THE REPUBLIC OF INDIA
CENTRAL PUBLIC HEALTH AND ENVIRONMENTAL ENGINEERING ORGANIZATION (CPHEEO),
MINISTRY OF URBAN DEVELOPMENT (MOUD)

THE STUDY FOR FORMULATION AND REVISION OF MANUALS ON SEWERAGE AND SEWAGE TREATMENT

PHASE-1

IN

THE REPUBLIC OF INDIA

FINAL REPORT

MARCH 2011

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

TOKYO ENGINEERING CONSULTANTS CO., LTD.

IN ASSOCIATION WITH

NIHON HELS INDUSTRY CORPORATION

PREFACE

Japan International Cooperation Agency (JICA) conducted the Study for Formulation and Revision of Manuals on Sewerage and Sewage Treatment (Phase 1) in the Republic of India, and organized a study team headed by Mr. Akira TAKECHI of Tokyo Engineering Consultants Co, Ltd. from August 2010 to March 2011.

The study team held a series of discussions with the Expert Committees which comprise central and state government officials as well as academic experts in India, and conducted several field surveys. As a result of further studies in Japan, the present report was finalized.

I hope that this report will become a basis for the forthcoming works to formulate manuals in the sewerage sector, which is envisaged in the Phase 2 of the Study.

Finally, I wish to express my sincere appreciation to the officials concerned for their close cooperation extended to the study team.

March 2011

Shinichi YAMANAKA
Chief Representative,
India Office
Japan International Cooperation Agency

FINAL REPORT

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ABBREVIATIONS

AL	Aerated Lagoon
ASP	Activated Sludge Process
AWWA	American Water Works Association
BOD	Biochemical Oxygen Demand
BOOT	Build, Own, Operate, and Transfer
BOT	Build, Operate, and Transfer
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health and Environmental Engineering Organization
DFG	Dual Fuel Generator
DG	Diesel Generator
DHS	Down-flow Hanging Sponge Reactor
DO	Dissolved Oxygen
EAC	Expert Appraisal Committee
EC	Environmental Clearance
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
FAB	Fluidized Aerobic Bed
FPU	Final Polishing Unit
GIS	Geographic Information System
GOI	Government of India
GOJ	Government of Japan
GRP	Glass-reinforced Plastic
HRT	Hydraulic Retention Time
HUDA	Haryana Urban Development Authority
INR	Indian Rupees
IS	Indian Standard
JICA	Japan International Cooperation Agency
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
JPY	Japanese Yen
JST	JICA Study Team
lpcd	Litre per capita per day
m^3/day	Cubic meter per day
M/M	Minutes of Meeting

MBBR	Moving Bed Biofilm Reactor
MBR	Membrane Bioreactor
MDG	Millennium Development Goals
MF	Microfiltration Membrane
MIS	Management Information System
MLD	Million litres per day
MLSS	Mixed Liquor Suspended Solids
MLVSS	Mixed Liquor Volatile Suspended Solids
MOEF	Ministry of Environment and Forests
MOUD	Ministry of Urban Development
MPCB	Maharashtra Pollution Control Board
MPS	Main Pumping Station
MS	Mild Steel
NGO	Non-Governmental Organization
NGRBA	National Ganga River Basin Authority
NIUA	National Institute of Urban Affairs
NLCP	National Lake Conservation Plan
NRCD	National River Conservation Directorate
NRCP	National River Conservation Plan
OD	Oxidation Ditch
ODA	Official Development Assistance
O&M	Operation and Maintenance
PCC	Plain Cement Concrete
PHE	Public Health Engineering
PHEE	Public Health and Environmental Engineering
PLC	Programmable Logic Control
PP	Polishing Pond
PPP	Public-Private Partnership
PS	Pumping Station
PSP	Private Sector Partnership
PST	Primary Sedimentation Tank
PVC	Polyvinyl Chloride
RCC	Reinforced Cement Concrete
RCCNP4	Reinforced Cement Concrete NP4 type
R.N.D.P.	Recycled Nitrification Denitrification Process
RSSS	Return Sludge Suspended Solids

RTU	Remote Terminal Unit
SAF	Submerged Aeration Fixed film Reactor
SAR	Sodium Absorption Ratio
SBR	Sequencing Batch Reactor
SCADA	Supervisory Control and Data Acquisition
SDB	Sludge Drying Bed
SEIAA	State or Union territory level Environment Impact Assessment Authority
SEMIS	Sewerage Mapping and Information System
SPCB	State Pollution Control Board
SRT	Solids Retention Time
STP	Sewage Treatment Plant
SS	Suspended Solids
S/W	Scope of Work
TAIMS	Tokyo Advanced Information Management System
TF	Trickling Filter
TOC	Table of Contents
TSS	Total Suspended Solids
UASB	Upflow Anaerobic Sludge Blanket
UPJN	Uttar Pradesh Jal Nigam
UIDSSMT	Urban Infrastructure Development Scheme for Small and Medium Towns
UT	Union Territory
UV	Ultra Violet
WEF	Water Environment Federation
WSP	Waste Stabilization Ponds
WWTP	Wastewater Treatment Plant

CHAPTER 1 INTRODUCTION

1.1 Background of the Study

In India, increasing urbanization and economic development has necessitated provision, augmentation and maintenance of infrastructure in urban areas. The untreated sewage from urban areas situated on the banks of rivers/lakes is polluting the receiving water bodies (river, lakes, etc.) and has severely deteriorated the water quality. Foreseeing the problem of pollution because of sewage, the Government of India initiated the National River Conservation Plan (NRCP) and the National Lake Conservation Plan (NLCP) which are being implemented through the National River Conservation Directorate (NRCD), Ministry of Environment and Forests (MOEF) since 1985 onwards to preserve the main rivers and lakes by setting up sewage treatment plants (STPs) and treating the sewage before discharging it into the water body.

A large number of sewage treatment plants along with sewage collection systems have been constructed under the Ministry of Urban Development (MOUD) and MOEF sponsored programmes including those by the State Governments under their own plan funds. The number will increase significantly with the launch of the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) and Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT), and increased allocation of funds under NRCD/NRCP. In light of demand, the first Manual on Sewerage and Sewage Treatment was published by MOUD on the basis of recommendations of the expert committee in 1977 for guidance of public health engineers and those associated to the field across the country. The said manual was revised in 1993.

However, over a period of time there has been advancement in technology options (in the field of treatment and collection of sewage), emerging issues like low cost technology options, decentralized sewage treatment systems and the possibility of involving private entrepreneurs in creating infrastructure for sewerage and sewage treatment based on BOOT, BOT, etc. In view of the above, the up-gradation and revision of the existing manual, last published in 1993, has been keenly felt from quite some time.

Further, there is no separate Manual on Operation and Maintenance (O&M) of Sewerage and Sewage Treatment for the benefit of field engineers, though a separate chapter describing O&M has been included in the existing sewerage manual. However, the content is grossly inadequate compared to the needs of the present changed scenario. Hence, it is absolutely necessary to prepare a separate manual for O&M of sewer network and sewage treatment plant. The need for such a manual has been felt especially since many sewage treatment plants in the country are not functioning properly due to lack of proper O&M, lack of trained manpower and requisite fund allocation, etc., resulting in the discharge of untreated or partly treated effluent to the water bodies, land and sea resulting in the pollution of water bodies and environmental degradation.

To cope with these situations, the Government of the Republic of India (GOI) requested the Government of Japan (GOJ) to implement the study for formulation and revision of manuals on sewerage and sewage treatment. In response to the request, GOJ decided to conduct the study and the Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of the technical cooperation programs of GOJ, was assigned to undertake the Study in close cooperation with the authorities of GOI.

In September 2008, JICA dispatched the Preparatory Study Team headed by Ms. Yumiko Asakuma to the Republic of India for discussing the Scope of Work (S/W) for the Study with the Indian side. The S/W and the Minutes of Meeting (M/M) were agreed upon

between the MOUD and JICA.

In the actual implementation, the Study was divided into following two phases:

Phase 1: Preparatory stage which includes analysis of actual conditions of sewerage system in India and requirements for the manuals and determination of contents of the manuals, resulting in the detailed scope of work for the Phase 2.

Phase 2: Actual drafting work of the manuals based on the scope of work specified in the Phase 1 and counterpart training in Japan.

This report presents all the results of the activities in Phase 1.

1.2 Objectives of the Study

The objective of the Study is to establish directions for the revision and formulation of manuals for the sewerage and sewage treatment through the analysis of actual conditions of sewerage facilities and their operations and discussions with Expert Committees. In other words, the Study will prepare a scope of work for the Phase-2 study, which will subsequently prepare and present the Manuals for the Sewerage and Sewage Treatment as its final output.

The Study started with the objectives to revise the existing manuals for sewerage and sewage treatment and to formulate a new manual for operation and maintenance, that is, preparing two volumes of manuals; the Design and Planning Manual for Sewerage and Sewage Treatment and Operation and Maintenance Manual for Sewerage and Sewage Treatment. However, it was agreed in the first Expert Committee meeting (refer to Appendix A5-1) to prepare a separate management manual because of the importance of management of the sewerage business.

1.3 Outline of the Study

1.3.1 Basic Policy of the Study

The main purpose of the manuals to be prepared is to provide technical guidance to persons currently involved in management, planning, design and operation and maintenance of the sewerage facilities in future. This means the manuals should properly accommodate the present situation and incorporate expected trends in the near future.

Presently, many kinds of sewerage systems applying various types of treatment technologies, from old to state of the art technologies, are prevalent in India. Considering relatively low sewerage coverage rate at present and expected rapid increase of the coverage rate in the near future, new kinds of systems will become the general trend. Therefore, the Design and Planning Manual can mainly focus on the present and future technologies. However, as far as the operation and maintenance is concerned, old types of sewerage systems are still important since they will still be in operation for some more time, and it is well known that their current operation has many problems to be addressed.

In addition, as the manuals aim to give guidance to persons directly involved in various activities related to sewerage, they must be practical and realistic. Therefore, persons who are concerned with the revision and formulation of the manuals must thoroughly understand the present actual conditions related to management, operation and maintenance of sewerage facilities in India.

On the other hand, it is necessary to consider future situation for preparation of such manuals. The sewerage system is developed as a basic urban infrastructure to ensure sanitary living conditions and to control pollution of the water-environment. Requirements

for sanitary living conditions and the effluent standards for pollution control are expected to become stricter in future. Therefore, although the manuals will be revised after a certain time interval, the new manuals should at least cover the needs resulting from progress in the next 5 to 10 years.

Based on these factors, the basic policy considered in this Study has been illustrated in Figure 1-1. As presented in Figure, the Study focuses on the analysis of existing systems and forecasting of future systems. Analysis of existing system has been mainly conducted through site surveys, in which data/information is collected from the actual sewerage system in operation, and from the review of existing reports which provide general information. The Study Team has placed higher importance to site surveys, because it is expected that wider and deeper knowledge could be obtained from experience obtained through visits to actual facilities and observing the actual operation.

For forecasting of future systems, the general trend of progress of sewerage systems can be obtained from the experience in developed countries. However, a more direct trend can be predicted from the sewerage development policy of India and the environmental policy, which define required sewage treatment level. For this purpose, the Study Team during its course of site visits has held intensive discussions with Indian authorities to obtain as much information as possible related to the existing condition and future developments and policies related to sewerage systems.

