (safe WS & S)	15.0
3.	Tourism	0.5
	Total	54.0

Source: World Bank, Water and Sanitation Program (WSP), 2006

The challenge of sanitation in Indian cities is acute. With very poor sewerage networks, a large number of urban poor still depend on public toilets. Many public and community toilets have no water supply while the outlets of many others toilets with water carriage systems are not connected to city's sewerage system. As per the estimate, over 50 million people in urban India defecate in the open every day. The cost in terms of Disability Adjusted Life Years (DALY) of diarrhoeal diseases for children from poor sanitation is estimated at Rs. 500 crores. The cost per DALY per person due to poor sanitation is estimated at Rs. 5,400 and due to poor hygiene practices at Rs. 900 (MoUD 2009). A study by the Water and Sanitation Program (WSP 2010) of the World Bank using data for 2006 shows that the per capita economic cost of inadequate sanitation including mortality rate in India is Rs. 2,180.

As mentioned above, the impacts of poor sanitation on human health are significant. Unsafe disposal of human excreta facilities are responsible for the transmission of oral-faecal diseases, including diarrhoea and a range of intestinal worm infections such as hookworm and roundworm. Diarrhoea accounts for almost one-fifth of all deaths (or nearly 535,000 annually) among Indian children under 5 years. Also, rampant worm infestation and repeated diarrhoea episodes result in widespread childhood malnutrition. Moreover, India is losing millions of rupees each year because of poor sanitation. Illnesses are costly to families, and to the economy as a whole in terms of productivity losses and expenditure on medicines, healthcare, etc. The economic toll is also apparent in terms of water treatment costs, losses in fisheries production and tourism, and welfare impacts, such as reduced school attendance, inconvenience, wasted time, and lack of privacy and security for women. On the other hand, ecologically sustainable sanitation can have significant economic benefits that accrue from recycling nutrients and using biogas as an energy source.

1.3 SECTOR ORGANIZATION

Water supply and sanitation is treated as a State subject as per the federal Constitution of India and, therefore, the States are vested with the constitutional right on planning, implementation, operation and maintenance and cost recovery of water supply and sanitation projects. At the local level, the responsibility is entrusted by legislation to the local bodies like Municipal Corporation, Municipality, Municipal Council, Notified Area Committee/Authority for towns or on a State/Regional basis to specialized agencies. The economic and social program of the country is formulated through five-year plans.

The Public Health Engineering Department (PHED) is the principal agency at State level for planning and implementation of water supply and sanitation programs. In a number of States, statutory Water Supply and Sanitation Boards (WSSBs) have taken over the functions of the PHEDs. The basic objectives for creation of WSSBs have been to bring in the concept of commercialization of the water supply and sanitation sector management and more accountability. Such boards have been set up in Assam, Bihar, Gujarat, Karnataka, Kerala, Maharashtra, Orissa, Punjab, Uttar Pradesh and Tamil Nadu. The metropolitan cities of Bangalore, Hyderabad and Chennai have separate statutory Boards. The water supply and sanitation services in the cities of Ahmedabad, Delhi, Kolkata, Mumbai, Pune and few other cities are under the Municipal Corporations.

The Ministry of Urban Development, Government of India formulates policy guidelines in

respect of Urban Water Supply and Sanitation Sector and provides technical assistance to the States and ULBs wherever needed. The expenditure on water supply and sanitation is met out of block loans and grants disbursed as Plan assistance to the States, and out of loans from financial institution like Life Insurance Corporation of India (LIC) and Housing and Urban Development Corporation (HUDCO). The Central Government acts as an intermediary in mobilizing external assistance in water supply and sanitation sector and routes the assistance via the State plans. It also provides direct grant assistance to some extent to water supply and sanitation programs in urban areas.

1.4 INITIATIVES OF GOVERNMENT OF INDIA

Government of India has taken number of initiatives during the last two decades by implementing number of reforms aimed at improving the working efficiency of ULBs in India. These reforms have been implemented in the form of Act (Amendment) and all the State Governments have been advised to implement these reforms by suitably modifying ULB's bye-laws so as to achieve the objectives of these reforms for the development of urban sector in the country. Few of the reforms such as institutional reform, financial reforms, legal reforms, etc., are in vogue. Reforms mainly relating to sewerage and sanitation are briefly described as under.

1.4.1 Initiative on Reforms – 74th Constitution Amendment Act, 1992

Quite often, multiplicity of agencies and overlapping of responsibilities are the reasons for ineffective and poor operation and maintenance of the assets created by civic bodies. In the light of 74th Amendment under the 12th Schedule of the Constitution, the role and responsibility of the ULBs have increased significantly in providing these basic facilities to the community on sustainable basis. The new Amendment has enabled ULBs to become financially viable and technically sound to provide basic amenities to the community.

As per the 74th Constitution Amendment Act, 1992, the ULBs have been delegated with sets of responsibilities and functions. But they are not supplemented with adequate financial resources. As a result, they are not able to perform their assigned functions in an efficient and effective manner. They are also not able to fix the rates of users' charges and are heavily dependent upon the higher levels of Governments grants. Consequent to the 74th Constitutional Amendment Act (74th CAA), the States are expected to devolved responsibility, powers and resources upon ULBs as envisaged in the Twelfth Schedule of the Constitution.

The 74th CAA has substantially broadened the range of functions to be performed by the elected ULBs. The Twelfth Schedule brings into the municipal domain among others such areas such as urban and town planning, regulation of land-use, planning for economic and social development, 'safeguarding the interests of weaker sections of Society'. The Constitution thus envisages ULBs as being totally responsible for all aspects of development, civic services, and environment in the cities, going far beyond the traditional role. The focus should not only be on the investment requirements to augment supplies or install additional systems in sanitation and water supply. Instead, greater attention must be paid to the critical issues of institutional restructuring, managerial improvement, better and more equitable service to citizens who must have a greater degree of participation. The 74th CAA also focuses on achieving sustainability of the sector through the adoption of adequate measures in operation and management (O&M), the financial health of the utilities through efficiency of operations and levy of user charges, and conservation and augmentation of water sources.

1.4.2 Liberation of Manual Scavengers

Government of India has enacted the Employment of Manual Scavengers and Construction of Dry Latrines (Prohibition) Act, 1993. It serves as a primary instrument to eradicate practice of manual scavenging. The Centrally sponsored scheme of Urban Low Cost Sanitation for

liberation of the Scavengers was started in year 1980-81, which is now being operated through the Ministry of Housing and Urban Poverty Alleviation. As per the scheme's Revised Guidelines, 2008, the objective of the scheme is to convert/construct low cost sanitation units through sanitary two pit pour flush latrines with superstructures and appropriate variations to suit local conditions and construct new latrines where EWS households have no latrines and follow the in-human practice of defecating in the open in urban areas.

This would improve overall sanitation in towns. Scavengers so liberated if any or their dependents would have to be rehabilitated under the scheme by the State Governments simultaneously with the help of funds provided by the Ministry of Social Justice and Empowerment. Towns are selected from the various States and Union Territories irrespective of their population criteria and also persons belonging to EWS households who have no latrines and defecate in the open in urban areas. Depending upon the prevalence of dry latrines, targets will be fixed. Priority is given to those towns which have a predominance of dry latrines. Scheme will be applicable to all towns where dry units exist or for persons who have no latrines and defecate in the open. The nodal Ministry for processing project proposals and monitoring the implementation of the scheme is Ministry of Housing and Poverty alleviation.

1.5 NATIONAL URBAN SANITATION POLICY (2008) OF GOVERNMENT OF INDIA

The Ministry of Urban Development, Government of India proposed a very ambitious program on urban sanitation for which the Ministry has prepared a Report on "National Urban Sanitation Policy" and published in October 2008.

1.5.1 Concepts of Totally Sanitized Cities

A totally Sanitized City will be one that has achieved the outputs or milestones specified in the National Urban Sanitation Policy.

1.5.2 The Salient Features of Urban Sanitation Policy

The salient features of Urban Sanitation Policy are as follows:

a) Cities must be open defecation free

b) Must eliminate the practice of manual scavenging and provide adequate personnel protection equipment that addresses the safety of sanitation workers

c) Municipal sewage and storm water drainage must be safely managed

d) Recycle and reuse of treated sewage for non-potable applications should be implemented wherever possible

e) Solid waste collected and disposed of fully and safely

f) Services to the poor and systems for sustaining results

g) Improved public health outcomes and environmental standards.

1.5.3 Vision and Key Policy Issues

In order to achieve the above Vision, key policy issues such as i) Lack of Awareness, ii) Social and occupational Aspects of Sanitation, iii) Fragmented Institutional Roles and Responsibilities, iv) Lack of an Integrated City-wide Approach, v) Limited Technology Choices, vi) Reaching the Un-served Poor, and vii) Lack of Demand Responsiveness, need to be addressed and translated on the field for long term sustainability of the project.

In order to rapidly promote sanitation in urban areas of the country (as provided for in the National Urban Sanitation Policy and Goals 2008), and to recognize excellent performance in this area, the Government of India intends to institute an annual rating award scheme for cities (NUSP 2008)

The Ministry of Urban Development is also promising a National Communication Campaign to generate awareness on sanitation both at the household level and at the service provider level. The aim of this exercise is to generate awareness of the benefits of the hygiene and clean environment and thereafter bring about behaviour.

1.5.4 National Sanitation Policy Goals

The overall goals of this policy are to transform Urban India into community-driven, totally sanitized, healthy, and liveable cities and towns.