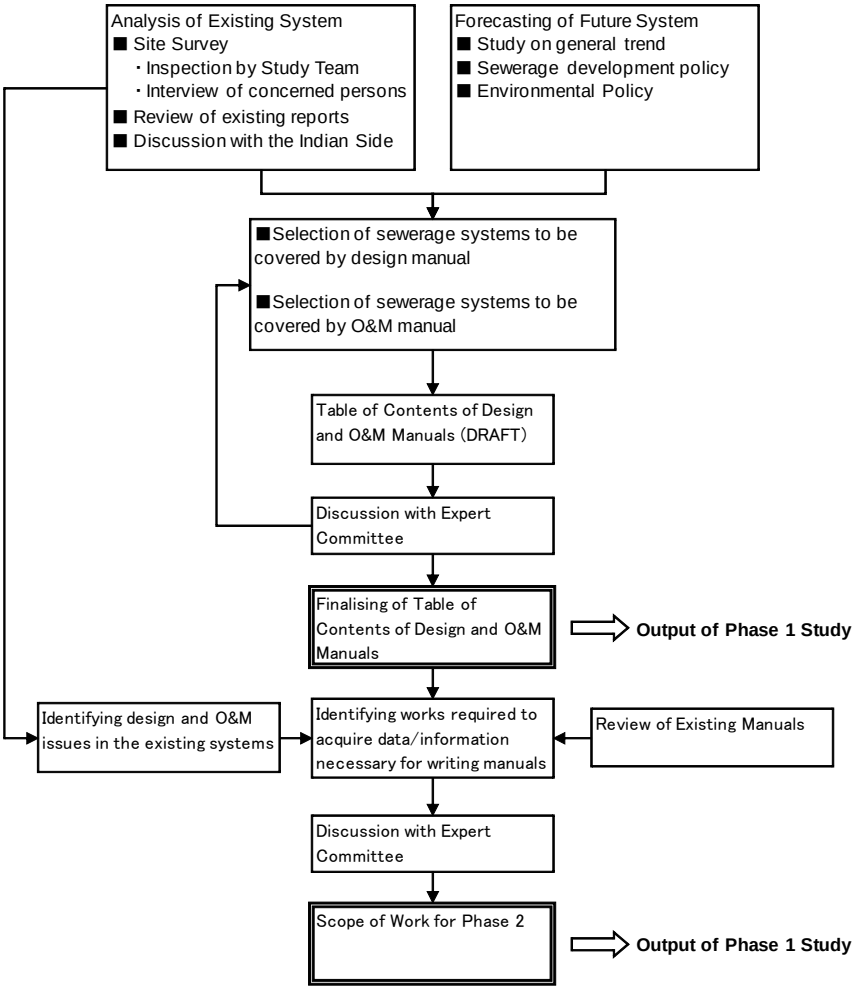

Figure 1-1 Basic Policy of the Study

1.3.2 Organization Structure

The Study has been conducted in coordination with the organizational structure presented in Figure 1-2. Two Expert Committees were formed by Central Public Health and Environmental Engineering Organization (CPHEEO), MOUD, to have three scheduled meetings in this Phase of Study, in order to review the works carried out by the JICA Study Team. In addition, one consultant (SMEC India) has been locally appointed by JICA Delhi office to coordinate the meetings.

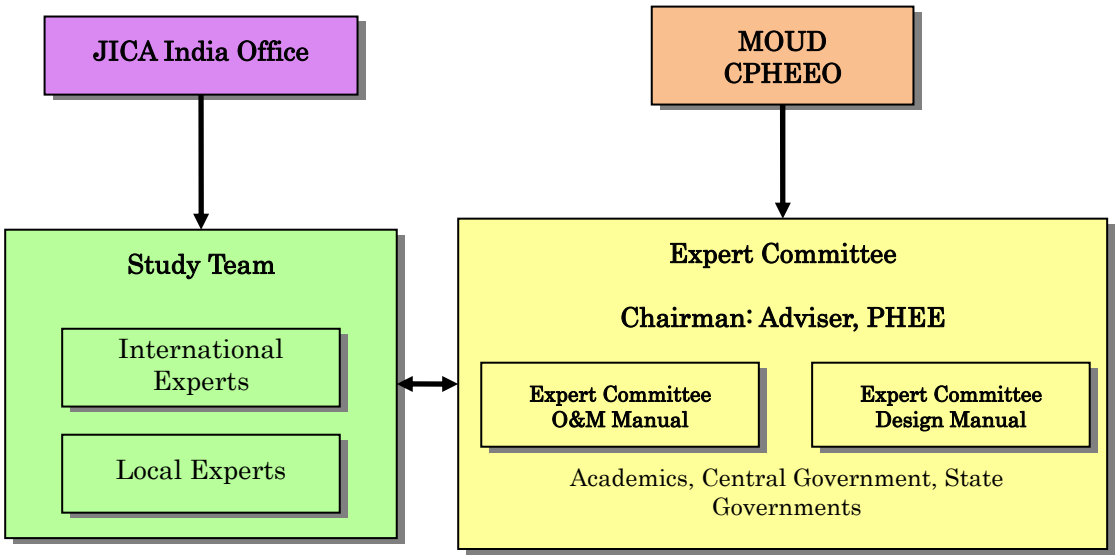

Figure 1-2 Organization Structure for this Study

1.3.3 Expert Committee

Two Expert Committees have been formed by CPHEEO namely “Expert Committee for Revision of Manual on Sewerage and Sewage Treatment” and “Expert Committee for Preparation of Manual on Operation and Maintenance of Sewerage System”, which include members from central and state government organizations and academic institutes. These Expert Committees are chaired by the Director (WS), MOUD/Adviser, PHEE and these Committees will review and finalise the two manuals. The list of members of the Expert Committees nominated by CPHEEO is given in Tables 1-1 and 1-2 below. For the list of members who actually participated in the First, Second, and Third Expert Committee meetings, refer to Appendix A1-1. In the first phase, the expert committee for preparation of manual on management of sewerage system was not organized; the draft table of contents on manual on management of sewerage system was discussed by the above two expert committee meetings.

Table 1-1 Members of Expert Committee for Revision of Manual on Sewerage and Sewage Treatment

S. No.	Name	
1	Ms. E.P. Nivedita Director (WS), Ministry of Urban Development	Chairperson
2	Dr. S.R. Shukla, Former Adviser (PHEE), CPHEEO	Co-Chairman & Member
3	Dr. Arvind K. Nema Associate Professor, IIT, Delhi	Member
4	Dr. A.K. Dussa, Director (UWE), Ministry of New & Renewable Energy	Member
5	Mr. B.B. Uppal, Former Dy. Adviser (PHE), CPHEEO	Member
6	Mr. D.P. Singh, Chief Engineer (Ganga), U.P. Jal Nigam	Member
7	Dr. Hemant C. Landge, Chief Engineer, Maharashtra Jeevan Pradhikaran, Thane-400603	Member
8	Dr. Absar Ahmed Kazmi, Associate Professor, IIT, Roorkee	Member
9	Dr. K.C. Rathore, Director, National River Conservation Directorate, Ministry of Environment & Forests	Member
10	Er. C. Lallunghnema, Superintending Engineer, PHED, Mizoram	Member
11	Mr. R. Sethuraman, Former Joint Adviser(PHEE), CPHEEO	Member
12	Dr. S. Sundaramoorthy, Retd. Engineering Director, CMWSSB	Member
13	Er. S.T. Gopalram, M.E. (PH), Joint Chief Engineer (P&D), TWAD Board	Member
14	Dr. Vinod Tare, Professor, IIT, Kanpur	Member
15	Representative from Ministry of Science & Technology*	Member
16	Dr. G.R. Pophali, Scientist, NEERI, Nagpur	Member
17	Mr. Nazimuddin, Senior Environmental Engineer, Central Pollution Control Board	Member
18	Mr. D.K. Agarwal, Scientist F, Bureau of Indian Standards (BIS)	Member
19	Mr. V.K. Chaurasia, Deputy Adviser (PHE), CPHEEO	Member
20	Mr. M. Dhinadhayalan, Deputy Adviser (PHE), CPHEEO	Member Secretary

Note: * Member from these organizations did not participate in the meetings and therefore, names are not mentioned.
PHEE (Public Health and Environmental Engineering) and PHE (Public Health Engineering) are used by different levels of officials of the same department of the CPHEEO.

Table 1-2 Members of Expert Committee for Preparation of Manual on Operation and Maintenance of Sewerage System

S. No.	Name	
1	Ms. E.P. Nivedita Director (WS), Ministry of Urban Development	Chairperson
2	Dr. S.R. Shukla, Former Adviser (PHEE), CPHEEO	Co-Chairman & Member
3	Mr. S.V. Ahuja, Project Director, Gujarat Water Supply and Sewerage Board	Member
4	Mr. G. Elangovam, Engineering Director CMWSS Board, Chennai	Member
5	Mr. J.P. Mani, Project Manager, Ganga Pollution Control Unit, U.P. Jal Nigam, Allahabad	Member
6	Dr. Absar Ahmed Kazmi, Associate Professor, IIT, Roorkee	Member
7	Mr. R. Sethuraman, Former Joint Adviser(PHEE), CPHEEO	Member
8	Dr. S. Sundaramoorthy, Retd. Engineering Director, CMWSSB	Member
9	Mr. S.M. Jejurikar, Chief Engineer (M&E) Municipal Corporation of Mumbai	Member
10	Mr. Sumit Dutta, Chief Engineer (S&D), Kolkata Metropolitan Development Authority	Member
11	Mr. V.K. Jain, Superintending Engineer (SDW)-IV, Delhi Jal Board	Member
12	Mr. Dilip Kumar Padhi, Chief Engineer, Member Secretary, Orissa Water Supply and Sewerage Board	Member
13	Representative from Bangalore Water Supply and Sewerage Board*	Member
14	Mr. J.S. Bahra, Executive Engineer, Punjab Water Supply and Sewerage Board	Member
15	Representative from Public Health Engg. Department, Government of Rajasthan*	Member
16	Mr. M. Satyanarayanan, Director Projects, Hyderabad Metropolitan Water Supply & Sewerage Board	Member
17	Mr. M. Sankaranarayanan , Deputy Adviser (PHE), CPHEEO	Member
18	Mr. J.B. Ravindar, Assistant Adviser (PHE)	Member
19	Mr. M. Dhinadhayalan, Deputy Adviser (PHE), CPHEEO	Member Secretary

Note: * Member from these organizations did not participate in the meetings and therefore, names are not mentioned.
PHEE (Public Health and Environmental Engineering) and PHE (Public Health Engineering) are used by different levels of officials of the same department of the CPHEEO.

1.3.4 Study Schedule

Phase 1 of the Study is to be completed in seven (7) months starting from the mid of August 2010 to the mid of March 2011. The schedule of various activities in the Study is shown in Table 1-3.

Table 1-3 Study Schedule

Work Item		Study Period: FY 2010 / 2010: 8	9	10	11	12	2011: 1	2	3
Step 1 Preparation in Japan	【1.1】 Collection of related information, Preparation of Inception Report	▭							
	【1.2】 Analysis of Existing Manual	▭							
Step 2 Ist Study in India	【2.1】 Preparation and Discussion on Inception Report	△▲△							
	【2.2】 First Meeting with Expert Committee	▬							
	【2.3】 Preparation for Site Survey	▬							
	【2.4】 Site Survey		▬▬						
Step 3 Ist Study in Japan	【3.1】 Analysis of Existing Design and O&M Manual of Sewerage System			▭					
	【3.2】 Study of New Technology			▭					
	【3.3】 Formulation of Framework for Manual Preparation			▭					
	【3.4】 Preparation of Progress Report			▭					
Step 4 2nd Study in India	【4.1】 Presentation and Discussion on Progress Report			△▲△					
	【4.2】 Second Meeting with Expert Committee			▬					
	【4.3】 Second Site Survey (Continued)			▬	▬				
Step 5 2nd Study in Japan	【5.1】 Analysis of Existing Design and O&M Manual of Sewerage System (Continued)					▭			
	【5.2】 Study of New Technology (Continued)					▭			
	【5.3】 Formulation of Framework for Manual Preparation (Continued)					▭			
	【5.4】 Preparation of Draft Report					▭			
Step 6 3rd Study in India	【6.1】 Submission of Draft Report						△▲△		
	【6.2】 Third Meeting with Expert Committee						▬		
Step 7 3rd Study in Japan	【7.1】 Preparation and Submission of Final Report							▭	

▭ Work in Japan ▬ Field Work △▲△ Explanation of Reports, etc.

1.3.5 Staffing and Assignment Schedule

The JICA Study Team is composed of the members shown in Table 1-4. There are altogether eight international experts supported by four local engineers to carry out activities in this Study. The members of JICA Study team (International Experts) are assigned to the Study according to the schedule presented in Figure 1-3.

Table 1-4 JICA Study Team

No.	Name	Job Title	Affiliation
1	Akira TAKECHI	Team Leader	TEC
2	Alok KUMAR	Deputy Team Leader/ Sewerage Facility Planning	TEC
3	Kiyoshi MORIYAMA	Sewerage O&M Planning	HELS
4	Kiyoshi MIZUFUNE	Sewerage Equipment Designing	TEC
5	Masaaki MUKAIDE	Civil Facility Designing	TEC
6	Takenori SHORYUJI	Facility O&M Planning (1)	HELS
7	Takehiro NAKANO	Water Quality/Safety	HELS
8	Gururaj RAO	Coordinator/ Facility O&M Planning (2)	TEC

TEC: Tokyo Engineering Consultants, HELS: Nihon Hels Industry Corporation

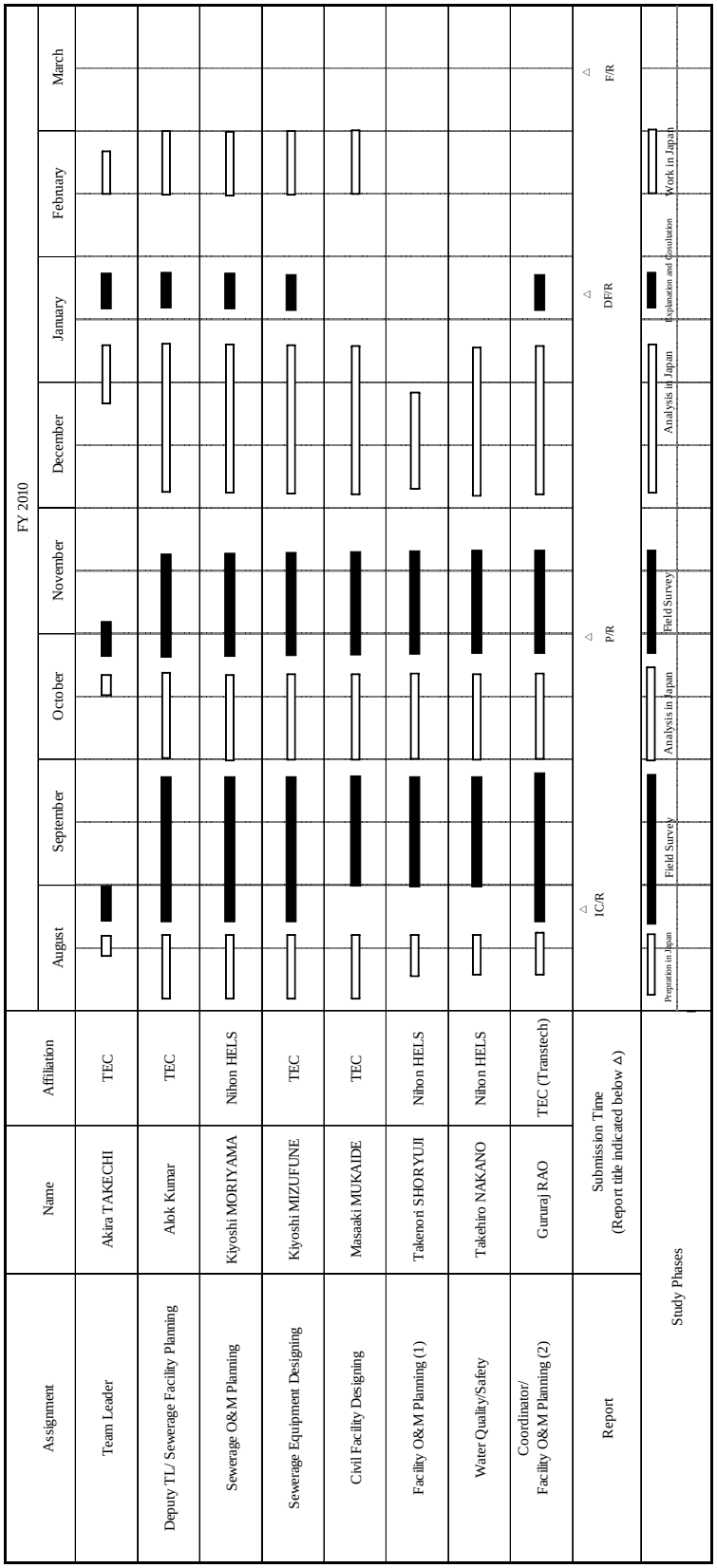

Figure 1-3 Staff Assignment Schedule

1.4 Report Structure

Chapter 1 of this Report is an introductory part that describes the background and objectives of this Study. The outline of the Study including information on basic policy, organization structure, expert committees, study schedule and assignment schedule pertaining to this Study is also covered in this chapter.

Chapter 2 includes an overview of sewerage sector in India including descriptions on existing conditions of wastewater generation, collection and treatment; operation and maintenance of sewerage system; and sewerage development policy and environmental policy. This chapter also covers general description on existing Manuals related to sewerage and water supply systems in India and few other countries. In this chapter, general issues to be addressed, when preparing the new manual, related to planning and design, operation and maintenance, and onsite management, are also briefly described.

Chapter 3 describes the analysis of present situation of sewerage systems based on the information collected through visits to towns/cities of India and through discussion with agencies related to sewerage services. Result of site survey and questionnaires survey are also presented in this chapter. This chapter also covers problems faced by existing sewerage systems related to planning and design, operation and maintenance, and onsite methods.

Chapter 4 outlines new technologies that are in application in many parts around the globe to improve the performance of operation and maintenance, and management of sewerage systems. This includes the description on new technologies related to pumps, sewage and sludge treatment facilities, electrical facilities, and sewer construction and rehabilitation systems, etc., the application of which is expected to improve the performance of sewerage services.

Chapters 5 explains about composition and contents of manual including Table of Contents of Part A Engineering, Part B Operation and Maintenance, and Part C Management, prepared based on discussion with the members of two Expert Committees. In this chapter, description is also made on works proposed to be undertaken in the next phase for preparation of Manual.

Appendix A1-1 lists the participants of the first, second and third expert committee meetings.

Appendix A2-1 describes about the condition of sewerage systems in India based upon the report namely: “Status of Water Supply, Sanitation and Solid Waste Management in Urban Areas” prepared by the National Institute of Urban Affairs in June 2005.

Appendix A2-2 lists the Table of Contents of Guidelines on Planning and Design of Sewerage Facilities in Japan, which was published in 2009. Reference has been made to this Guideline, in addition to other Guidelines, for preparation of the table of contents of Part A Engineering of the Manual.

Appendix A2-3 lists the Table of Contents of Guidelines on Operation and Maintenance of Sewerage Facilities in Japan, which was published in 2003. This Guideline has also been referred for preparation of the table of contents of Part B Operation and Maintenance of the Manual.

Appendix A2-4 presents problems experienced by the sewage treatment systems in India in terms of planning, design, and operation and maintenance based on the analysis made in the report “Status of Sewage Treatment in India” published by the Central Pollution Control Board in 2005.

Appendix A3-1 includes the questionnaires that were discussed with agencies during the

visit to sewage treatment plants during this Study, in order to understand existing situation of operation and maintenance of sewage treatment plants. The responses in these questionnaires have been analysed to understand problems and important issues related to operation and maintenance of sewage treatment plants.

Appendix A3-2 includes the questionnaires that were discussed with agencies during the visit to pumping stations and sewers during this Study, in order to understand existing situation of operation and maintenance of these facilities. The responses in these questionnaires have been analysed to understand problems and important issues related to operation and maintenance of these facilities.

Appendix A3-3 presents the check list which was used to select the STP for carrying out pilot project in the next stage of project in order to collect all relevant data on operation and maintenance that would be helpful in writing manual on operation and maintenance.

Appendix A3-4 describes in detail about the observations made during the site visits to various sewerage systems. The description has been made including photographs taken during visits.

Appendix A4-1 explains in detail about the new technologies adopted in sewerage facilities such as pumps, grinder, diffuser, aerators, biotower, membrane bioreactor, filters, microorganism treatment systems, UV disinfection system, Ozone disinfection system, BIOPAC system, egg type digestion tank, multi-disc screw press, dehydrator, decanter centrifuge, sludge drying system, sludge carbonization system, BITREC system, value composting system, electric generator, instrumentation, sewer construction, and rehabilitation facilities. In case of each facility, its outline and speciality have been described.

Appendix A5-1 briefly explains the outcomes of the first, second and third expert committee meetings held for discussing parts on design, operation and maintenance and management.

Appendix A5-2 presents the Minutes of the first, second and third expert committee meetings.

Appendix A5-3 includes the draft Table of Contents (including Chapter and Sections only) modified based on the discussion in the second expert committee meetings. This was used as a base for preparing the Table of Contents (including Chapter, Section, and Sub-section) to be presented and discussed in the third expert committee meetings.

CHAPTER 2 OVERVIEW OF SEWERAGE AND SEWAGE TREATMENT IN INDIA

2.1 General

Wastewater disposal is a major problem in most Indian cities. Only a small percentage of urban centres in the country have a sewerage system, and even where the system exists, the population covered by the system is partial. In some cities, the system does not function properly or is non-operational. Many urban centres with sewerage system do not have sewage treatment plants to treat wastewater. Discharge of untreated sewage into water bodies pollutes the limited water sources near urban centres. Improper collection and treatment of wastewater creates unhygienic conditions and results in serious health problems. Even in urban centres with sewerage system, the average population covered by the system is only 58 percent. Low coverage of population by sewers, even in the urban centres with sewerage system, is the reason for the low collection efficiency. There is thus a need to expand the coverage of the sewerage system in order to improve the collection efficiency.

In addition to the sewerage system, onsite sanitation has been used within and in the outskirt of urban areas as a wastewater disposal measures. MOUD has a clear policy to adopt onsite sanitation as one of wastewater disposal measures in urban areas where the development of the sewerage system is not expected in near future.

2.1.1 Wastewater Generation, Collection and Treatment

Cities with population of more than a hundred thousand in India are classified as Class I cities, and towns with population of fifty to hundred thousand are classified as Class II towns by MOUD.

According to “Status of Sewage Treatment in India” by the Central Pollution Control Board (CPCB) in 2005, the number of class I cities was 414 and class II towns was around 489. There are 211 sewage treatment plants (STPs) in 112 of the 414 Class I cities and 31 STPs in 22 of the 489 Class II towns. Besides, 27 STPs are in 26 other smaller towns. Of these, 186, 24 and 21 STPs are operational and 25, 7 and 6 are under construction in Class I cities, Class II towns and other smaller towns, respectively. Thus, in all there are 269 STPs, including 231 that are operational and 38 under construction. (Refer to Table 2-1)

According to “Status of Water Supply, Wastewater Generation and Treatment in Class I Cities and Class II towns of india” by CPCB in 2009, sewage generation and sewage treatment capacity over India is shown in Table 2-2. This is summary of status of sewerage system in the metropolitan cities, class I cities and class II towns across the country.

Table 2-1 Statewise Summary of STPs in Class-I and Class-II Towns

State	Class-I cities			Class-II cities			Smaller towns having STPs	
	Total no. of cities	Cities having STPs	No. of STPs	Total no. of towns	Towns having STPs	No. of STPs	Towns having STPs	No. of STPs
Andaman & Nicobar Islands	1	0	0	0	0	0		
Andhra Pradesh	46	9	15	52	1	2	1	1
Arunachal Pradesh	0	0	0	0	0	0		
Assam	4	0	0	9	0	0		
Bihar	19	4	7	18	1	1		
Chandigarh	1	1	4	0	0	0		
Chhattisgarh	7	1	3	7	0	0		
Dadra & Nagar Haveli	0	0	0	0	0	0		
Daman & Diu	0	0	0	0	0	0		
Delhi	1	1	30	0	0	0		
Goa	0	0	0	3	1	2		
Gujarat	23	5	10	36	0	0		
Haryana	20	7	12	7	0	0	5	5
Himachal Pradesh	1	1	6	0	0	0		
Jammu & Kashmir	2	0	0	4	0	0		
Jharkhand	7	0	0	17	0	0		
Karnataka	28	11	14	30	2	2	3	3
Kerala	7	1	1	24	0	0	1	1
Lakshadweep	0	0	0	0	0	0		
Madhya Pradesh	23	7	12	25	1	1	2	2
Maharashtra	40	19	21	44	2	2	1	1
Manipur	1	0	0	0	0	0		
Meghalaya	1	0	0	1	0	0		
Mizoram	1	0	0	0	0	0		
Nagaland	1	0	0	1	0	0		
Orissa	8	3	3	15	0	0	1	1
Puducherry	2	0	0	1	0	0		
Punjab	13	2	4	20	2	3	4	4
Rajasthan	17	1	2	28	0	0		
Sikkim	0	0	0	0	0	0		
Tami Nadu	26	6	10	57	3	3	1	1
Tripura	1	0	0	0	0	0		
Uttar Pradesh	52	14	28	57	2	5	2	2
Uttarakhand	3	1	1	4	1	2	2	3
West Bengal	58	18	28	29	6	8	3	3
TOTAL	**414**	**112**	**211**	**489**	**22**	**31**	**26**	**27**

Remarks: Figures based on Census 2001 data, MIS-November 2004 report and 1995 Class-I cities questionnaire survey

Source: Status of Sewage Treatment in India, CPCB, 2005.