1.5.5 Service Level Benchmarking on Sewage Management (Sewerage and Sewage Treatment)

As already mentioned, the Millennium Development Goals (MDGs) enjoins upon the signatory nations to extend access to improved sanitation to at least half the urban population by 2015, and 100% access by 2025. This implies extending coverage to households without improved sanitation, and providing proper sanitation facilities in public places to make cities and towns open defecation free. The Ministry proposed to shift focus on infrastructure in urban water supply and sanitation sector (UWSS) to improve service delivery. Ministry formulated the set of Standardized Service Level Benchmarks for UWSS as per International Best Practice and brought out a "Handbook on Service Level Benchmarking" on water supply and sanitation sector in the year 2008. The Service Level Benchmarks (SLB) on Sewage Management (Sewerage and Sewage management) are given in Table 1.3 which are required to be achieved within a specified timeframe.

Table 1.3 Sewage Management (Sewerage and Sanitation)

S. No.	Proposed Indicator	Benchmark
1.	Coverage of toilets	100%
2.	Coverage of sewage network services	100%
3.	Collection efficiency of sewage network	100%
4.	Adequacy of sewage treatment capacity	100%
5.	Quality of sewage treatment	100%
6.	Extent of reuse and recycling of sewage	20%
7.	Efficiency of redressal of customer complaints	80%
8.	Extent of cost recovery in sewage treatment	100%
9.	Efficiency in collection of sewage charges	90%

Source: Handbook on Service Level Benchmarking, Ministry of Urban Development, Government of India, (Third Edition: 2011)

1.6 EMERGING TRENDS AND TECHNOLOGIES OF SEWERAGE AND SEWAGE TREATMENT

1.6.1 Recent Trend - Centralized vis-a-vis Decentralized Sewage Treatment Systems

While the conventional sewerage may be a comprehensive system for sewage collection and transport, it also remains as a highly resource-intensive technology. Consequently, high capital cost, and significant O&M cost of this system inhibits its widespread adoption in all sizes of urban areas.

The implementation of Centralized Wastewater Management System (CWMS) should not be

considered as the only option available for collection, transportation and treatment of sewage. There are certain factors which govern the selection of options between CWMS and Decentralized Wastewater Management System (DWMS). These have been elaborately discussed in relevant Chapter of the Manual.

Decentralized wastewater management system (DWMS) may be designed as the collection, treatment, and disposal/reuse of sewage from individual houses, cluster of houses, isolated communities, industries or institutional facilities as well as from portion of existing communities at or near the point of generation of sewage.

Decentralized systems maintain both the solids and liquid fraction, although the liquid portion and any residual solids can be transported to a centralized point for further treatment and reuse.

Recognizing the many applications and benefits of sewage reuse, some important points may be kept in view such as (i) review of the impact of the population growth rate (ii) review of potential water reuse applications and water quality requirements (iii) review of appropriate technologies for sewage treatment and reuse (iv) considering the type of management structure that will be required in the future and (v) identification of issues that must be solved to bring about water reuse for sustainable development on a broad scale.

It has been emphasized that if the sewage from the urban and semi urban areas were reused for a variety of non-potable uses, the demand on the potable water supply would be reduced.

The choice of appropriate technology will also depend on several factors such as composition of sewage, availability of land, availability of funds and expertise. Different operation and maintenance options will have to be considered with respect to sustainable plant operation, the use of local resources, knowledge, and manpower.

1.7 NEED FOR REVISION AND UPDATING OF THE EXISTING MANUAL ON SEWERAGE AND SEWAGE TREATMENT (1993)

Ever since the publication of the Manual on sewerage and sewage treatment in 1993 a number of new developments and changes have occurred in the complete range technologies of collection, transportation, treatment and reuse of treated sewage and sludge for various usages during the last two decades. Broad approaches adopted for the need of revision and updating of the manual on sewerage and sewage treatment are as mentioned below:

i) a greater fundamental understanding of the mechanisms of the biological treatment

ii) the application of advanced treatment methods for the removal of specific constituents

iii) the increased emphasis on the management of sewerage and sewage treatment in general and management of sludge resulting from the treatment of sewage, and

iv) the issuance of more comprehensive and restrictive permit requirements for the discharge of effluent and reuse of treated sewage.

Even though the sewerage and sewage treatment practices have continued to evolve and grow during last two decades, no time period in the past can equal this intervening period in terms of technological development.

In addition, the awareness of environmental issues among the national urban communities has reached a level not experienced before. This active awareness is a driving force for the agencies responsible for sewerage and sewage treatment to achieve the level of performance far beyond those envisioned even as during the last two decades.

Pressure for environmental compliance today is greater than before. The need for sewerage and sanitation schemes in urban areas and regulatory requirements have, at present, become more forceful. Support from the Central and State governments for environmental-related programs is becoming a strong driving force than ever before. Communities are quite aware, well organized, and informed.

The revision and updating of the existing manual (1993) aims to meet some of those needs by providing advice on the selection of technology options for urban sanitation, whether of new infrastructure or upgrading of existing services. It is applicable both to small interventions in specific locations and larger programs that aim to improve sanitation citywide. The selection of technologies with various options for providing techno-economic solutions keeping in view health of the community and safeguarding the environment, are listed below so as to provide a wide range of options to the planners and designers:

i) Decentralized sewerage system

ii) Sludge treatment and septage management

iii) Recent technologies on sewerage and sewage treatment

iv) New pipe materials for construction of sewers

v) Guidelines for recycling and reuse of treated sewage

vi) New guidelines for discharging treated effluent into water bodies used for drinking.

1.7.1 Guidelines for Preparation of City Sanitation Plan (CSP)

One of the most important objectives of revising and updating of this manual is 'Preparation of City Sanitation Plan' which has been amply described in Chapter 10 so as to give proper guidance to decision makers, planners, designers and also suitably involve political initiatives as a tool to envision affordable upgrade of existing sanitation systems and futuristic sanitation systems in a self-sustaining basis.

The algorithm given in Chapter 10 is a very useful chart for decision makers and planners to adopt the most suitable strategy for providing safe sanitation to the urban community within the policy framework of the Government of India in the country.

1.8 SETTING-UP OF ENVIRONMENTAL POLLUTION STANDARDS AT THE STATE LEVEL

While planning the citywide sanitation program, concerned agencies must set-up standards and follow at the State Level (within overall framework of national standards) such as CPHEEO and BIS guidelines values as mentioned below:

a) Environment Outcome (e.g. State Pollution Control Boards standards on effluent parameters, diminishing water resources, impact of climate change, use of low energy intensive onsite/decentralized sewage treatment technologies, distributed utilities, etc.),

b) Public Health Outcomes (e.g. State Health Departments),

c) Processes (e.g. safe disposal of on-site septage) and infrastructure (e.g., design standards) (PHEDs/Parastatals) and coverage of the informal sector activities like disposal of sewage, solid waste, etc.,

d) Service delivery standards (e.g. by the Urban Development Departments),

e) Manpower issues such as adequate remuneration, hazardous nature of work, employment on transparent terms and conditions, use of modern and safe technology, provision of adequate safety equipment such as glove, boots, masks, regular health check-ups, medical and accident insurance, etc.,

f) States are recommended to not just emulate but set their standards higher than the national standards in order to encourage its institutions and citizens to target higher standards of public health and environment (new guidelines).

1.9 RELATIONSHIP BETWEEN PART-A (ENGINEERING), PART-B (OPERATION AND MAINTENANCE), AND PART-C (MANAGEMENT) OF PROPOSED MANUAL

The Manual on Sewerage and Sewage Treatment (second edition) published in 1993 which has been revised and updated mainly gave thrust to engineering aspects of the sewerage and sewage treatment systems. Though, it covered topics of management and operation and maintenance of sewerage systems but these aspects were not dealt with in details so as to create awareness amongst the practicing and field engineers regarding the importance of these two topics which are so important for the sustainability of the systems in the long run.

The present Manual on Sewerage and Sewage Treatment has been divided into three sections, as under, which are inter-related to each other as described below:

i) Part – A on 'Engineering'

ii) Part – B on 'Operation and Maintenance', and

iii) Part – C on 'Management'

Part – A on 'Engineering' addresses the core technologies and updated approaches towards the incremental sanitation from onsite to decentralized or conventional collection, conveyance, treatment and reuse of the misplaced resource of sewage and is simplified to the level of the practicing engineer for his day to day guidance in the field in understanding the situation and coming out with his choice of approaches to remedy the situation. In addition it also includes recent advances in sewage treatment, sludge and septage management to achieve betterment of receiving environment. By no means, this is a text book nor it should be. It is a simple to understand guideline for the field engineer.

Part – B on 'Operation and Maintenance' addresses the issues of standardizing the human resources and financial resources that are needed to sustain a system created at huge costs without it slipping into an edifice for want of codified requirements of these so that it becomes possible to address these in the estimate stage itself and seek a comprehensive approval of fund allocations and human resources besides ushering in the era of public private partnership to make the projects self-sustaining. It is a simple to understand guidance for the resource seeker and resource allocating authorities.

Part – C on 'Management' is a refreshing approach to modern methods of project delivery and project validation and gives a continual model for the administration to foresee the deficits in allocations and usher in newer mechanisms. It is a tool for justifying the chosen project delivery mechanism and optimizing the investments on need based allocations instead of allocations in budget that remain unutilized and get surrendered in end of fiscal year with no use to anyone. It is a straightforward approach to a mundane approach over the decades.

CHAPTER 2 PLANNING

2.1 VISION

The vision for urban sanitation in India as mentioned in the National Urban Sanitation Policy (2008) of Government of India is:

'All Indian cities and towns become totally sanitized, healthy and liveable, and ensure and sustain good public health and environmental outcomes for all their citizens with a special focus on hygienic and affordable sanitation facilities for the urban poor and women'.

2.2 OBJECTIVES

The objective of a sewage collection, treatment and disposal system is to ensure that sewage discharged from communities is properly collected, transported, and treated to the required degree in short, medium, and long-term, and disposed-off / reused without causing any health or environmental problems.