Table 2-2 Volume of Wastewater Generated, Collected and Treated (1999)

Wastewater Volume	Metropolitan Cities	Class I cities	Class II Towns	Total
Sewage generation (mld)	15,644	19,914.12	2,696.70	38,254.82
Capacity of sewage treatment (mld)	8,040	3,513.68	233.7	11,787.38
Capacity of sewage treatment/sewage generation (%)	51.4	17.6	8.7	30.8
No. of cities/towns	35	463	410	908

Metropolitan cities: populations ≥ 1,000,000
Class I cities: 100,000 > population ≥ 100,000
Class II towns: 100,000 > population ≥ 50,000
Source: Status of Water Supply, Wastewater Generation and Treatment in Class- I Cities and Class- II Towns of India, CPCB, 2009

In Jawaharlal Nehru National Urban Renewal Mission (JNNURM, 2005-2012) under the jurisdiction of MOUD (refer to the section 2.1.4), the number of sewerage-related schemes approved till 2010 is 111 and the approved estimated cost is 1,483,414 (Lakh rupees). In addition, in the eleventh five year plan (2007-2012) (refer to the section 2.1.5) under the jurisdiction of MOEF, the investment is 254,000 (Lakh rupees). Through these investments, a significant increase of sewerage system is expected in the future.

2.1.2 Sewage Treatment Technology

According to "Status of Sewage Treatment in India" by CPCB in 2005, an analysis of various treatment technologies employed in different sewage treatment plants is presented in Table 2-3 and Table 2-4 for Class I cities and Class II towns, respectively.

Table 2-3 Sewage Treatment Technologies Employed in STPs of Class I Cities

S. No.	Technology	No. of Plants	% age as number	Combined capacity, MLD	% age as capacity	Average size, MLD
1	Activated sludge process (ASP)					
	PST + ASP	42	28.0	3,059.63	52.6	72.8
	ASP-Ext. Aer.	3	2.0	63.36	1.1	21.1
	ASP-Ext. Aer. + Ter. Sed.	7	4.7	58.04	1.0	8.3
	High rate ASP + Biofilter	1	0.7	181.84	3.1	181.8
	Aerated lagoon + fish pond	3	2.0	49.50	0.9	16.5
	Facultative lagoon + ASP	1	0.7	44.50	0.8	44.5
	ASP (sum of all the above processes)	57	38.0	3,456.87	59.5	60.6
2	Fluidized aerobic bio-reactor (attached growth)	5	3.3	66.00	1.1	13.2
3	Trickling Filters or Biofilters	6	4.0	192.62	3.3	32.1
4	UASB + Activated sludge process	1	0.7	86.00	1.5	86.0
5	UASB					
	Grit channel or PST + UASB + PP	24	16.0	1,229.73	21.2	51.2
	UASB + Sedimentation	1	0.7	126.00	2.2	126.0
	Grit channel or PST + UASB	5	3.3	158.17	2.7	31.6
	UASB (sum of all the above processes)	30	20.0	1,513.90	26.0	50.5
6	Waste Stabilization Ponds	42	28.0	327.53	5.6	7.8
7	Oxidation Pond (single stage)	3	2.0	69.00	1.2	23.0
8	Anaerobic digester + Trickling filter	1	0.7	4.45	0.1	4.5
9	Karnal Technology (for plantation)	2	1.3	12.46	0.2	5.2

10	Only Primary treatment	3	2.0	84.00	1.4	28.0
	Total	150 (100%)		5,812.83 (100%)		

Source: Status of Sewage Treatment in India, CPCB, 2005.

Table 2-4 Sewage Treatment Technologies Employed in STPs of Class II Towns

S. No.	Technology	No. of Plants	% age as number	Combined capacity, MLD	% age as capacity	Average size, MLD
1	ASP (preceded by primary sedimentation)	1	3.4	12.5	5.8	12.5
2	Grit channel or PST + UASB + PP	3	10.3	23.83	10.6	7.9
3	Waste Stabilization Ponds	21	72.4	161.26	71.9	7.7
4	Trickling Filters	2	6.9	16.68	7.4	8.3
5	Karnal Technology (for plantation)	2	6.9	10.13	4.5	5.1
	Total	29 (100%)		224.4 (100%)		

Source: Status of Sewage Treatment in India, CPCB, 2005

In Class I cities, Activated Sludge Process (ASP) is the most commonly employed technology, covering 59.5% of the total installed capacity, followed by Upflow Anaerobic Sludge Blanket (UASB) technology, covering 26% of the total installed capacity. The Waste Stabilization Ponds (WSP) process is also important as it is used in 28% of the plants even though its combined capacity is only 5.6%.

In Class II towns, the WSP technology is the most commonly used technology, covering 71.9% of total installed capacity and 72.4% of STPs, followed by the UASB technology, covering 10.6% of total installed capacity and 10.3% of STPs.

The ASP technology is suitable for large cities because it requires less space as compared to the other two technologies, namely, UASB technology and WSP technology, as both of these technologies require ponds with large land area.

Most of the treatment schemes using UASB technology include grit chamber as preliminary treatment unit and one-day retention time pond as the terminal polishing unit. Operationally, this treatment scheme is an economical one, as it merely requires passing the sewage through the treatment scheme with the added advantage of biogas generation.

Although it is desirable to provide sewerage system in urban centres, heavy capital investment is required for construction and regular funds are necessary for maintenance. Providing sewerage system to all urban centres may not be feasible or desirable, given the water supply situation and the state of municipal finances.

The Central Pollution Control Board has conducted performance evaluation of 115 sewage treatment plants. Table 2-5 shows the state-wise summary of performance status of the STPs.

Table 2-5 Statewise Summary of Performance Status of STPs

State	STPs studied by CPCB	STPs that achieved general standards for discharge in surface waters*	STPs did not achieve general standards
Bihar	3	3	0
Chandigarh	2	1	1
Chhattisgarh	3	2	1
Delhi	26	20	6
Gujarat	9	6	3
Haryana	7	2	5
Himachal Pradesh	5	5	0
Karnataka	4	2	2
Madhya Pradesh	2	1	1
Maharashtra	4	0	4
Punjab	4	4	0
Rajasthan	1	0	1
Uttar Pradesh	25	8	17
Uttarakhand	2	1	1
West Bengal	18	15	3
TOTAL	**115**	**70**	**45**

*BOD: 30mg/L; TSS: 100mg/L and COD: 250mg/L
Source: Status of Sewage Treatment in India, CPCB, 2005

Based on the analysis of 106 raw sewage samples, average sewage characteristics in terms of main parameters BOD, COD and TSS were found to be 185.5 mg/L, 481 mg/L and 328 mg/L, respectively. The average COD to average BOD ratio was 2.6. A more detailed analysis of these results is presented in Table 2-6.

Table 2-6 Raw Sewage Characteristics in 115 STPs Studied by CPCB

BOD, mg/L		COD, mg/L		TSS, mg/L	
Range	No. of samples in the range	Range	No. of samples in the range	Range	No. of samples in the range
0-50	7	0-100	3	0-100	11
50-100	28	100-200	14	100-200	33
100-150	20	200-300	12	200-300	23
150-200	22	300-400	19	300-400	12
200-250	15	400-500	16	400-500	12
250-300	4	500-600	15	500-600	6
300-500	5	600-700	12	600-700	3
500-100	6	700-800	9	700-1,000	4
		800-1200	5	900-1,200	1
		>2,000	1	200-2,300	2
Average: 185.5 and SD: 175		**Average: 481 and SD: 343**		**Average: 328 and SD: 329**	

Source: Status of Sewage Treatment in India, CPCB, 2005

It can be observed that the BOD of raw sewage lies between 50 and 250 mg/L in nearly eighty six percent observations, the COD of raw sewage lies between 100 and 700 mg/L in nearly eighty three percent observations, and the TSS of raw sewage lies in the range of 100-500 mg/L in nearly eighty five percent observations.

Of the 115 STPs studied, capacity utilization was reported in 80 cases, and the average

capacity utilization was only 72.2 %.

In 47 STPs using the Activated Sludge Process with a secondary clarifier as the terminal treatment unit, TSS was found to be less than 30 mg/L in 26 cases, 30-50 mg/L in 6 cases and more than 50 mg/L in 15 cases. Thus, it is possible to achieve TSS value less than 30 mg/L in the final clarified effluent of the biological processes.

In 47 STPs using the Activated Sludge Process with no tertiary treatment, BOD was found to be less than 20 mg/L in 28 cases, 20-30 mg/L in 7 cases, 30-50 mg/L in 7 cases and 50-100 mg/L in 5 cases. In most of the cases where BOD exceeded 20 mg/L, TSS also exceeded 30 mg/L. From this and other observations, it can be concluded that Primary Settling + Activated Sludge (PST+ASP) technology can provide treated effluent having BOD<20 mg/L and TSS< 30 mg/L.

In 41 STPs employing the Upflow Anaerobic Sludge Blanket (UASB) technology or the Waste Stabilization Pond (WSP) technology and having ponds as terminal treatment units, TSS was found to be less than 30 mg/L in 9 cases, 30-50 mg/L in 11 cases, 50-100 mg/L in 13 cases and greater than 100 mg/L in 8 cases. This indicated that in spite of a larger settling area available in ponds as compared to secondary clarifiers, fewer ponds are able to provide effluent having TSS less than 30 mg/L. The most obvious reasons behind this discrepancy appear to be excessive algal growth due to stagnation and high weir loading. Efficiency of ponds in terms of effluent TSS can be improved by preventing excessive algal growth, which generally occurs when effluent remains stagnant in ponds, and providing adequate effluent structures with sufficient weir length and baffle preceding the effluent weir to arrest floating matter. With these precautions/improvements, ponds are also expected to provide effluent having TSS <30 mg/L.

In 18 STPs using UASB + Polishing Pond technology, BOD has been found to be less than 20 mg/L in 3 cases, 20-30 mg/L in 3 cases, 30-50 mg/L in 7 cases, 50-100 mg/L in 3 cases and >100 mg/L in 2 cases. In most of the cases where BOD exceeded 20 mg/L, TSS also exceeded 30 mg/L.

Most of the STPs in India use one of the three technologies, namely, Primary settling followed by Activated Sludge Process (PST+ASP), Upflow Anaerobic Sludge Blanket + Polishing Pond (UASB+PP) and Waste Stabilization Pond (WSP). The first technology has been found to be capable of providing final effluent having BOD<20 mg/L and TSS< 30 mg/L. An effluent conforming to this quality in terms of BOD and TSS will also easily conform to COD value<100 mg/L.

2.1.3 Status of Operation and Maintenance of Sewerage System

The amount of sewage collected by the sewerage networks as of 1999 was 8,546.6 MLD as mentioned above. Of this, the amount of sewage treated was 5,274.0 MLD. However, operation and maintenance of the STPs is not always carried out appropriately.

“Evaluation of Operation and Maintenance of Sewage Treatment Plants in India-2007” published by the CPCB in 2007 reported the situation on operation and maintenance of STP as follows:

The study brought out a large number of technological and management problems in the operation of these STPs. The report has included only 84 STPs applying 13 different treatment processes (Table 2-7) spread over 9 States of India (Table 2-8) out of the total of 175 identified STPs spread over 15 States.

Table 2-7 Technology-wise Information on STPs Covered

S. No.	Main technology	Number of STPs visited
1.	Activated Sludge Process (ASP) (conventional)	36
2.	Activated Sludge Process (ASP) (extended aeration)	3
3.	Fluidized Aerobic Bed (FAB) (Densadeg)	3
4.	Fluidized Aerobic Bed (FAB)	3
5.	Trickling Filters	2
6.	SAF	1
7.	UASB + Aerated Lagoons	2
8.	UASB	1
9.	Aerated Lagoons	6
10.	SBR	1
11.	Waste Stabilization Ponds	12
12.	UASB + Polishing Ponds	12
13.	Micro STPs	2
	Total	84

Source: Evaluation of Operation and Maintenance of Sewage Treatment Plants in India-2007, CPCB

Table 2-8 Statewise Number of STPs Visited

S. No.	State	Number of STPs visited
1.	Bihar	4
2.	Delhi	30
3.	Goa	1
4.	Haryana	6
5.	Maharashtra	11
6.	Tamil Nadu	5
7.	Uttar Pradesh	17
8.	Uttarakhand	2
9.	West Bengal	8
	Total	84

Source: Evaluation of Operation and Maintenance of Sewage Treatment Plants in India-2007, CPCB

Overall, the performance scenario of STPs is dismal, as the overall performance of 46 STPs has been found to be Poor or Very Poor. The performance of only 8 STPs has been rated Good while that of 30 other STPs has been rated Satisfactory. Capacity utilization in general was inadequate.

The report has described the problems in maintenance management as follows.

i) Capacity utilization of observed STPs is in general inadequate. Information on capacity utilization was collected from 55 STPs. Out of 55 STPs, only 18 STPs (i.e. 33%) were operating at normal flow (90 to 110% of design flow) whereas rest 37 (i.e. 67%) were either under-loaded or over-loaded.

ii) Sludge removal/treatment/handling appear to be the most neglected area in operation of STPs.

Moreover, the report has specifically made the following important proposals in “Chapter 4 Conclusion and Recommendations”.

i) In most cases, influent to the STPs was found to contain a lot of solid wastes including plastics, pouches, etc. This caused wear and tear of pumps and machinery and reduced efficiency of treatment, especially in case of UASB process where the feeding pipes and overflow weirs/V-notches in division boxes/effluent gutters, are chocked/obstructed, thus resulting in reduced STP capacity. It is generally observed that mechanical screens installed in STPs/PSs are out of order, mainly because these are not regularly run and also due to poor maintenance. Comprehensive scheme for providing solid waste management in all the towns including public awareness, institutional strengthening, etc., need to be implemented. As an immediate solution to the problem, especially in the UASB process, fine/mesh screens can be used instead of ordinary bar screens. Larger size of feeding pipes with more frequent cleaning can also solve this problem.

ii) Polishing ponds (in case of UASB process) and Waste Stabilization Ponds (WSPs) are mostly found to have accumulated sludge resulting in reduced capacity/detention time in the tank. This also affects the quality of treated effluent due to sludge carry-over. Sludge levels should be checked regularly and the ponds should be cleaned to remove the deposited sludge.

iii) Sludge in UASB reactors is not withdrawn regularly based on its level and concentration in the reactors which results in sludge carry-over into the polishing ponds and poor quality of treated effluent. Regular checking of sludge level and its concentration in the reactors is essential for proper sludge withdrawal.

iv) Due to improper removal of filtrate from sludge drying beds, subsequent removal/withdrawal of sludge from sludge drawing beds/reactors is not possible in a desired manner, as the capacity of sludge drying beds is reduced. Hence, filtrate from the beds and sludge from the reactors/sludge drying beds need to be taken out regularly in a proper way.

As to the operation and maintenance of sewers, choking caused by inflowing of silt and solid wastes to sewers, corrosion and collapse caused by inflowing of industrial effluent to sewers, infiltration of groundwater to sewers, and leakage of sewage from sewers are common issues to be dealt with. Inspection and examination, cleaning, and rehabilitation of sewers are not practiced from the view point of preventive maintenance.

2.1.4 Sewerage Development Policy

India being a signatory to Millennium Development Goals, access to improved sanitation should be extended to at least half of the urban population by 2015 and to the entire urban population by 2025. Considering this, the Government of India has prepared the National Policy for Sanitation and Environment.

In the “National Urban Sanitation Policy” prepared by MOUD in 2008, the vision for urban sanitation in India is defined as follows:

> “All Indian cities and towns to become totally sanitized, healthy and liveable, to 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.”

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

One of the specific goals of this policy is *Sanitary and Safe Disposal*: Under this Goal, 100% of human excreta and liquid wastes from all sanitation facilities including toilets must be disposed of safely. In order to achieve this goal, the following activities shall be

undertaken:

i) Promoting proper functioning of network-based sewerage systems and ensuring connections of households to them wherever possible;

ii) Promoting recycling and reuse of treated wastewater for non potable applications, wherever possible.

iii) Promoting proper disposal and treatment of sludge from on-site installations (septic tanks, pit latrines, etc.);

iv) Ensuring that all the human wastes are collected safely, conveyed, and disposed of after treatment so as not to cause any hazard to public health or the environment.

The national policy will help urban areas adopt a citywide, demand based approach towards sanitation and prepare city sanitation plan including households that are still not served. The Government will explore the possibility of providing financial assistance for projects proposed as part of city sanitation plans through the following schemes:

- Jawaharlal Nehru National Urban Renewal Mission (2005-12)
- Urban Infrastructure Development Scheme for Small and Medium Towns (2005-12)
- 10% lump sum for north-eastern States for creation of urban infrastructures
- Schemes for new satellite township for creation of urban infrastructures

The Government will also support periodic rating of cities in respect of sanitation.

For improving the efficiency of urban local bodies in the delivery of basic services in cities, the MOUD has adopted National Benchmarks in four key sectors including water supply, sewerage, solid waste management, and storm water drainage and has prepared the "Handbook on Service Level Benchmarking". The benchmarks set in the handbook for sewage management are given in Table 2-9 below.

Table 2-9 Benchmarks for Sewage Management (Sewerage and Sanitation)

S. No.	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 (within 24 hours or next working day)	80%
8	Extent of cost recovery in sewage management (O&M Cost)	100%
9	Efficiency in collection of sewage charges	90%

Source: Handbook on Service Level Benchmarking, MOUD

The MOUD is planning to facilitate the adoption of these benchmarks through its various schemes and intends to provide appropriate support to urban local bodies that move towards adoption of these benchmarks. The Ministry also expects that State governments and cities would adopt these indicators to improve the quality of services in related sectors.

2.1.5 Environmental Policy

The Ministry of Environment and Forests (MOEF) is the prime agency of the Central

Government for planning, promotion, coordination and overseeing the implementation of India's environmental policies and programs. It focuses on the implementation of policies and programs relating conservation of the country's natural resources including lakes and rivers, biodiversity, forests and wildlife, ensuring the welfare of animals, and the prevention and abatement of pollution.

Measures against conservation of water bodies for the protection of environment, especially in the field of water prevention and control of pollution, are described in the Annual Report 2009-2010 prepared by MOEF as follows:

> The National River Conservation Directorate (NRCD) of MOEF is implementing the River and Lake Action Plans under the National River Conservation Plan (NRCP) and National Lake Conservation Plan (NLCP) by providing financial assistance to the State Governments. Under these plans, in general, the ratio of financial assistance is 70% from the central government.
>
> The objective of the National River Conservation Plan (NRCP) is to improve the water quality of the rivers, which are the major water sources in the country, through the implementation of pollution abatement works, to the level of designated best use. So far a total of thirty eight rivers have been covered under the programme.
>
> The pollution abatement works taken up so far under the NRCP include:
>
> – Interception and diversion works to capture the raw sewage flowing into the river through open drains and divert them for treatment.
> – Setting up sewage treatment plants for treating the diverted sewage.
> – Construction of low cost sanitation toilets to prevent open defecation on river banks.
> – Construction of electric crematoria and improved wood crematoria to conserve the use of wood.
> – River front development works such as improvement of bathing ghats.
> – Afforestation on the river banks, Public Participation & Awareness etc.
>
> For the conservation of the Ganga river, the Central Government has given Ganga the status of a 'National River' and has constituted a 'National Ganga River Basin Authority' (NGRBA) on February 20, 2009. The NGRBA has been set up as an empowered planning, financing, monitoring and coordinating authority for the conservation of Ganga River with a holistic approach under the Environment (Protection) Act, 1986.
>
> The first meeting of the NGRBA was held on 5th October, 2009 under the Chairmanship of the Prime Minister. The Authority decided that under Mission Clean Ganga it will be ensured that by 2020 no untreated municipal sewage and industrial effluents flow into Ganga.
>
> Currently, there is a sewage treatment capacity of only about 1,000 mld against 3,000 mld sewage being generated in the towns along Ganga. An estimated investment of INR 15,000 crores over the next ten years will be required to create the necessary treatment and sewerage infrastructure. It was agreed that the required resources would be provided by Centre and States over a ten-year period to be shared suitably between the Centre and the States after Planning Commission consultations. New and innovative models for implementation such as, special purpose vehicles, are to be adopted.

As described above, to improve the urban environment and contribute to sound development and enhancement of public sanitation, sewerage systems have an important role to play and have to cover the whole country.

The Central Pollution Control Board (CPCB) is an organization that provides technical assistance to MOEF on the provisions of Environmental (Protection) Act, 1986, to prevent

and to control air and water pollution. The CPCB also monitors air and water quality at various locations in the country through its branches in States namely State Pollution Control Boards.

(A) Laws on Water Pollution Control

Realizing the importance of qualitative conservation of natural resources including water, the Government of India has enacted a number of laws to deal with the rising pollution problems and to ensure a healthy water environment in the country. Some of the important legislations dealing with water pollution control are listed as follows:

- **The Water (Prevention and Control of Pollution) Act, 1974** – This act deals with the establishment of an institutional structure for preventing and abating water pollution. It establishes standards for water quality and effluent. According to this law, polluting industries must seek permission to discharge waste into effluent bodies. The Central Pollution Control Board (CPCB) was constituted under this act.
- **The Water (Prevention and Control of Pollution) Cess Act, 1977 –** This act provides for the levy and collection of cess or fees on water consuming industries and local authorities.
- **The Environment (Protection) Act, 1986** – This act authorizes the central government to protect and improve environmental quality, control and reduce pollution from all sources, and prohibit or restrict the setting and/or operation of any industrial facility on environmental grounds.
- **The Environment (Protection) Rules, 1986** – This law lays down procedures for setting standards of emission or discharge of environmental pollutants.

(B) River Water Quality Standards

The Central Pollution Control Board (CPCB) has classified various rivers in the Country into the following five categories as shown in Table 2-10 based on their 'Designated Best Use'.

Table 2-10 Water Quality Standards Based on Designated Best Use

Class A	Drinking water source without conventional treatment, but after disinfection	pH: 6.5-8.5 DO: ≥ 6mg/L	BOD: ≤ 2mg/L* Total Coliform: ≤ 50MPN/100ml
Class B	Outdoor bathing	pH: 6.5-8.5 DO: ≥ 5mg/L	BOD: ≤ 3mg/L Total Coliform: ≤ 500MPN/100ml**
Class C	Drinking water source after conventional treatment and disinfection	pH: 6-9 DO: ≥ 4mg/L	BOD: ≤ 3mg/L Total Coliform: ≤ 5,000MPN/100ml
Class D	Propagation of wildlife and fisheries	pH: 6.5-8.5 DO: ≥ 4mg/L	Free Ammonia (as N): ≤ 1.2mg/L
Class E	Irrigation, industrial cooling and controlled waste disposal	pH: 6.0-8.5 Sodium Absorption Ratio***: ≤ 26	Boron: ≤ 2mg/L Electrical Conductivity (at 25℃): ≤ 2,250 μmhos/cm

Note: *Defined limit of BOD are for 20°C and 5days.

**NRCD norms are Faecal Coliform: ≤ 500 MPN/100ml (Desirable), ≤ 2,500 MPN/100ml (Maximum permissible).

***Appropriateness of sodium concentration in irrigation water is judged by irrigation water volume, infiltration volume to the ground, and the ratio of sodium content to calcium and magnesium content of soil water, that is, Sodium Absorption Ratio. Using good quality irrigation water not containing salts is effective to prevent soil from becoming salty. Using water which has EC under 0.25 mS/cm and having low salt content does not result into saline soil. (Source: Institute of Environment Rehabilitation and Conservation)

These criteria are followed by various agencies responsible for the management and control of water quality in the country including the two ongoing programs, i.e., the National River Conservation Plan (NRCP) and the National Lake Conservation Plan (NLCP). The primary objective of the national policy of the River Action Plan under NRCP is to attain Class B or C level of water quality in major rivers. To achieve this goal, general standards have been defined for the effluents into inland water bodies besides the defined values for effluent standards for different kinds of industries.

The general standards for the discharge of treated wastewater into inland surface waters are according to the Schedule II of Environment (Protection) Rules 1986. The values for these Standards in terms of important parameters are given in Table 2-11.

These standards vary depending on the nature of the receiving environment or water body. For instance the limits imposed for discharge into inland water bodies are most stringent followed by those specified for discharge onto land for irrigation, and then marine outfalls. The most relaxed standards are specified for discharge into public sewers that lead to a sewage treatment plant and it is assumed that the wastewater will eventually receive adequate treatment at the plant.

Table 2-11 Discharge Standards

Indicator	Inland surface water	Public sewers	Land for irrigation	Marine outfall
BOD_3 (27°C), mg/l*	30	350	100	100
COD_{cr}, mg/l	250	-	-	250
Suspended solids, mg/l	100	600	200	10% above influent
Total Kjeldahl nitrogen as N, mg/l	100	-	-	100
Ammoniacal nitrogen as N, mg/l	50	50	-	50
Free Ammonia as NH_3, mg/l	5	-	-	5
Sulphide, mg/l	2	-	-	5
Oil and grease, mg/l	10	20	10	20
pH	5.5-9.0	5.5-9.0	5.5-9.0	5.5-9.0

Note: All values (except for pH) are in mg/L and are the maximum permissible levels
*Based on research carried out by CPCB (Parivesh, June 2003, CPCB) to validate BOD determination at higher temperature in case of India, adoption of test at 27°C and 3-days incubation was recommended and approved by the Bureau of Indian Standards. Hence, many samples are measured using 27°C and 3-days incubation.

Source: Pollution Control Acts, Rules and Notifications, CPCB, 2001.