Short term: It implies immediate provision of onsite system. It is an interim arrangement till the implementation of long term system. Short term plan should be formulated targeting up to 5 years from the base year.

Medium term: It implies the provision of a decentralized (nonconventional) system of collection for rapid implementation of collection, transportation, treatment, and disposal/local reuse to avoid sporadic sewage discharges into the environment and where conventional sewerage system is yet not feasible. Medium-term plans should have a target of 15 years from the base year.

Long term: It implies conventional sewage collection, transportation, treatment, and environmentally sound disposal/reuse. It encompasses the short term and medium term. Long-term plans should be formulated for a target of 30 years from the base year.

2.3 NEED FOR PLANNING

Sewage collection, treatment and disposal systems can be either the short-term, or medium-term or long-term. To keep overall costs down, most urban systems today are planned as an optimum mix of the three types depending on various factors.

Planning is required at different levels: national, state, regional, local and community. Though the responsibility of various organizations in charge of planning sewage collection, treatment and disposal systems is different in each case, they still have to function within the priorities fixed by the national and state governments and keep in view overall requirements of the area.

2.4 BASIC DESIGN CONSIDERATIONS

2.4.1 Engineering considerations

2.4.2 Institutional aspects

2.4.3 Environmental considerations

2.4.4 Treatment process

2.4.5 Financial aspects

2.4.6 Legal issues

2.4.7 Community awareness

2.4.8 Inter and Intra departmental coordination

2.4.9 Geographical information systems

2.4.10 City master plan

2.4.11 City sanitation plan.

2.4.1 Engineering Considerations

Topographical, engineering and other considerations which figure prominently in project design are noted below:

a) Design period, stage wise population to be served and expected sewage flow quality and fluctuation

b) Topography of the general area to be served, its slope and terrain, and soil profiles affecting construction. Tentative sites available for treatment plant, pumping stations and disposal works, considering flooding

c) Available hydraulic head in the system up to high flood level in case of disposal to a nearby river or high tide level in case of coastal discharge or the level of the irrigation area to be commanded in case of land disposal

d) Depth of groundwater table and its seasonal fluctuation affecting construction, sewer infiltration, structural design (uplift considerations)

e) Soil bearing capacity and type of strata expected to be met with in construction

f) On site disposal facilities, including the possibilities of segregating the sullage water and sewage and reuse or recycle sullage water within the households

g) Existing water supply, sewerage and sanitation conditions

h) Water reliability, augmentation steps, drought conditions

i) Reuse in agriculture, farm forestry, non-potable urban, industry

j) Decentralized sewerage and progressive coverage.

2.4.2 Institutional Aspects

a) Capability of existing local authority

b) Revenue collection and reliability

c) Capacity building needs

d) Public Private Partnership.

2.4.3 Environmental Considerations

The following aspects should be considered during design:

a) Surface Water Hydrology and Quality

Hydrological considerations affect the location of outfalls to rivers with regard to protection of nearby water supply intake points either upstream or downstream, especially at low flow

conditions in the river. Hydrological considerations also help determine expected dilutions downstream, frequency of floods and drought conditions, flow velocities, travel times to downstream points of interest, navigation, etc.

Surface water quality considerations include compliance with treated effluent standards at the discharge point with respect to parameters like BOD, suspended and floating solids, oil & grease, nutrients, coliforms, etc. Special consideration may be given to the presence of public bathing ghats downstream. The aquatic ecosystem (including fish) may also need protection in case of rivers through minimum dissolved oxygen downstream, ammonia concentrations in the water, uptake of refractory and persistent substances in the food chain, and protection of other legitimate uses to which the river waters may be put.

b) Ground Water Quality

Another environmental consideration is the potential for ground water pollution presented by the treatment units proposed to be built. For example, in certain soils, special precautions may be needed to intercept seepage of sewage from lagoons and ponds. Land irrigation would also present a potential for ground water pollution especially from nitrates. In case of low cost sanitation methods involving on-site disposal of excreta and sullage waters, ground water pollution may need special attention if the ground water table is high and the topsoil relatively porous.

c) Coastal Water Quality

Shoreline discharges of sewage effluents, though treated, could lead to bacterial and viral pollution and affect bathing water quality of beaches. Discharges have to be made sufficiently offshore and at sufficient depth through marine outfall to benefit from dilution and natural die-away of organisms before they are washed back to the shoreline by currents. The presence of nutrients could also promote algal growth in coastal waters, especially in bays where natural circulation patterns might keep the nutrients trapped in the water body.

d) Odour and Mosquito Nuisance

Odour and mosquito nuisance in the vicinity of sewage treatment plants, particularly in the downwind direction of prevailing winds, can have adverse impacts on land values, public health and well-being and general utility of amenities may be threatened. These factors have to be considered in selecting technologies and sites for location of sewage treatment plants and treated sewage irrigation fields.

e) Public Health

Public health considerations pervade through all aspects of design and operation of sewage treatment and disposal projects. Some aspects have already been referred to in earlier part of this Section. Public health concepts are built into various byelaws, regulations and codes of practice which must be observed, such as:

i) Effluent discharge standards including permissible microbial and helminthic quality requirements

ii) Standards for control of toxic and accumulative substances in the food chain

iii) Potential for nitrate and microbial pollution of ground waters

iv) Deterioration of drinking water resources including wells

v) Deterioration of bathing water quality

vi) Control measures for health and safety of sewage plant operators and sewage farm workers, and nearby residents, who are exposed to bio-aerosols or handle raw and/or treated sewage.

f) Landscaping

Sewage treatment plant structures need not be ugly and unsightly. At no real extra cost, some architectural concepts can be used and the buildings designed to suit the main climates (humid or dry) generally met within India.

Apart from the usual development of a small garden near the plants office or laboratory, some considerations need to be given to sites for disposal of screenings and grit in an inoffensive manner, general sanitation in the plant area and provision of a green-belt around the treatment plant. Green belt around the treatment plant shall be preferably of plants with shallow roots in order to avoid deep and spread roots from trees accessing the water retaining structures and damaging their construction by ingress to the moist zones.

g) Status of pollution of surface waters, ground waters and coastal waters

h) Remediation needs and realistic solutions to mitigation of pollution

i) Solid wastes disposal and leachates as affecting the likely siting of STPs

j) Fate of sludge generated in STPs and potential to go in for vermicomposting

k) Clean Development Mechanism by biomethanation and energy recovery from STPs

l) Vital statistics and frequency of water borne and vector borne diseases.

2.4.4 Treatment Process

Process considerations involve factors which affect the choice of treatment method, its design criteria and related requirements such as the following:

a) Sewage Flow and Characteristics

This constitutes the primary data required for process design. The various parameters to be determined are described in other Sections of this manual.

b) Degree of Treatment Required

In case of domestic or municipal sewage, this is considered, for example, in terms of removal of BOD nutrients (nitrogen and phosphorous), coliforms, helminths etc. Land disposal generally has to meet less stringent discharge standards than disposal to surface waters. Land disposal also has the advantage of avoiding nutrient removal and is, thus, preferred wherever it is feasible. It is often not enough to aim only at BOD removal and let other items be left to unspecified, incidental removal, whatever may occur. The selection of a treatment process thus, depends on the extent of removal efficiency required for all important parameters and the need to obviate nuisance conditions.

c) Performance Characteristics

The dependability of performance of a process in spite of fluctuations in influent quality and quantity are very useful attributes in ensuring a stable effluent quality. Similarly, ability to withstand power and operational failures, also form important considerations in choice of process. The more high-rated process, the more sensitive it is in operation. Other processes like digesters, lagoons and ponds may be sensitive to extreme temperature range. The choice has to match with the discharge standards to be met in a specific case. The performance characteristics

for some methods of sewage treatment are indicated in Appendix 2.1.

d) Other Process Requirements

Various other factors affecting the choice of a process include requirements in terms of:

- Land
- Power and its dependability
- Operating (and control) equipment requirement and its indigenous availability
- Skilled staff
- Nature of maintenance problems
- Extent of sludge production and its disposal requirements
- Loss of head through plant in relation to available head (to avoid pumping as far as possible)
- Adoption of modular system.

Between land and power requirements, a trade-off is often possible, based on actual costs of the two items. This could well be exploited to get an optimum solution for meeting treatment requirements and giving a dependable performance.

The operating equipment and its ancillary control equipment should be easy to operate and maintain (with indigenously available spare parts) as far as possible. It is to be noted that, methane gas collection, scrubbing to remove hydrogen sulphide wherever necessary and its conversion to electricity, should be effectively done. The option of gas collection and supply to a nearby industry or area should be favoured during the site selection stage wherever possible. The related issues are

e) To be affordable by the local body for its O&M

f) Trade-offs between portions to be treated for industries and portions to be discharged

g) Possibility of upgrading with respect to incrementing flows over time

h) Depending on proprietary spares to be avoided or inbuilt into the O&M contract itself

i) Local skills to comprehend and implement monitoring.

2.4.5 Financial Aspects

Finally from among the few selected options, the overall costs (capital and operating) and financial sustainability have to be determined in order to arrive at the most optimum solution.

a) Capital costs include all initial costs incurred up to plant start-up, such as:

- civil construction, equipment supply and erection costs
- land purchase costs including legal fees, if any
- engineering design and supervision charges
- Interest charge on loan during construction period.

b) Operating costs after start-up of plant include direct operating costs and fixed costs,

such as:

- amortization and interest charges on capital borrowing
- direct operation and maintenance costs on
  - Staff
  - Chemicals
  - Energy
  - Transport
  - Maintenance and repairs
  - Tools and Plants
  - Insurance
  - Overheads.

c) Financial sustainability

- Levy of appropriate sewerage charges
- Willingness to pay by the end user
- Efficient sewerage charge collection
- Supplementary budget from alternate sources
- Revenue generation potential of the concerned local body, water boards, PHED's / Jal Nigams, Parastatal organizations, as the case may be
- Actual recovery generated

2.4.6 Legal Issues

In general, legalities do not affect sewerage projects except land acquisition issues which require tact, patience and perseverance.

2.4.7 Community Awareness

In general, the decision making on sewerage system management is carried out without involving the public at large and this has to change by appropriate web based messages, hand-outs, public hearings and documenting the outcomes and taking the population along.

2.4.8 Inter- and Intra-departmental Coordination

a) Co-ordination between local body and water boards/PHEDs/Jal Nigams/as the case may be

b) Co-ordination among water boards/PHEDs/Jal Nigams/Local Bodies as the case may be and elected representatives

c) Intra-departmental coordination

2.4.9 Geographical Information Systems

Geographical Information Systems (GIS) should be an integral part of sewage collection system. It allows developing city master plans including city sanitation plan rapidly and in a precise manner and can be related precisely to its position in the ground. The spatial modelling capabilities of GIS can be used to estimate current and future sewage flows, evaluate the capacity of the sewers, and estimate the condition of the sewers.

2.4.10 City Master Plan

The city master plan shall be prepared clearly indicating the various aspects as this will form a basis for the project. The city sanitation plan shall also mandatorily form part of the city master plan. The various aspects to be considered are in Chapter 10. Any proposal submitted for funding shall mandatorily include the city master plan and city sanitation plan. It is very important and pertinent to include and account for the mandatory provision of adequate and proper sanitation facilities in each and every school in the country thus complying with the directive of the Government of India.

The planning period to be adopted for the preparation of the master plan shall be 30 years. In order to bring the master plan projections on the same time line for comparison and funding, the Town & Country planning authority would also be required to increase their planning period from the present 20 years to 30 years for the reasons mentioned earlier.

2.4.11 City Sanitation Plan

City sanitation plan should be a part of city master plan and it should be prepared in accordance with NUSP.

The planning design period for onsite, decentralised and centralised systems shall be 5 years, 5 to 15 years and 30 years, respectively.

2.5 DESIGN PERIOD

The project components may be designed for the periods mentioned in Table 2.1.

Table 2.1 Design period of sewerage components

Sl. No	Component	Design Period, Years (from base year)
1	Land Acquisition	30
2	Conventional sewers (A)	30
3	Non-conventional sewers (B)	15
4	Pumping mains	15
5	Pumping Stations-Civil Work	30
6	Pumping Machinery	15
7	Sewage Treatment Plants	15
8	Effluent disposal	30
9	Effluent Utilization	15 or as the case may be
(A) Typical underground sewers with manholes laid in the roads (B) All types such as small bore, shallow sewers, pressure sewers, vacuum sewers		

2.6 POPULATION FORECAST

2.6.1 General Considerations

The design population should be estimated paying attention to all the factors governing the future growth and development of the project area in the industrial, commercial, educational, social, and administration spheres. Special factors causing sudden immigration or influx of population should also be predicted as far as possible.

A judgement based on these factors would help in selecting the most suitable method of deriving the probable trend of the population growth in the area or areas of the project from the following mathematical methods, graphically interpreted where necessary:

a) Demographic method of population projection

Population change can occur in three ways: by birth (population gain), by death (population loss), or by migration (population loss or gain depending on whether movement-out or movement-in occurs in excess). Annexation of area may be considered a special form of migration. Population forecasts are frequently made by preparing and summing up separate but related projections of natural increases and of net migration, and are expressed below.

The net effect of births and deaths on population is called natural increase (natural decrease, if deaths exceed births).

Migration also affects the number of births and deaths in an area, and so, projections of net migration are prepared before projections for natural increase.

This method thus takes into account the prevailing and anticipated birth rates and death rates of the region or city for the period under consideration. An estimate is also made of the emigration from and immigration to the community, its growth area-wise and the net increase of population is calculated accordingly considering all these factors by arithmetical balancing.

b) Arithmetic increase method

This method is generally applicable to large and old cities. In this method, the average increase of population per decade is calculated from the past records and added to the present population to estimate population in the next decade. This method gives a low value and is suitable for well settled and established communities.

c) Incremental increase method

In this method, the increment in arithmetical increase is determined from the past decades and the average of that increment is added to the average increase. This method gives increased values compared to the figures obtained by the arithmetical increase method.

d) Geometrical increase method

In this method, the percentage increase is assumed to be the rate of growth and the average of the percentage increase is used to determine the increment in future population. This method gives a much higher value and is mostly applicable to growing towns and cities having vast scope of expansion.

e) Decreasing rate of growth

In this method, it is assumed that the rate of percentage increase decreases and the average decrease in the rate of growth is calculated. The percentage increase is modified by deducting the decrease in the rate of growth. This method is applicable only to those cases where the rate

of growth of population shows a downward trend.

f) Graphical method

There are two methods: in the first method, only the city in question is considered; and in the second method, other similar cities are also taken into account.

i) Graphical method based on single city

In this method the population curve of the city (i.e., the population vs. past decades) is smoothly extended for obtaining values for the future. The curve should be extended carefully; this requires vast experience and good judgement. The line of best fit may be obtained by the method of least squares.

ii) Graphical method based on cities with similar growth pattern

In this method, the city in question is compared with other cities that have already undergone the same phases of development which the city in question is likely to undergo. Based on this comparison, a graph of populations versus decades is plotted and extrapolated.

g) Logistic method

The S shaped logistic curve for any city gives the complete trend of growth for the city right from beginning to the saturation limit of population of the city. This method is applicable to very large cities with adequate demographic data.

h) Method of density

In this approach, the trend in rate of increase in population density for each sector of a city is determined and population is forecasted for each sector based on the above approach. Addition of population sector-wise gives the population of the city.

2.6.2 Final Forecast

While the forecast of the population of a project area at any given time during the design period can be derived by any one of the foregoing methods appropriate to each case, the density and distribution of such population in several areas, zones or districts will again have to be estimated based on the relative probabilities of expansion in each zone or district, according to the nature of development and based on existing and contemplated town planning regulations. Wherever population growth forecast or master plans prepared by town planning authorities or other appropriate authorities are available, the design population should take these figures into account.

Floating population should also be considered which includes number of persons visiting the project area for tourism, pilgrimage or for working. The numbers should be decided in consultation with the tourism departments and specified for water supply and sewerage.

Workout examples for estimation of future population by some of the methods are given in Appendix 2.2.

2.7 PROJECT AREA

The factors which influence determination of project area include natural topography, layout of buildings, political boundaries, economic factors, city master plan, etc. For larger drainage areas, though it is desirable that the sewer capacities be designed for the total project area, sometimes political boundaries and legal restrictions prevent construction of sewers beyond the limits of

the local authority. However, when designing sewers for larger areas, there is usually an economic advantage in providing adequate capacity initially for a certain period of time and constructing additional sewers, when the pattern of growth becomes established. The need to finance projects within the available resources necessitates the design to be restricted to political boundaries. The project area under consideration should be marked on a key plan so that the area can be measured from the map.

2.8 REUSE AND DISPOSAL

Reuse of treated sewage should be given preference over disposal. Various options are discussed in Chapter 7.

2.9 LAYOUT AND ARRANGEMENT OF SEWERAGE

Layout of collection systems shall resist the tendency to go in for underground sewerage flat out even in habitations that are only sparsely developed and options of either time deferred underground sewerage or incremental sewerage commensurate with the pace of development by such options as small bore, shallow sewers, twin drains, etc., to start with and eventual underground sewerage when habitations have been populated to a certain level where the revenue will be able to sustain the O&M. Layouts by small communities shall be mandated to include the twin drain/small bore sewer system in both sides of roads whereby the house side drain will receive the septic tank effluent and the road side drain will receive the storm water runoff. In metropolitan urban centres, decentralized sewerage shall be confined to institutional boundaries only and not culled out of habitations itself and zoning of sewerage with STPs fanning out radially outwards is to be encouraged.

A flat out choice of underground sewerage with sewers in middle of roads shall be discouraged and incremental sanitation as settled sewers, small bore sewers, twin drain for septic tank effluents and sewers on shoulders of wide roads are to be evaluated as detailed in Chapter 3.

2.10 LEGISLATION AND REGULATIONS

a. Water (Prevention and Control) Act, 1974

Under this Act, it is necessary to obtain a “consent to establish (CTE)” from the Pollution Control Board (PCB) before starting the work of STP. Similarly, it is necessary to obtain the “consent to operate (CTO)” after completion of the construction and before actual operation. The CTE is based on whether the proposed STP design meets the discharge standards for treated sewage and the CTO is based on whether all the units originally committed are actually built and to the same size. Starting the construction without the CTE and starting the operation without CTO are punishable as an offence.

b. Environment (Protection) Act, 1986

The discharge standards for treated sewage, the noise standards governing the STP, the air emission standards governing the STP are prescribed in this act and are binding without exception. The PCB is empowered to tighten these standards wherever it is needed.

c. Municipal Byelaws

Most municipal byelaws provide for the owner of any property to dispose of sewage in a proper manner without causing any nuisance to others. Wherever municipal sewers exist within a specified distance as per the respective byelaws, it is obligatory that the sewage of the property be discharged into it. The byelaws provide for action against defaulting owners.

d. Environment Impact Assessment

According to the EIA notification issued in 2006 by MOEF, this is not needed for Sewerage projects.

e. Indian Standards

The Indian Standards (by BIS) lay down quality levels of bought out items and construction quality and shall not be diluted under any account. Wherever Indian Standards are not available, internationally accepted standards may be used.

f. Town and Country Planning Act

The Town & Country Planning Act shall be mandatorily followed. Wherever there is a possibility, storm water drains on both sides of the road shall be built mandatorily.