(C) Standards for Effluent from Treatment Plants

In order to achieve improved water quality in the water bodies including major rivers, the effluents from STPs should be maintained within the range of effluent standards so as to not add extra pollution loads to the river every day. Therefore, the STPs constructed in all the States are designed for the target effluent standards and in some cases the effluent standards are more stringent than those defined in the CPCB standards (Table 2-12).

Table 2-12 Standards for Sewage Treatment Plant Effluents

States	Effluent Standards, mg/L	
	BOD	TSS
Discharge Standards for inland surface water (CPCB)	30	100
Delhi (revised from BOD and TSS effluent level of 30 and 50mg/L)	20	30
Haryana	30	50

States	Effluent Standards, mg/L	
	BOD	TSS
Karnataka	20 5 (Tertiary level)	30 5 (Tertiary level)
Tamil Nadu	20	30
Uttar Pradesh	30	50

A few new STPs are designed to satisfy more rigorous effluent level such as the Sen Nursing Home STP (Delhi), where the effluent standards are 10mg/L and 15mg/L of BOD and TSS, respectively. In case of Nerul STP at Navi Mumbai (Maharashtra), the design effluent standards are: BOD 5mg/L and TSS 10mg/L.

(D) Environmental Impact Assessment

In 2006, notification was issued by MOEF related to Environment Impact Assessment or Environmental Clearance based on their potential environmental impact, for imposing certain restrictions and prohibitions on new projects or on the expansion of existing projects, under the Environment (Protection) Rules, 1986. According to this notification, prior environmental clearance approval is required to be obtained from the Central Government or the State or Union territory Level Environment Impact Assessment Authority (SEIAA) in accordance with the procedures specified in the notification for all the projects listed in the Schedule (List of Projects or Activities Requiring Prior Environmental Clearance). The Projects listed in Schedule are categorized either as A, B1, or B2 and the environmental clearance for each category is as follows:

- Category A projects require prior environmental clearance from the MOEF on the recommendations of an Expert Appraisal Committee (EAC) to be constituted by the MOEF for the purposes of this notification (require Environmental Impact Assessment).
- Category B1 projects require EIA and EC is granted at the State level. Depending on the location of the project (defined through General Conditions), a project is re-categorized from B1 to A.
- Category B2 projects do not require EIA and are appraised at State level.

The list does not include any project related to sewerage system infrastructure development, except the projects on common effluent treatment plant (for industries) and common municipal solid waste management facility.

Based on the discussion with the officials of NRCD (MOEF), it is concluded that there is no directive or law that indicates requirement of EIA clearance for sewerage projects. However, some organizations responsible for providing sewerage services in States responded that Environmental Impact Assessment was prepared by them for implementation of large scale sewerage projects.

2.1.6 On Site Sanitation

Providing sewerage systems in urban centres, though desirable, requires heavy capital investment for construction and requires regular funds for maintenance. However, providing sewerage system in all urban centres may not be feasible or desirable, given the water supply situation and the state of municipal finances (the present survey shows that almost half the sampled urban centres do not get adequate water).

Therefore, the urban centres that do not have a sewerage system and cannot provide one, can opt for low cost solutions. Septic tanks and low cost sanitation systems are the solutions for providing safe sanitation facilities for such urban centres, even for those that have partial

coverage by sewerage system. A section of the population in most urban centres uses community toilets while the remaining resorts to open defecation.

Dry latrines too are still in existence in some cities. Data on this aspect was very difficult to obtain from local governments. Even where data has been provided by the agency concerned, the data were not found to be very reliable. Most urban centres have population that depends on septic tanks and low cost sanitation, even in the urban centres that have a sewerage system. A section of the population in almost all urban centres uses community toilets while others resort to open defecation.

2.2 Outline of Existing Manuals

Various existing manuals related to sewerage facilities and water supply facilities both in India and outside India will be referred to for revising the "Manual on Sewerage and Sewage Treatment (Second Edition)" and for preparing the new Operation and Maintenance Manual.

An overview of the various manuals that will be referred to is given below.

2.2.1 Manual on Sewerage and Sewage Treatment in India (Second Edition)

The first "Manual on Sewerage and Sewage Treatment in India" was prepared in 1977 and was revised and updated in 1993. It has been used as guidelines until now for the planning and design of sewerage facilities, and for the operation and maintenance of sewerage facilities.

This Manual covers topics such as the Planning, Management, Design/Construction of Sewers, Maintenance of Sewerage Systems, Sewage and Storm Water Pumping Stations, Design of Sewage Treatment Systems and Sludge Treatment Systems, Effluent Disposal/Utilization, On-Site Sanitation, Corrosion Prevention and Control, Treatment Plant Operation and Maintenance, Flow Measurement, and Emerging Technology for Sewage Treatment.

This Manual not only focuses on the planning and design of sewerage facilities, but also covers matters related to operation and maintenance of sewerage facilities. Additionally, it includes topics related to on-site sanitation considering the status of diffusion of sewerage works all over India. Detailed design methods for sewerage facilities are also described in the Appendices.

However, 18 years have elapsed since the preparation of this Manual. During this period, the policies on sewerage systems and the status of diffusion of the systems in India have changed. In addition, there have been advancements in various technologies related to the sewerage sector. In view of the circumstances mentioned above, it has become essential to prepare revised and new manuals that can be used effectively henceforth in India.

This Manual is likely to be used as the base on which the revised and new manuals will be prepared.

2.2.2 Manual on Water Supply and Treatment (Third Edition) in India

This Manual was prepared in 1999, and is being widely used in India for the planning and design of water supply facilities.

This is a manual meant for water supply facilities. It includes, however, items that can be referred to during the preparation of manuals on sewerage facilities such as Planning, Measurement of Flow, Transmission of Water, Water Treatment, Disinfection, Distribution System, Pumping Station and Machinery, Instrumentation and Controls in Water Treatment Plant, Water Works Management, and Financial Management of Water Supply Projects.

2.2.3 Manual on Operation and Maintenance of Water Supply System in India

In the "Manual on Operation and Maintenance of Water Supply Systems" published in 2005, "Energy Audit & Conservation of Energy" has been described in Chapter 16. Sewerage facilities consume considerable amount of energy, especially for treatment of sewage. In some cases, electricity is generated at the STPs from the methane obtained by carrying out anaerobic digestion of the sludge which is generated in the STPs, and the generated electricity is utilized for its own operation. In future, when effluent standards become stricter, or when mechanical sludge-dewatering equipment is installed, the amount of energy used is expected to increase. For this reason, it is important to perform energy audits for sewerage systems and to conserve energy.

In practice, the facilities are different in case of water supply and sewerage. However, measures for energy conservation are effectively described in the water supply manual and it should be positively taken into consideration for inclusion in the sewerage O&M Manual also.

2.2.4 Manuals in Other Countries

(A) Japan

The following manuals related to sewerage facilities have been prepared in Japan:

- Sewerage Facility Design Guidelines (Published in 1959, Revised in 1972, 1984, 1994, 2009)
- Guidelines on Operation and Maintenance of Sewerage System (Published in 1966, Revised in 1979, 1991, 2003)
- Guidelines on Industrial Pre-Treatment Facility (Book 1 published in 1971, Book 2 published in 1976, Book 3 published in 1980, All revised in 1993, 2002)
- Guidelines on House Connection (Published in 1996, Revised in 2004)
- Wastewater Examination Method (Published in 1935, Revised in 1953, 1964, 1974, 1984, 1997)

The first two manuals mentioned above will be referred to during the preparation of the manuals this time, so an overview of the two manuals is given below.

"The Sewerage Facility Design Guidelines" includes chapters such as Planning, Design of Sewers, Sewage and Storm Water Pumping Stations, Design of Sewage Treatment Systems, Design of Sludge Treatment systems, Electrical and Instrumentation Facility.

This Manual was revised in 2009, and so, it includes the latest information and technologies on planning of sewerage facilities, design of sewage treatment facilities and sludge treatment facilities, reuse of treated effluent, effective use of sludge, and so on.

These guidelines are inter-related. Where the relation with other guidelines is strong, an additional chapter is introduced with the details referred to in the other guidelines. The relation of "Guidelines on Operation and Maintenance of Sewerage System" with the "Sewerage Facility Design Guidelines" is also strong, but in the case of Japan, its relation with "Guidelines on Industrial Pre-treatment Facility" is particularly strong. For this reason, a separate chapter on "regulations and guidance related to industrial wastewater" is included in the "Guidelines on Operation and Maintenance of Sewerage System".

Moreover, the relation of "Guidelines on Operation and Maintenance of Sewerage System" with "Wastewater Examination Method" is also very strong; therefore, items such as SRT

and BOD-MLSS loading have been included in the "Wastewater Examination Method". As mentioned above, each of the Japanese guidelines supplement each other mutually by including parts relevant to each other in the respective guidelines.

The compositions of the Guidelines on Operation and Maintenance of Sewerage System are as given below:

This guidelines firstly gives a general introduction in Chapter 1, followed by "Sewerage Ledger" in Chapter 2, in which preparation of Sewerage Ledger containing various design specifications of sewerage equipment and various kinds of sewerage facilities including sewer, pumping station, and sewage treatment plant are described. Chapter 3 describes O&M of pipelines, and Chapter 4 describes house connections and surveillance guidance for industrial pretreatment facility. Chapter 5, which is "Pumping Station Facility, describes the O&M of the pumping station.

In "Wastewater Treatment Facility" of Chapter 6, the O&M of plants using activated sludge process (which has a share of more than 90% of the treatment processes in Japan) is described by treatment process and by facility. Moreover, in the "Sludge Treatment Facility" of Chapter 7, thickening of sludge, dehydration, incineration, and effective utilization of sludge by unit operation are described. Next, the O&M of electric equipment and instrumentation is explained, and later, planned facility management, water quality analyses, environmental preservation measures, and safety and sanitation management system are described.

(B) USA

(i) EPA

US EPA provides Technology Factsheets which describe various technologies of sewerage systems. These Technology Factsheets are classified into 10 technology divisions and several technologies are described in each division as follows:

- Combined Sewer Overflows Treatment
  Alternative Disinfection Methods, Proper Operation and Maintenance, etc.
- Storm Water
  Employee Training, Handling and Disposal of Residuals, Preventative Maintenance, Record Keeping, etc.
- Disinfection
  Ozone Disinfection, Ultraviolet Disinfection, etc.
- Biological Treatment (Secondary and Advanced)
  Fine Bubble Aeration, Sequencing Batch Reactors
- Water Efficiency
  High Efficiency Toilets, Composting Toilets, etc.
- Decentralized Systems Technology
  Septic Tank-Soil Absorption Systems, Septic Tank Systems for Large Flow Applications, Septic System Tank, etc.
- Collection Systems
  Sewer Cleaning and Inspection, Sewers-Conventional Gravity, Sewers- Lift Station, Trenchless Sewer Rehabilitation
- Biosolids Technology Fact Sheet
  Belt Filter Press, Centrifuge Thickening & Dewatering, Gravity Thickening,

Heat Drying, In-Vessel, etc.

- Wastewater Technology Fact Sheet
  Aerated, Partial Mix Lagoons, Anaerobic Lagoons, Chemical Precipitation, Dechlorination, Disinfection for Small Systems, Facultative Lagoons, Membrane Bioreactors, Oxidation Ditches, Pipe Construction and Materials, Screening and Grit Removal, Sewers-Pressure, Sewers-Force Main, Trickling Filters, etc.

- Energy Conservation and Management
  Energy Conservation, Fuel Cells, Microturbines, Solar Cells, Viable Sources, Wind Turbines

These Technology Factsheets are instructive for revising the "Manual on Sewerage and Sewage Treatment (Second Edition)" and for preparing the "Manual on Operation and Maintenance of Sewerage System".

(ii) 10 States Standards (Recommended Standards for Wastewater Facilities, 2004 Edition

In the USA, a "Committee on Development of Uniform Standards for Sewage Works" was formed in 1947 by the group now known as the Great Lakes - Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers. This Committee, composed of a representative from each state, was assigned the responsibility to review existing standards for sewage works, to investigate the possibility of preparing common standards to be adopted by the states represented, and to report its findings to the Board.

Based on this initial report, the Board authorized the Committee to prepare sewage works design standards, which were first published in 1951. They were subsequently revised and published again in 1960, 1968, 1971, 1973, 1978, 1990 and 1997. These standards have again been revised and are published as the 2004 edition. They are intended for use as a guide in the design and preparation of plans and specifications for wastewater facilities insofar as these standards are applicable to normal situations for an individual project.

These standards are composed of 11 chapters and content of these chapters are described below.

- Engineering Reports and Facility Plans

- Engineering Plans and Specifications
  Plans and Support Documents, Specifications, Revisions to Approved Plans

- Design of Sewers
  Approval of Sewers, Design Capacity and Design Flow, Details of Design and Construction, Manholes, Inverted Siphons, etc.

- Wastewater Pumping Stations
  Design, Suction-Lift Pump Stations, Submersible Pump Stations, Screw Pump Stations, Instructions and Equipment, Force Mains, etc.

- Wastewater Treatment Facilities
  Plant Location, Quality of Effluent, Design, Plant Details, etc.

- Screening, Grit Removal, and Flow Equalization
  Screening Devices, Grit Removal Facilities, Flow Equalization, etc.

- Settling
  Design Considerations, Sludge and Scum Removal, Protective and Service

Facilities, etc.

- Sludge Processing, Storage, and Disposal
  Process Selection, Sludge Thickeners, Anaerobic Sludge Digestion, Aerobic Sludge Digestion, Sludge Pumps and Piping, Sludge Dewatering, Sludge Storage and Disposal, etc.

- Biological Treatment
  Trickling Filters, Activated Sludge, Wastewater Treatment Ponds, Other Biological Systems

- Disinfection
  Chlorine Disinfection, Dechlorination, Ultraviolet Radiation Disinfection, Ozone

- Supplemental Treatment Processes
  Phosphorus Removal by Chemical Treatment, High Rate Effluent Filtration.

(C) WEF

WEF (Water Environment Federation, USA) has issued and revised many Manuals of Practices of Sewage Works up to the present. Some of the Manuals of Practices are listed below.

(i) Planning and Design

"Gravity Sanitary Sewer Design and Construction - MOP FD-5, 2nd Edition"

This manual provides theoretical and practical guidelines for the design and construction of gravity sanitary sewers, and covers the administrative and organizational phases of sanitary sewer projects, as well as the parameters necessary to establish the design criteria, complete the design, and award a construction contract.

"Design of Wastewater and Storm water Pumping Stations - MOP FD-4"

This manual covers the similarities between wastewater and stormwater pumps, pipes, valves, and controls, and covers the differences in station hydraulics and operational considerations such as the intermittent operation of a stormwater pumping station.

"Design of Municipal Wastewater Treatment Plants – MOP 8, 5th Edition"

This manual incorporates the collective experience of more than 300 practicing professionals, and provides new information on membranes, energy conservation, enhanced nutrient-control systems, odour control, approaches to minimizing biosolids production, and more.

"Natural systems for Wastewater Treatment- MOP FD-16, 3rd Edition"

This Manual covers soil-based treatment systems and aquatic-based treatment systems including up-to-date information on pond effluent treatment technologies for algae removal, floating aquatic treatment using periphyton, vertical flow constructed wetlands, and reciprocating operation of subsurface constructed wetlands.

(ii) Operation and Maintenance

"Wastewater Collection Systems Management - MOP 7 6th Edition"

This manual provides up-to-date guidance on the oversight of wastewater collection

systems, including gravity sewers, pumping stations, force mains, and other sewer conveyance-related facilities.

"Operation of Municipal Wastewater Treatment Plants - MOP 11, 6th Edition"

This manual includes information related to the evolution of the Clean Water Act, changes in financing, advances in wastewater treatment technology such as membrane and microfiltration and ultrafiltration, and environmental management systems.

"Septage Handling - MOP 24"

This manual is comprised of the collective experiences and innovations of many individuals related to the applications of the best principles and practices for treatment and disposal of septage.

2.3 General Issues to be Addressed

Results of surveys on sewerage and low-cost sanitation by NIUA show that the sanitation in urban areas is unsatisfactory. The population covered by sewerage systems in urban centres is partial. A large amount of generated wastewater is not collected, and even if collected, a major part of it is untreated.

About half the urban centres with sewerage system have sewage treatment plants. Recycling of wastewater is not yet very common in the sampled urban centres. Only a small percentage of urban centres recycle wastewater, using it mainly for irrigation.

Low cost sanitation covers about one-third of the population in the urban centres, according to the survey. A significant percentage of the population is still not covered by safe sanitation and is forced to use open spaces for defecation.

2.3.1 Planning and Design of Sewerage System

Considering the general issues mentioned above, the new Planning and Design Manual will attempt to provide information and technologies relevant to addressing some of the main issues as follows:

- How to rehabilitate sewerage systems in cities where a sewerage system exists but has become non-functional
- How to promote mandatory wastewater treatment for all urban centres
- Measures to improve the existing sewage treatment capacity
- Measures to increase the population covered by the sewerage systems
- Measures to increase the percentage of treatment of collected sewage so as to cut down the widening gap between sewage generated and treatment capacity
- Measures to prevent pollution of land or water body by untreated wastewater
- Measures to promote recycling/reuse of wastewater through technical and financial assistance, if required
- Means to achieve more efficient cost recovery after providing wastewater treatment services
- How to promote people's participation in contributing to the cost of construction of the sewerage system.

2.3.2 Operation and Maintenance of Sewerage System

The problems in the existing practices of O&M of the sewerage facilities in India are as follows. Currently, there is negligence in maintenance of equipment required for proper operation of the sewage treatment plant. During visits to the plants, in many cases, sewage pump, return sludge pump, sludge removal pump, or aerator, etc. was observed to be in breakdown condition. Moreover, while these important equipment were removed for repair, many STPs were operating in the state where no spare equipment was available. These equipment are important for proper operation of STP, and when they breakdown, the function of STP in terms of sewage treatment to desired level cannot be achieved.

For this reason, it is necessary to repair these equipment immediately when a breakdown occurs.

Even in cases when all the facilities of STPs, and equipment and apparatus work normally, if the BOD-MLSS load, the amount of aeration, and the amount of sludge withdrawal are not properly adjusted to suit the amount of influent sewage, it is difficult to maintain the treated wastewater quality within effluent standard value. In order to maintain good quality of treated water, proper operation and effective management are necessary so that the amount of sewage which flows into STPs, pH in the reaction tank, DO, etc., are always grasped correctly.

Therefore, the importance of instrumentation, such as flow meter and pH meter, should be described in the manual for suitable O&M of STPs.

However, at many STPs broken or non-functional flow meter, pH meter, and DO meter, etc., were not being repaired. In everyday operation of STPs, and adjustment of various facilities, these meters are very important tools for obtaining indispensable data, and are needed to be in proper working condition. In almost all cases, the administrator of STPs mentioned inadequate budget as a reason for not performing repairs on time. To overcome this issue, the budget required for repair must be ensured from the amount collected as sewerage tariff.

As to the operation and maintenance of sewers, choking caused by inflowing of silt and solid wastes to sewers, corrosion and collapse caused by inflowing of industrial effluent to sewers, infiltration of groundwater to sewers, and leakage of sewage from sewers are common issues to be dealt with. Inspection and examination, cleaning, and rehabilitation of sewers are not practiced from the view point of preventive maintenance. It is also pointed out that properly skilled contractors for operation and maintenance are scarce.

With respect to the organization of operation and maintenance, after construction of sewerage systems, they are transferred to local bodies which carry out operation and maintenance of the facilities. However, at the local body level, there are some issues such that standard operation and maintenance system is not built up, preventive maintenance system is not established and proper organization and skilled manpower is not available.

Regarding the financial aspect, it is big issue to secure the resources for operation and maintenance in the situation of lack of construction budget. Fundamentally, charges from customers are used for operation and maintenance, but charges are not collected adequately.

2.3.3 Onsite Management

The new manual will aim to provide adequate information on new technologies and measures that contribute to addressing some of the issues related to onsite management prevalent in India today.

These include:

- Information on infrastructure comprising improved latrines, septic tanks and other household level technologies that do not involve sewerage systems
- Low cost solutions such as septic tanks and low-cost sanitation systems
- Promotion of community toilets, and information on various kinds of toilets such as simple pit latrines, dry latrines and pour flush water seal latrines
- Overview of other alternative onsite sanitation systems
- Overview of small package treatment plants
- Management of new onsite sanitation systems.

CHAPTER 3 ANALYSIS OF PRESENT STATUS

3.1 Site Survey

3.1.1 Objectives of Site Survey

For the installed sewerage facility to fully exhibit its sewage treatment function, proper planning and design of facilities are necessary. When there is a plan or design problem, such as flow meter is not installed for measuring the amount of inflow sewage, return sludge, and the amount of sludge withdrawal, the data required for appropriate operation and management of the facilities, such as STPs and PSs, cannot be obtained. In order to carry out operation and maintenance of the STPs properly and continuously, is it very important to record and analyze daily operation and maintenance data. When these data are not recorded and stored, it is difficult for STPs to fully demonstrate the capacity and performance of sewerage facilities. Moreover, in STPs where sludge drying bed is used for sludge treatment, drying of sludge and removal of dried sludge becomes difficult in rainy season when the rain falls continuously, and sewage treatment may be inadequate.

These are examples of design problem leading to inadequate operation and maintenance and the STP not performing to its full capacity. On the other hand, even when the design of STPs is proper, STPs cannot perform the treatment to required level after the start of operation due to lack of sufficient check, repair, maintenance, etc., of facility, equipment and apparatus.

This shows that there are problems in the operation and maintenance for preserving the functions of facilities, equipment, and machines. Similarly, even if checks of the facilities, equipment and machines, and repair are fully performed, if the sludge management and sludge removal from the reactor based on the results of periodical water quality analysis are not carried out properly in STPs, the quality of treated effluent deteriorates. When water quality analysis is carried out only for the final effluent and the inflow sewage using grab samples, it is difficult to carry out operation and maintenance of the STPs appropriately based only on these data.

In order to manage STPs properly, water quality analysis is needed for samples collected from several stages of the treatment process, such as sludge concentration at the entrance, exit, and within the reactor for grasping the situation clearly. Moreover, the administrator needs to carry out daily tests of quality to grasp the SS and BOD loading of the wastewater which flows into each STP, and to grasp the material balance at least once every season as illustrated in Figure 3-1.

From the water analysis data and the flow data of inflow sewage, the amount of return sludge, the amount of withdrawn sludge, etc., the administrator grasps the situation of STPs and determines the required air volume and BOD-MLSS loading, SRT, the amount of sludge removal, and the amount of sludge that is carried out of the STPs for disposal. The operation is called “wastewater treatment control”, and when wastewater treatment control is insufficient, the quality of final effluent deteriorates.

It is difficult to grasp the actual conditions of STPs and problem of design, and operation and maintenance through only questionnaire survey. Visiting and analysing the actual conditions in STPs is effective for understanding these problems correctly. Considering the above, it was decided to study the actual situation of operation and maintenance by carrying out questionnaire surveys and by actually inspecting the operation and maintenance situation of STPs.

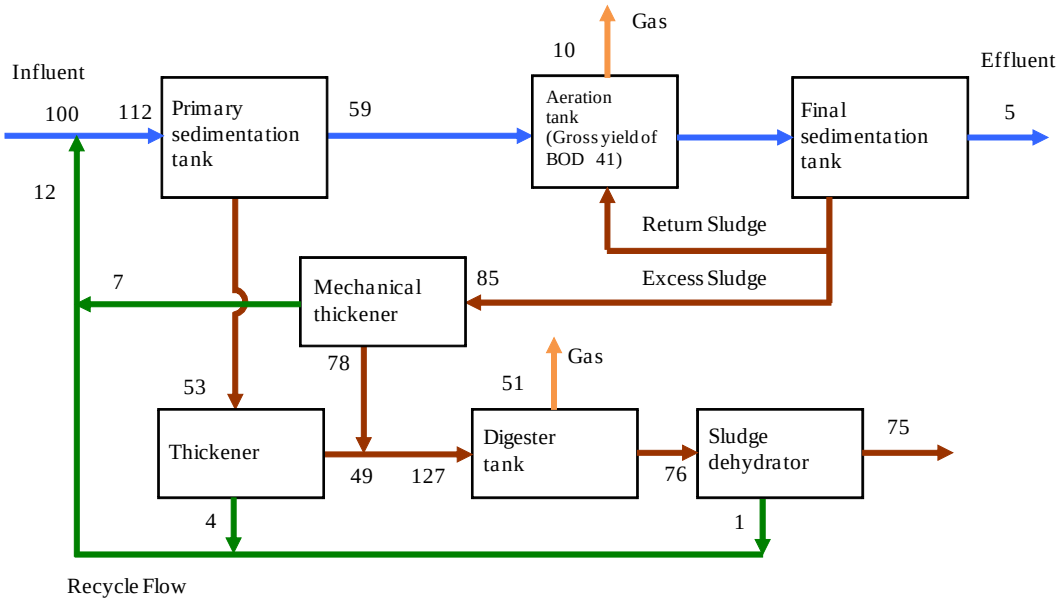

Figure 3-1 Example of Solid Material Balance in Sewage Treatment Plant

3.1.2 Contents and Schedule

The purpose and advantages of acquiring operation and maintenance data of STPs in India are explained below. Except in case of sedimentation by gravity, the correct O&M conditions for biological treatment vary depending on the fluctuations in water temperature, water quality and flow rate of influent. The operating condition for performing proper wastewater treatment control changes significantly with the water temperature, water quality, and inflow patterns of sewage to each STP. To determine the operating condition, the results of operation at the relevant operating condition, and the quality of effluent as mentioned in the operation and maintenance manual, the data for Indian conditions such as influent temperature, water quality, inflow pattern, and so on, are needed.