2.11 GUIDELINES ON HOUSE SEWER CONNECTIONS

a) There is a compelling need to amend byelaws to make it compulsory for the population to avail house sewer connection wherever public sewerage is provided and if this is not forthcoming, the local authority shall effect the connection and institute revenue recovery proceedings.

b) Include house service connections as part of the sewerage project itself

c) Float EMI (Equated monthly instalments) schemes for repayment of house service sewer costs.

2.12 SURVEY AND INVESTIGATION

Survey and investigation are pre-requisites both for framing of the preliminary report and the preparation of a detailed sewerage project. The engineering and policy decisions taken are dependent on the correctness of the data collected and its proper evaluation.

2.12.1 Basic Information

Broad knowledge of the problems likely to be faced during the various phases of implementation of the project is essential for performing investigations effectively. Information on physical, developmental, fiscal and other aspects has to be collected.

The philosophy of survey is to rule out simple initial mistakes which will make the entire project a blunder eventually. Because the entire geographical coverage of the project area relies very seriously on gravity transmission and eligible pathways, affordability by users, etc., initial survey will chalk out what all are to be considered and what all shall have to be time deferred and what all to be relegated in each case.

2.12.1.1 Physical Aspects

These would necessitate the collection of information related to:

a) Topography or elevation difference needed for design of sewers and location of sewage treatment works, outfall and disposal works

b) Subsoil conditions, such as types of strata likely to be encountered, depth of groundwater table and its fluctuations. In the absence of any records, preliminary data should be collected by putting at least 3 trial bores or trial pits per hectare.

c) Underground structures like storm drains and appurtenances, city survey stones, utility services like house connections for water supply and sewerage, electric and telephone cables, gas lines

d) Location of streets and adjoining areas likely to be merged or annexed

e) Possible sources of information are existing maps and plans showing streets from revenue or town surveys or Survey of India maps. Other sources are topographical maps of Survey of India if available with existing spot-levels, aerial photographs, photographs of complex surfaces for supplementing the existing instrumental surveys by concerned authorities like Municipalities and Roads Departments.

f) Contour map of the area to be superimposed on the village/town/city maps

g) Survey of India maps

h) Subsoil such as types of strata, or at least 3 trial bores or trial pits per hectare

i) Groundwater table and its fluctuations from local enquiries and past records

j) Underground utility services and Survey of India bench marks

k) Location of streets and adjoining areas likely to be merged or annexed

l) Land use maps, density and trends of population growth and demographic studies

m) Type and number of industries for potential reuse and discharge of effluent

n) Existing drainage and sewerage facilities and data related to these facilities

o) Flow in sewers and sewers of similar areas to assess the flow characteristics

p) Historical and socioeconomic data

q) Problems of maintenance of existing sewers

r) Effluent disposal sites and their availability.

2.12.1.2 Survey of Natural Conditions

a) Societal preferences and local habits

b) Present status of the governmental, semi-governmental or municipal authority sponsoring the project, its capacity, adequacy, effectiveness and the desirability of its modification or necessity of a new organization to satisfactorily implement and maintain the project.

2.12.1.3 Survey on Related Plans

a) Sewerage master plan

b) Other related sewerage plans

c) Long-term comprehensive development plans for cities and towns

d) Urban planning

e) City planning area, urbanization zone, and urbanization control area

f) Land use plan

g) Road plan

h) Urban development as rezoning, residential estates, and industrial complexes

i) Design longitudinal section, transverse section

j) Design high water level and corresponding flood flow

k) Design low water level and corresponding flow

l) Other plans.

2.12.1.4 Survey on Pollution Loads and Receiving Bodies

a) Survey on generated pollution load

b) Existing conditions and future plans related to water supply

c) Existing conditions and future plans related to industrial uses

d) Population, industrial production, agriculture, forestry and animal husbandry

e) Data on quality and quantity of sewage from large factories, offices, etc.

f) Data on sewage generated from sightseeing sources

g) Data on wells

h) Data on standard unit pollution loads from different sources

i) Survey to gather information on receiving water bodies

j) Data on existing water quality and flow in water bodies at the time of sampling

k) Data on environmental standards for water quality

l) Utilization of existing water bodies and future plans related to uses.

2.12.1.5 Survey on Existing Facilities

a) Underground installations

b) Existing sewerage and onsite sanitation facilities

c) Existing conditions of disposal of human waste

d) Existing conditions and alignment of road

e) Cultural assets and historic relics

f) Other existing facilities.

2.12.1.6 Survey on Resources of Sewerage System and its Utilization

a) Utilization of space in sewage treatment plant and pumping stations like space on the top of STP structures or pumping stations is precious open space especially in highly populated cities for terrace garden and green houses.

b) Utilization of space in large sewers as conduits for optical fibre cables.

2.12.1.7 Survey on Treated Sewage, Sludge and Biogas Utilization

a) Reuse of treated sewage should be taken up after discussions between urban local body, water boards, PHEDs / Jal Nigams and public, as the case may be. Various possible reuses could be in case of farm forestry, greenbelt development, and lawns

in road medians.

b) Utilization of sludge, like public acceptance issues defy use of sludge in public areas, best to focus on farm forestry.

c) Utilization of alternative energy, like in plant energy to be harnessed from biomethanation and to evaluate the ambient temperature suitability or heating of sludge vs. economics.

d) Reuse of treated sewage to a minimum extent of 20% by volume shall be mandatorily explored and the proposed use for achieving this 20% target shall mandatorily form part of the city sanitation plan.

e) Utilization of sludge as construction materials (as porous pavements, bricks, etc.).

2.12.1.8 Project Surveys

It should include overall survey of the population, their historical outlook, their willingness for a change, acceptance of the concept to pay for the services, responsibility of local body under the national law of the land and above all, a public hearing on these.

2.12.1.9 Preliminary Project Surveys

This is concerned with the broad aspects of the project. Data on aspects such as capacity required, basic arrangement and size, physical features affecting general layout and design, availability of effluent disposal facilities, probable cost and possible methods of financing, shall be collected to prepare an engineering report describing the scope and cost of the project with reasonable accuracy. In framing such estimates, due consideration must be given to the escalation of prices of basic materials and their availability. While extreme precision and detail are not required in this phase, all the basic data obtained must be reliable.

2.12.1.10 Detailed Project Surveys

Surveys for this phase form the basis for the engineering design as well as for the preparation of plans and specifications for incorporation in the detailed project report. In contrast to preliminary survey this survey must be precise and contain contours of all the areas to be served giving all the details that will facilitate the designer to prepare design and construction of plans suiting the field conditions. It should include, inter-alia, network of bench marks and traverse surveys to identify the nature as well as extent of the existing underground structures requiring displacement, negotiation or clearance. Such detailed surveys are necessary to establish rights-of-way, minimize utility relocation costs, obtain better bids and prevent changing and rerouting of lines.

2.12.1.11 Construction Surveys

All control points such as base lines and bench marks for sewer alignment and grade should be established by the engineer along the route of the proposed construction. All these points should be referred adequately to permanent objects.

a) Preliminary Layouts

Before starting the work, rights-of-way, work areas, clearing limits and pavement cuts should be laid out clearly to ensure that the work proceeds smoothly. Approach roads, detours, by-passes and protective fencing should also be laid out and constructed prior to undertaking sewer construction work. All layout work must be completed and checked before construction begins.

b) Setting Line and Grade

The transfer of line and grade from control points, established by the engineers, to the construction work should be the responsibility of the executing agency till work is completed. The methods generally used for setting the line and grade of the sewers are discussed in Chapter 3. The procedures for establishing line and grade where tunnels are to be employed in sewer system are also discussed.

2.12.1.12 Developmental Aspects

The following should be taken into account:

a) Types of land use, such as commercial, industrial, residential and recreational uses; extent of areas to be served

b) Density of population, trends of population growth and demographic studies

c) Type and number of industries for determining quantity and nature of wastes, and locations of their discharge points

d) Existing drainage and sewerage facilities and data related to these facilities

e) Flow in existing sewers and sewers of similar areas to assess the flow characteristics

f) Historical and socioeconomic data

g) Basis of design and information on the maintenance of existing sewers

h) Effluent disposal sites and their availability.

Possible sources of information are census records, town and metropolitan master plans, city development plans, regional planning records, land use plan, flow gauging records, stream flow records, meteorological data and data from pollution control boards.

2.12.1.13 Fiscal Aspects

The various factors that will have an important bearing are:

a) Existing policies or commitments/obligations which may affect the financing of the project

b) Outstanding loan amounts and instalments of repayments

c) Availability of Central and State Government loans, grant-in-aid, loans from other financing bodies such as Life Insurance Corporation, Industrial Development Corporation, HUDCO, International Bank for Reconstruction and Development and other Banks and Institutions

d) Present water rates, sewer-tax and revenue realized from the service, size of property plots and land holding, the economic condition of community with respect to their tax-paying capacity

e) Factors affecting the cost of constructions, operation and maintenance. Some of the information can be obtained from the records related to Municipal and State Tax Levies, Acts and Rules governing loans, procedures for financing projects and registers and records of the authorities maintaining water supply and sewerage systems.

2.12.1.14 Other Aspects

The considerations that are likely to influence the planning of sewerage system are:

a) Changes in political boundaries by physical acquisition or merger of adjacent communities or by possible extension of limits

b) Feasibility of multi-regional or multi-municipal systems

c) Prevailing water pollution prevention statutes, other rules and regulations related to discharge of industrial and domestic wastes

d) Present status of the governmental, semi-governmental or municipal authority sponsoring the project, its capacity, adequacy, effectiveness and the desirability of its modification or necessity of a new organization to satisfactorily implement and maintain the project

e) Inconveniences likely to be caused to the community during execution and the feasibility of minimizing them by suitable alignment or location of the components of the sewerage system.

Possible sources of information are National Acts, State and Municipal Laws and Byelaws, minutes of the past meetings of the municipal or other governing bodies and discussions with officials, municipal councillors and other local leaders.

2.13 PROJECT REPORT

2.13.1 General

All projects have to follow distinct stages between the period they are conceived and completed. The various stages are:

- Pre-investment planning
  - Identification of a project
  - Preparation of project report
- Appraisal and sanction
- Construction of facilities and carrying out support activities
- Operation and maintenance
- Monitoring and feed back

2.13.1.1 Project Reports

Project reports deal with all aspects of pre-investment planning and establish the need as well as the feasibility of projects technically, financially, socially, culturally, environmentally, legally and institutionally. For big projects economical feasibility may also have to be examined. Project reports should be prepared in three stages viz. (i) identification report (ii) pre-feasibility report and (iii) feasibility report. Projects for small towns or those forming parts of a programme may not require preparation of feasibility reports. Detailed engineering and preparation of technical specification and tender documents are not necessary for taking investment decisions, since these activities can be carried out during the implementation phase of projects. For small projects, however, it may be convenient to include detailed engineering in the project report, if standard design and drawing can be adopted.

Since project preparation is quite expensive and time consuming, all projects should normally proceed through three stages and at the end of each stage a decision should be taken whether to proceed to the next planning stage and commit the necessary manpower and financial resources for the next stage. Report at the end of each stage should include a time table and cost estimate for undertaking the next stage activity and a realistic schedule for all future stages of project development, taking into consideration time required for review and approval of the report, providing funding for the next stage, mobilizing personnel or fixing agency (for the next stage of project preparation) data gathering, physical surveys, site investigations, etc.

The basic design of a project is influenced by the authorities/organizations who are involved in approving, implementing, operating and maintaining the project. Therefore the institutional arrangements, through which a project will be brought into operation, must be considered at the project preparation stage. Similarly responsibility for project preparation may change at various stages. Arrangements in this respect should be finalized for each stage of project preparation. Some times more than one organization may have a role to play in the various stages of preparation of a project. It is therefore necessary to identify a single entity to be responsible for overall management and coordination of each stage of project preparation. It is desirable that the implementing authority is identified and those responsible for operation of a project are consulted at the project preparation stage.

2.13.2 Identification Report

Identification report is basically a desk study, to be carried out relying primarily on the existing information. It can be prepared reasonably quickly by those who are familiar with the project area and needs of project components. This report is essentially meant for establishing the need for a project indicating likely alternatives which would meet the requirements. It also provides an idea of the magnitude of cost estimates of a project to facilitate bringing the project in the planning and budgetary cycle and makes out a case for obtaining sanction to incur expenditure for carrying out the next stages of project preparation. The report should be brief and include the following information:

a) Identification of the project area and its physical environment

b) Commercial industrial, educational, cultural and religious importance and activities in and around the project area (also point out special activities or establishments like defence or others of national importance)

c) Existing population, physical distribution and socioeconomic analysis

d) Present sewage collection, treatment and disposal arrangements in the project area, pointing out deficiencies, if any, in system of collection and treatment

e) Population projection for the planning period, according to existing and future land use plans or master plans, if any

f) Establish the need for taking up a project in the light of existing and future deficiencies in sewage collection, treatment and disposal services, pointing out adverse impacts of non-implementation of the project, on a time scale

g) Bring out, how the project would fit in with the national/regional/sectoral strategies and with the general overall development in the project area

h) Identify a strategic plan for long term development of sewage collection, treatment and disposal services in the project area, in the context of existing regional development plans and such other reports, indicating phases of development

i) State the objectives of the short term project under consideration, in terms of population to be served and the impact of the project after completion, clearly indicating the design period

j) Identify project components, with alternatives if any; both physical facilities and supporting activities

k) Preliminary estimates of costs (component-wise) of construction of physical facilities and supporting activities, cost of operation and maintenance

l) Identify source for financing capital works and operation and maintenance, work out annual burden (debt servicing + operational expenditure)

m) Indicate institutions responsible for project approval, financing, implementation, operation and maintenance (e.g., Central Government, State Government, Zilla Parishad, Local Body, Water Supply Boards)

n) Indicate organization responsible for preparing the project report (pre-feasibility report, feasibility report), cost estimates for preparing project report and sources of funds to finance preparation of project reports

o) Indicate time table for carrying out all future stages of the project and the earliest date by which the project might be operational

p) Indicate personnel strength required and training needs for implementation of the project. Indicate if any particular/peculiar difficulties of policy or other nature that are likely to be encountered for implementing the project and how these could be resolved

q) Recommend actions to be taken to proceed further.

The following plans may be enclosed with the report:

i) An index plan to a scale of 1 cm = 2 km showing the project area, existing works, proposed works and location of community/township or institution to be served

ii) A schematic diagram showing the salient levels of project component.

2.13.3 Prefeasibility Report

After clearance is received, on the basis of identification report from the concerned authority and/or owner of the project and commitments are made to finance further studies, the work of preparation of prefeasibility report should be undertaken by an appropriate agency, which may be a central planning and design cell of the Department dealing with Sewerage Board, Local Body, or professional consultants working in the water supply-sanitation environmental areas. In the latter case terms of reference for the study and its scope should be carefully set out. Prefeasibility study may be a separate and discrete stage of project preparation or it may be the first stage of a comprehensive feasibility study. In either case it is necessary that it precedes taking up of a feasibility study because the prefeasibility study is essentially carried out for screening and ranking of all project alternatives, and to select an appropriate alternative for carrying out detailed feasibility study. The prefeasibility study helps in selecting a short term project which will fit in the long term strategy for improving services in the context of overall perspective plan for development of the project area.

A prefeasibility report can be taken to be a Preliminary Project Report, the structure and component of which are as follows:

i) Executive summary

ii) Introduction

iii) The project area and the need for a project

iv) Long term plan for sewage collection, treatment and disposal

v) Proposed sewage collection, treatment and disposal project

vi) Conclusions and recommendations

vii) Tables, figures/maps and annexes.

2.13.3.1 Executive Summary

It is a good practice to provide an Executive Summary at the beginning of the report, giving its essential features, basic strategy, approach adopted in developing the project and the salient features of financial and administrative aspects.

2.13.3.2 Introduction

This section explains the origin and concept of the project, how it was prepared and the scope and status of the report. These subsections may be detailed as under:

a) Project Genesis

i) Describe how the idea of the project originated, agency responsible for promoting the project.

ii) List and explain previous studies and reports on the project, including the project identification report and agencies which prepared them

iii) Describe how the project fits in the regional development plan, long term sector plan, land use plan, public health care and sewage management programme, etc.

b) How was the Study Organized

i) Explain how the study was carried out, agencies responsible for carrying out the various elements of work and their role in preparing the study.

ii) Time table followed for the study.

c) Scope and Status of the Report

i) How the pre-feasibility report fits in the overall process of project preparation

ii) Describe data limitation

iii) List interim reports prepared during the study

iv) Explain the prefeasibility report is intended to be used for obtaining approval for the proposed project.

2.13.3.3 Project Area and the Need for the Project

This section establishes the need for the project. It should cover the following main items.

2.13.3.3.1 Project Area

i) Give geographical description of the project area with reference to maps

ii) Describe special features such as topography, climate, culture, religion, migration, etc., which may affect project design, implementation and operation

iii) Map showing administrative and political jurisdiction

iv) Describe any ethnic, cultural or religious aspects of the communities which may have a bearing on the project proposal.

2.13.3.3.2 Population Pattern

i) Estimate population in the project area, indicating the sources of data or the basis for the estimate

ii) Review previous population data, historic growth rates and causes

iii) Estimate future population growth with different methods and indicate the most probable growth rates and compare with past population growth trends

iv) Compare growth trends within the project area, with those for the region, state and the entire country

v) Discuss factors likely to affect population growth rate

vi) Estimate probable densities of population in different parts of the project area at future intervals of time e.g. five, ten and twenty years ahead

vii) Discuss patterns of seasonal migration, if any, within the area

viii) Indicate implication of the estimated growth pattern on housing and other local infrastructure.

2.13.3.3.3 Economic and Social Conditions

i) Describe present living conditions of the people of different socioeconomic and ethnic groups

ii) Identify locations according to income levels or other indications of socioeconomic studies

iii) Show on the project area map location-wise density of population, poverty groups and ethnic concentrations and the present and future land uses (as per development plan).

iv) Information on housing conditions and relative proportions of owners and tenants

v) Provide data on education, literacy and unemployment by age and sex

vi) Provide data and make projection on housing standards and average household occupancy in various parts of the project area

vii) Describe public health status within the project area with particular attention to diseases related to water and sanitary conditions

viii) Provide data on maternal and infant mortality rates and life expectancy

ix) Discuss the status of health care programmes in the area, as well as other projects which have bearing on improvements in environmental sanitation.

2.13.3.3.4 Sector Institutions

i) Identify the institutions (Government, Semi-Government, Non-Government) which are involved in any of the stages of water supply and sanitation project development in the area (Planning, preparing projects, financing, implementation, operation and maintenance and evaluation)

ii) Comment on roles, responsibilities and limitation (territorial or others) of all the identified institutions, in relation to water supply and sanitation (This may also be indicated on a diagram).

2.13.3.3.5 Existing Sewage Collection, Treatment and Disposal Systems and Population Served

Describe each of the existing sewage collection, treatment and disposal systems (including conventional, decentralized, and onsite systems) in the project area, indicating the details as under:

i) Area served, quantity and quality of sewage collected, components of the system such as collection network, pumping stations, treatment works and effluent reuse and disposal methods, etc.

ii) Private sewage disposal methods such as septic tanks, on site latrines, etc.

2.13.3.3.6 Drainage and Solid Wastes

Briefly describe existing systems of storm water drainage and solid waste collection and disposal. This discussion should be focused in terms of their impact on sewerage management and environment.

2.13.3.3.7 Need for the Project

i) Comment as to why the existing system cannot satisfy the existing and projected demands for services with reference to population to be served

ii) Describe the consequences of not taking up a project, (which may include rehabilitation or developing a new system)

iii) Indicate priorities to improvement of existing system, expansion of systems, construction of new system, assessment of the need for consumer education in hygiene and comments on urgency of project preparation and implementation.

2.13.3.4 Long Term Plan for Sewage Collection, Treatment and Disposal

a) Sewage collection, treatment and disposal services have to be planned as a phased development programme and any short term project should be such as would fit in the long term strategy. Such a long term plan or the strategic plan should be consistent with the future overall development plans for the areas. A long term plan may be prepared for a period of 30 years and alternative development sequences may be identified to provide target service coverage at affordable costs. From these alternative development sequences, a priority project to be implemented in short term can be selected. It is this project which then becomes the subject of a comprehensive feasibility study.

b) Alternative development sequences should be identified in the light of the coverages to be achieved during the planning period in phases. This calls for definition of the following:

i) Population to be covered with improved sewage management facility

ii) Target dates by which the above mentioned coverage would be extended within the planning period, in suitable phases

iii) Consistency and coordination to be maintained between projections for both water supply and sanitation services.

c) It must be noted that availability of funds is one of the prime factors which will ultimately decide the scope and scale of a feasible project

d) Selection of a Strategic Plan

Each of the alternative development sequences, which can overcome the existing deficiencies and meet the present and future needs, consists of a series of improvements and expansions to be implemented over the planned period. Since all needs cannot be satisfied in immediate future, it is necessary to carefully determine priorities of target groups for improvement in services and stages of development and thus restrict the number of alternatives.

e) Planning for system requirement includes consideration of the following:

i) Possibilities of rehabilitating and/or de-bottlenecking the existing systems

ii) Alternative treatment systems and pumping schemes

f) It may also be necessary to ascertain if supporting activities like health education, staff training and institutional improvements etc., are necessary to be included as essential components of the project. All the physical and supporting input need to be carefully costed (capital and operating) after preparing preliminary designs of all facilities identified for each of the development sequences. These may then be evaluated for least cost solution by 'net present worth' method, which involves expressing all costs (capital and operating) for each year in economic terms, discounting future costs to present value, selecting the sequence with the lowest present value.

g) As stated above, costs are to be expressed in economic terms and not in terms of their financial costs. This is because the various alternatives should reflect resource cost to the economy as a whole at different future dates. Costing of the selected project may however be done in terms of financial costs, duly considering inflation during project implementation.

2.13.3.5 Proposed Sewerage Project

a) Details of the Project

The project to be selected may consist those components of the least cost alternative of development sequence, which can be implemented during the next 3 to 4 years. Components of the selected project may be as follows:

i) Rehabilitation and de-bottlenecking of the existing facilities

ii) Construction of new facilities for improvement and expansion of existing systems

iii) Support activities like training, consumer education, public motivation, etc.

iv) Equipment and other measures necessary for operation and maintenance of the existing and expanded systems

v) Consultancy services needed (if any) for conducting feasibility study, detail engineering, construction supervision, socioeconomic studies, support activities.

b) Project Components

All project components should be thoroughly described, duly supported by documents such as:

i) Location maps

ii) Technical information for each physical component and economic analysis where necessary

iii) Preliminary engineering designs and drawings in respect of each physical component, such as collection network, pumping stations, treatment plants, disposal system

c) Implementation Schedule

A realistic implementation schedule should be presented, taking into consideration time required for all further steps to be taken, such as conducting feasibility study, appraisal of the project, sanction to the project, fund mobilization, implementation, trial and commissioning. In preparing this schedule due consideration should be given to all authorities/groups whose inputs and decisions can affect the project and its timing.

d) Cost Estimates

Cost estimates of each component of the project should be prepared and annual requirement of funds for each year should be worked out, taking into consideration the likely annual progress of each component. Due allowance should be made for physical contingencies and annual inflation. This exercise will result in arriving at total funds required annually for implementation of the project.

e) Prefeasibility Report

The prefeasibility report should bring out any major environmental and social impact the project is likely to cause and if these aspects will affect its feasibility (Refer to Subsection 2.4.3).

f) Institutional Responsibilities

The prefeasibility report should identify the various organizations/departments/agencies that would be responsible for further planning and project preparation, approval, sanction, funding, implementation, operation and maintenance of the project and indicate also the manpower needed to implement and later operate and maintain the project. It should also discuss special problems likely to be encountered during operation and maintenance, in respect of availability of skilled and technical staff, funds, transport, chemicals, communication, power, spare parts, etc. Quantitative estimates of all these resources should be made and included in the project report.

g) Financial Aspects

The capital cost of a project is the sum of all expenditure required to be incurred to complete design and detailed engineering of the project, construction of all its components including support activities and conducting special studies. After estimating component-wise costs, they may also be worked out on annual basis throughout the implementation period, taking into consideration construction schedule and allowances for physical contingencies and inflation. Basic item costs to be adopted should be of the current year. Annual cost should be suitably increased to cover escalation during the construction period. Total of such escalated annual costs

determines the final cost estimate of the project. Financing plan for the project should then be prepared, identifying all the sources from which funds can be obtained and likely annual contribution from each source, until the project is completed. The possible sources of funds include:

i) Cash reserves available with the project authority

ii) Grant-in-aid from government

iii) Loans from government

iv) Loans from financing institutions like Life Insurance Corporation, Banks, HUDCO, etc.

v) Open market borrowings

vi) Loans/grants from bilateral/international agencies

vii) Capital contribution from voluntary organization or from consumers.

h) Interest on Loan

If the lending authority agrees, interest payable during implementation period can be capitalized and loan amount increased accordingly.

i) Recurring Expenditure

The next step is to prepare recurrent annual costs of the project for the next few years (say 10 years) covering operation and maintenance expenditure of the entire system (existing and proposed). This would include expenditure on staff, chemicals, energy, spare parts and other materials for system operation, transportation, up-keep of the systems and administration. The annual financial burden imposed by a project comprises the annual recurring cost and payment towards loan and interest (debt-servicing) less the revenue derived from taxes, tariffs, etc.

j) Financing Plan

Every State Government and the Government of India have schemes for financing water supply and sewage collection, treatment and disposal schemes in the urban and rural areas and definite allocations are made for the national plan periods. It will be necessary at this stage to ascertain if and how much finance can be made available for the project under consideration and to estimate annual availability of funds for the project till its completion. This exercise has to be done in consultation with the concerned department of the Government and the lending institutions, which would see whether the project fits in the sector policies and strategies and can be brought in an annual planning and budgetary cycle taking into consideration the commitments already made in the sector and the overall financial resource position. The project may be finally sanctioned for implementation if the financing plan is firmed up.

2.13.3.6 Conclusion and Recommendations

a) Conclusions

This section should present the essential findings and results of the prefeasibility report. It should include a summary of the following main items:

i) Existing coverage

ii) Review of the need for the project

iii) Long-term development plans considered

iv) Recommended project, and its scope in terms of coverage and components

v) Priorities concerning target-groups and areas to be served by the project

vi) Capital costs and tentative financing plan

vii) Annual recurring costs and debt servicing and projection of operating revenue

viii) Urgency for implementation of the project

ix) Limitation of the data/information used and assumption and acknowledgements made and need for in-depth investigation, survey and revalidation of assumptions and judgments, while carrying out feasibility study.

The administrative difficulties likely to be met with and risks involved during implementation of the project should also be commented upon. These may pertain to boundary of the project area, availability of land for constructing project facilities, coordination with the various agencies, acceptance of service by the beneficiaries, shortage of construction materials, implementation of support activities involving peoples' participation, supply of power, timely availability of funds for implementation of the project and problems of operation and maintenance of the facilities.

b) Recommendations

i) This should include all actions required to be taken to complete project preparation and implementation, identifying the agencies responsible for taking these actions. A detailed time table for actions to be taken should be presented. If found necessary and feasible, taking up of works for rehabilitating and/or de-bottlenecking the existing system should be recommended as an immediate action. Such works may be identified and cost be estimated so that detailed proposals can be developed for implementation.

ii) It may also be indicated if the project authority can go ahead with taking up detailed investigations, data collection and operational studies, pending undertaking feasibility study formally.

iii) In respect of small and medium size projects, the prefeasibility report can be considered sufficient for obtaining investment decision for the project if:

- The results of the prefeasibility study are based on adequate and reliable data/information,
- Analysis of the data and situation is carried out fairly intensively,
- No major environmental and social problems are likely to crop up that might jeopardise project implementation, and
- No major technical and engineering problems are envisaged during construction and operation of the facilities.

iv) In that case the prefeasibility study with suitable concluding report should be processed for obtaining investment decision for the project. The feasibility study can then be taken up at the beginning of the implementation phase and if results of the study are noticed to be at variance with the earlier ones, suitable modification may be introduced during implementation.

v) In respect of major projects however and particularly those for which assistance

from bilateral or international funding agencies is sought for, comprehensive feasibility study may have to be taken up before an investment decision can be taken.

2.13.4 Feasibility Report

Feasibility study examines the project selected in the prefeasibility study as a short-term project, in much greater details, to check if it is feasible technically, financially, economically, socially, legally, environmentally and institutionally. Enough additional data/information may have to be collected to examine the above mentioned aspects, though the details necessary for construction of project components may be collected during execution of works.

It is a good practice to keep the authority responsible for taking investment decision, informed of the stage and salient features of the project. If there are good prospects of the project being funded immediately after the feasibility study is completed, detailed engineering of priority components may be planned simultaneously.

The feasibility report may have the following sections:

a) Background

b) Proposed project

c) Institutional and financial aspects

d) Techno Economic Appraisal Procedure

e) Conclusion and recommendations

2.13.4.1 Background

This section describes the history of project preparation, how this report is related to other reports and studies carried out earlier, and in particular it's setting in the context of a prefeasibility report. It should also bring out if the data/information and assumptions made in the prefeasibility report are valid and if not, changes in this respect should be highlighted. References to all previous reports and studies should be made.

In respect of the project area, need for a project and strategic plan for the same, only a brief summary of the information covered in pre-feasibility report should be presented, highlighting such additional data/information if any collected for this report. The summary information should include planning period, project objectives, service coverage, service standards considered and selected for long-term planning and for the project, community preferences and affordability, quantification of future demands for services, alternative strategic plans, their screening and ranking, recommended strategic plan and cost of its implementation.

2.13.4.2 Proposed Project

This section describes details of the project recommended for implementation. Information presented here is based on extensive analysis and preliminary engineering designs of all components of the project. The detailing of this section may be done in the following subsections.

a) Objectives

Project objectives may be described in terms of general development objectives such as health improvements, ease in sewerage management, improved environmental conditions, human resources development, institutional improvements and also terms of specific objectives such as coverage of various target groups.

b) Project Users

Define number of people by location and institutions who will benefit and/or not benefit from the project area and reasons for the same, users involvement during preparation, implementation and operation of the project.

c) Rehabilitation and De-bottlenecking of the Existing Sewerage System

In fact rehabilitation, improvements and de-bottlenecking works, if necessary, should be planned for execution prior to that of the proposed project. If so these activities should be mentioned in the feasibility report, if however these works are proposed as components of the proposed project, necessity of undertaking the rehabilitation/improvement de-bottlenecking works should be explained.

d) Project Description

This may cover the following items in brief:

i) Definition of the project in the context of the recommended development alternative (strategic plan) and explanation for the priority of the project

ii) Brief description of each component of the project, with maps and drawings

iii) Functions, location, design criteria and capacity of each component

iv) Technical specification (dimension, material) and performance specifications

v) Stage of preparation of designs and drawings of each component

vi) Constructing in-house facilities

vii) Method of financing

viii) Existing benchmarks (for relevant indicators mentioned in the "Handbook on Service Level Benchmarking", MOUD) and benchmarks expected to be achieved after implementation of the project should be mentioned in the report. The indicators included in above reference are given in Table 2.2.

Table 2.2 Service level benchmarks for sewage management

S. No.	Proposed Indicator	Benchmark
1	Coverage of toilets	100%
2	Coverage of sewage network services	100%
3	Collection efficiency of the sewage network	100%
4	Adequacy of sewage treatment capacity	100%
5	Quality of sewage treatment	100%
6	Extent of reuse and recycling of sewage	20%
7	Efficiency in redressal of customer complaints	80%
8	Extent of cost recovery in sewage management	100%
9	Efficiency in collection of sewage charges	90%

Source: Handbook on Service Level Benchmarking, MOUD

e) Support Activities

Need for and description of components such as staff training, improving billing and accounting, consumer education, health education, community participation, etc., and timing of undertaking these components and the agencies involved should be included.

f) Integration of the Proposed Project with the Existing and Future Systems

Describe how various components of the proposed project would be integrated with the existing and future works.

g) Agencies Involved in Project Implementation and Relevant Aspects

i) Designate the lead agency

ii) Identify other agencies including government agencies, who would be involved in project implementation, describing their role, such as granting administrative approval, technical sanction, approval to annual budget provision, sanction of loans, construction of facilities, procurement of materials and equipment, etc.

iii) Outline arrangements to coordinate the working of all agencies

iv) Designate the operating agency and its role during implementation stage

v) Role of consultants, if necessary, scope of their work, and terms of reference

vi) Regulations and procedures for procuring key materials and equipment, power, and transport problems, if any

vii) Estimate number and type of workers and their availability

viii) Procedures for fixing agencies for works and supplies and the normal time it takes to award contracts

ix) List of imported materials, if required, procedure to be followed for importing them and estimation of delivery period

x) Outline any legislative and administrative approvals required to implement the project, such as those pertaining to environmental clearance, prescribed effluent standards, acquisition of lands, permission to construct across or along roads and railways, high-tension power lines, in forest area and defence or other such restricted areas

xi) Comment on the capabilities of contractors and quality of material and equipment available indigenously.

h) Cost Estimates

i) Outline basic assumptions made for unit prices, physical contingencies, price contingencies and escalation

ii) Summary of estimated cost of each component for each year till its completion and work out total annual costs to know annual cash flow requirements

iii) Estimate foreign exchange cost if required to be incurred

iv) Work out per capita cost of the project on the basis of design population, cost per unit of sewage treated and disposed and compare these with norms, if any, laid down by government or with those for similar projects.

i) Implementation Schedule

Prepare a detailed and realistic implementation schedule for all project components, taking into consideration stage of preparation of detailed design and drawings, additional field investigations required, if any, time required for preparing tender documents, notice period, processing of tenders, award of works/supply contract, actual construction period, period required for procurement of material and equipment, testing, trials of individual components,

and commissioning of the facilities, etc.

If consultant's services are required, the period required for completion of their work should also be estimated.

A detailed PERT/CPM network showing implementation schedule for the whole project, as well as those for each component should be prepared, showing linkages and inter-dependence of various activities.

Implementation schedule should also be prepared for support-activities such as training, consumers' education, etc., and their linkages with completion of physical components and commissioning of the project should be established.

j) Operation and Maintenance of the Project

Estimate annual operating costs considering staff, chemicals, energy, transport, routine maintenance of civil works, maintenance of electrical/mechanical equipment, including normal cost of replacement of parts and supervision charges. Annual cost estimates should be prepared for a period of 10 years from the probable year of commissioning the project, taking into consideration expected coverage and escalation.

Procedure for monitoring and evaluating the project performance with reference to project objectives should be indicated.

2.13.4.3 Institutional and Financial Aspects

a) Institutional Aspects

It is necessary to examine capabilities of the organizations that would be entrusted with the responsibility of implementing the project and of operating the same after it is commissioned. The designated organization(s) must fulfil the requirements in respect of organizational structure, personnel, financial, health and management procedures, so that effective and efficient performance is expected. This can be done by describing the following aspects:

i) History of the organization, its functions, duties and powers, legal basis, organization chart (present and proposed), relationship between different functional groups of the organization and with its regional offices, its relation with government agencies and other organizations involved in sector development

ii) Public relations in general and consumer relations in particular, extension services available to sell new services, facilities for conducting consumer education programme and settling complaints

iii) Systems for budgeting for capital and recurring expenditure and revenue, accounting expenditure and revenue, internal and external audit arrangements. inventory management

iv) Present positions and actual staff, comments on number and quality of staff in each category, ratio of staff proposed for maintenance and operation of the project to the population served, salary ranges of the staff and their comparison with those of other public sector employees

v) Staff requirement (category wise) for operating the project immediately after commissioning, future requirements, policies regarding staff training, facilities available for training

vi) Actual tariffs for the last 5 years, present tariff, tariff proposed after the project is

commissioned, its structures, internal and external subsidies, procedure required to be followed to adopt new tariff, expected tariff and revenues in future years, proposal to meet shortage in revenue accruals

vii) Prepare annual financial statements (income statements, balance sheets and cash flows) for the project operating agency for five years after the project is commissioned, explain all basic assumptions for the financial forecast and the terms and conditions of tapping financial sources, demonstrate ability to cover all operating and maintenance expenditure and loan repayment, workout rate of return on net fixed assets and the internal financial rate of return of the project.

b) Financing Plan

Identify all sources of funds for implementation of the project, indicating year-by-year requirements from these sources, to meet expenditure as planned for completing the project as per schedule, state how interest during construction will be paid, or whether it will be capitalized and provided for in the loan, explain the procedures involved in obtaining funds from the various sources.

2.13.4.4 Techno Economic Appraisal Procedure

Decision between technologies of Sewerage as well as Sewage Treatment should be carried out on life cycle analysis of major components. In general, the life cycle of civil works can be taken as 30 years and equipment taken as 15 years in non-sewage treatment locations and 10 years in sewage treatment locations. The analysis should include:

a) Net Present Value (NPV) of capital costs

b) Equivalent cost of annuity and O&M costs

c) Revenue recoverable if any by way of by-products

d) Land Cost

e) Dependency on Imports for day to day spares

f) Import substitution

g) Time required to achieve the desired project objectives

h) Mitigation of any adverse environmental impacts

i) Long term sustainability by the finances of the ULB

While aspects of a) through d) can be attributed to numerical values, the aspects e) through i) will be subjective and has to be appraised based on higher weightage for most preferred technologies. Thus, the exercise of techno-economic appraisal is not fully mathematical approach and has to be tempered as two interdependent aspects both kept up and reasoned out interactively. The tendency to overly complicate the exercise with undue mathematics shall be resisted.

2.13.4.5 Conclusion and Recommendations

This section should discuss justification of the project, in terms of its objectives, cost effectiveness, affordability, willingness of the beneficiaries to accept the services and effect of not proceeding with the project.

Issues which are likely to adversely affect project implementation and operation should be