Moreover, there are some treatment processes that are used in India and rarely used in other countries. For such treatment processes, it is required to collect detailed information including the actual condition of use, operation record and the data on the quality of treated water, etc.

To write an operation and maintenance manual, it is preferable to collect accurate O&M data related to all treatment processes presently used in India. The actual status of operation and maintenance must be understood for ensuring the functions of a facility, equipment, and machines by studying the operation and maintenance situation of STPs. Moreover, even if the function of a facility, equipment, and machines is ensured, when the water quality of final effluent is poor, the causes must be studied and analyzed. Considering these factors, it was decided to actually inspect the operation and maintenance status of several STPs, equipment, and machines, and the status of wastewater treatment control, and to grasp the actual status of operation and maintenance through discussions on the questionnaire for the visited systems.

The questionnaire was prepared to understand the existing status of operation and maintenance of STPs, pumping stations, and sewers, and was distributed in advance to local bodies responsible for sewerage services in the visited towns/cities.

In the first expert committee meetings, 43 sewerage systems in 20 towns and onsite sanitation systems in 3 towns were selected for visit considering variations in climatic condition, size of sewerage systems, and treatment processes used.

Of these, during the first field visit, 14 STPs in 11 towns were visited. Also, sewers and pumping stations were visited in 9 towns where discussions on questionnaires were also made. The names of STPs covered in the first field survey are listed in Table 3-1, and the visit schedule to STPs in the first field survey is shown in Table 3-2. In addition, the list of names of cities where the questionnaire were discussed about sewers and pumping stations in the first field survey is presented in Table 3-3. The visit was also made to onsite sanitation facilities in one town.

However, in the second expert committee meeting, it was recommended to the JICA Study Team to spend more time in one city and understand all components of sewerage system in more detail rather than visiting all selected systems and it was agreed that study team will visit Allahabad, Bangalore and Chennai in detail. Accordingly, visits were made to 6 STPs in these three towns during the second field visit. Also, sewer and pumping stations were visited in these 3 towns and questionnaires related to design and operation and maintenance was discussed.

The names of STPs that were visited for discussion on the questionnaire during second field visit is shown in Table 3-4, and schedule of visit to these STPs are shown in Table 3-5. The list of cities where the questionnaire related to sewer and pumping station was discussed in the second field visit is given in Table 3-6.

Table 3-1 List of Treatment Plants Surveyed (First Study)

STP No.	Name of state	Name of city/town	Name of STP	Sewage treatment process	Capacity MLD
1	Delhi	Delhi	Coronation Pillar STP	ASP	45.46
2			Rithala 40-N STP	ASP, BIOFOR	181.84
3			Okhla 45 STP	ASP	204.57
4			Intl. Airport STP	R.N.D.P.	15
5	Haryana	Karnal	Karnal-I STP	UASB+FPU	40
6		Gurgaon	Gurgaon STP	ASP	69
7	Uttar Pradesh	Ghaziabad	Dundahera STP	UASB+PP	70
8		Noida	Sector 50 STP	UASB+PP	34
9		Agra	Peelakhar STP	WSP	10
10	Maharashtra	Bandra	Bandra Marine Outfall	None	1,500
11		Ghatkopar	Ghatkopar STP	AL	300
12		Navi Mumbai	Nerul STP	SBR	100
13		Pune	Tanajiwadi STP	TF, ASP	17
14	Uttar Pradesh	Kanpur	Tannery STP	UASB	36

ASP: Activated Sludge Process, R.N.D.P.: Recycled Nitrification Denitrification Process, UASB: Upflow Anaerobic Sludge Blanket, FPU: Final Polishing Unit, PP: Polishing Pond, WSP: Waste Stabilization Pond, AL: Aerated Lagoon, SBR: Sequencing Batch Reactor, TF: Trickling Filter

Table 3-2 Schedule of Treatment Plants Surveyed (First Study)

Name of state	Name of city/town	Name of STP	Survey day
Delhi	Delhi	Coronation Pillar STP	1.Sep.2010
		Rithala 40-N STP	1.Sep.2010
		Okhla 45 STP	3.Sep.2010
		Intl. Airport STP	4.Sep.2010
Haryana	Karnal	Karnal-I STP	6.Sep.2010
	Gurgaon	Gurgaon STP	7.Sep.2010
Uttar Pradesh	Ghaziabad	Dundahera STP	8.Sep.2010
	Noida	Sector 50 STP	9.Sep.2010
	Agra	Peelakhar STP	10.Sep.2010
	Kanpur	Tannery STP	21.Sep.2010
Maharashtra	Bandra	Bandra Marine Outfall	13.Sep.2010
	Ghatkopar	Ghatkopar STP	13.Sep.2010
	Navi Mumbai	Nerul STP	14.Sep.2010
	Pune	Tanajiwadi STP	16.Sep.2010

Table 3-3 List of Sewer Networks and Pumping Stations Surveyed (First Study)

Sewer Networks Pumping Station No.	Name of state	Name of city/town
1	Delhi	Delhi
2	Haryana	Gurgaon
3	Uttar Pradesh	Ghaziabad
4		Noida
5		Agra
6	Maharashtra	Bandra
7		Navi Mumbai
8		Pune
9	Uttar Pradesh	Kanpur

Table 3-4 List of Treatment Plants Surveyed (Second Study)

STP No.	Name of State	Name of City/Town	Name of STP	Sewage Treatment Process	Capacity, MLD
15	Uttar Pradesh	Allahabad	Naini STP	ASP	60
16			Salori STP	MBBR	29
17	Karnataka	Bengaluru	Mailasandra STP	ASP	75
18			Cubbon Park STP	MBR	1.5
19	Tamil Nadu	Chennai	Perungudi STP	ASP	54
20			Nesapakkam STP	ASP	40

ASP: Activated Sludge Process, MBBR: Moving Bed Biofilm Reactor, MBR: Membrane Separation Bioreactor

Table 3-5 Schedule of Treatment Plants Surveyed (Second Study)

Name of state	Name of city/town	Name of STP	Survey Day
Uttar Pradesh	Allahabad	Naini STP	2.Nov.2010
		Salori STP	2.Nov.2010
Karnataka	Bengaluru	Mailasandra STP	8.Nov.2010
		Cubbon Park STP	8.Nov.2010
Tamil Nadu	Chennai	Perungudi STP	11.Nov.2010
		Nesapakkam STP	12.Nov.2010

Table 3-6 List of Sewer Networks and Pumping Stations Surveyed (Second Study)

	Name of state	Name of city/town
10	Uttar Pradesh	Allahabad
11	Karnataka	Bengaluru
12	Tamil Nadu	Chennai

3.2 Results of Study

3.2.1 Site Survey (of Sewage Treatment Plant)

As mentioned above, in O&M manual, it is important to describe the operating conditions including the local characteristics, such as water temperature, and water quality of inflow sewage, inflow pattern, etc. using the data in Indian conditions, for achieving the quality of final effluent.

However, based on the site visits to several treatment facilities, it was observed that instruments required to collect important data on operation management, such as flow meter, DO meter, pH meter, etc., were not installed in most of the STPs. Observing the existing conditions at STPs, it became clear that appropriate attention has not been paid to the instrumentation side during the design of STPs.

In many cases, sludge drying beds are used in India for sludge treatment. Several parts of India experience heavy rainfall and the rainy season lasts for a prolonged period. During the rainy season, drying of sludge in drying beds and disposal of dried sludge become difficult. Based on the discussion with O&M staff, it was understood that it takes more than 2 months to dry sludge in such conditions. As a result, most of the drying beds were full of water and this adversely affects appropriate withdrawal of sludge from reactors, and thereby has a negative impact on wastewater treatment control. It became clear that appropriate consideration has not been made for weather while planning and designing the sludge treatment process.

Moreover, it was also observed that repair of non-functional flowmeters (that were installed at the time of STP Construction) had not been carried out. The reason for not repairing these was attributed to lack of funds. Hence, it was understood through field visit that administrative and maintenance funds had to be secured for appropriate operation and maintenance of facilities.

Water quality measurement is being carried out at most of the STPs. However, in most cases,

the samples of only influent and final effluent, or in some cases only final effluent were being taken.

Also, water quality parameters that are measured do not include MLSS, MLVSS and RSSS. The material balance of SS and BOD that are required to understand inflowing and outgoing SS and BOD-MLSS loading is also not estimated. Therefore, it was concluded that the data required for suitable wastewater treatment control of STPs is not being collected and recorded appropriately.

During the first field survey, as described above, data required to prepare the operation and maintenance manual was not obtained. Based on the information collected through observation during site visit to facilities and discussion on questionnaires, the results are summarized in Table 3-7.

Table 3-7 Overview of the Status of Operation and Maintenance of STPs (First Study)

STP No.	Sewage treatment process	Capacity MLD	Pre treatment process	Treat-ment process	Sludge treatment process	Electri-cal Facility	Instrum-entation Facility	Manage-ment of planned facilities	Water Quality of Effluent	TSS material balance
1	ASP	45.46	2	1	2	1	2	1	2	1
2	ASP, BIOFOR	181.84	2	2	1	2	2	2	2	1
3	ASP	204.57	1	1	1	2	1	2	1	1
4	R.N.D.P.	15	2	2	1	4	4	2	2	1
5	UASB +FPU	40	1	1	1	2	1	1	2	1
6	ASP	69	1	1	1	2	1	2	1	1
7	UASB +PP	70	1	1	1	1	1	1	2	1
8	UASB +PP	34	1	1	1	1	1	1	2	1
9	WSP	10	1	1	None	2	1	2	2	1
10	Marine Outfall	1,500	2	None	None	2	2	1	2	1
11	AL	300	1	1	None	2	1	1	2	1
12	SBR	100	4	4	2	4	4	4	4	2
13	TF, ASP	17	4	2	1	2	2	1	1	1
14	UASB	36	1	1	1	2	1	1	1	1

None: Sewage treatment or sludge treatment facilities are not available.
5 Excellent: Required management and operating records are fully performed.
4 Good: Required management and operating records are performed in general.
3 Fair: Required minimum management and operating records are performed.
2 Poor: A part of required minimum management and operating records are performed.
1 Very Poor: Required management and operating records are performed to very little extent.
TSS: Total Suspended Solid, ASP: Activated Sludge Process, R.N.D.P.: Recycled Nitrification Denitrification Process, UASB: Upflow Anaerobic Sludge Blanket, FPU: Final Polishing Unit, PP: Polishing Pond, WSP: Waste Stabilization Pond, AL: Aerated Lagoon, SBR: Sequencing Batch Reactor, TF: Trickling Filter,

3.2.2 Questionnaire Survey

(1) General Questionnaire Survey

During the visit of the JICA Study Team to sewerage systems in several towns, discussion was held with organizations related to planning and design of sewerage system, and on general questionnaires to obtain information on existing practices in planning and design and problems faced at these stages.

In this Subsection, based on the answers to the general questionnaire from some cities/towns visited by JICA Study Team, the existing status or trend in India regarding current status of planning & design, O&M of sewerage and sewage treatment, manual on sewerage and sewage treatment, and new technology recently adopted, are summarized as follows.

(A) Current Status and Main Technical Issues in Planning and Design

In most of the cases, preparation of master plan of sewerage projects on city level is carried out by consultants. Also, the design and planning of large-scale sewerage projects are subcontracted to consultants, and implementing agencies mainly check and approve the design. Only small works are carried out by the implementing agencies themselves. For laying of small-size sewers, some of the implementing agencies prepare the design by themselves. Most of the design and planning works are checked and verified using manuals, so it is expected that manuals should satisfy the needs of the works. Of the several issues, the following were observed to be very common:

- Land availability and its influence on the adoption of technology.
- Due to shortage of land in towns, use of dewatering units for sludge treatment is essential.
- Recycling of treated wastewater for obtaining revenues

Some of the main issues raised by the respondents of the implementing agencies are listed as follows:

(i) Problems faced during formulation of the sewerage plan

- Drainage is not included but drains and industrial discharges contribute to significant inflow. Planning should be integrated as a whole and not piece meal.
- In case of the UASB treatment process, operation and maintenance is difficult and requires trained persons; it is difficult to find such trained persons.
- Water supply is not even and average value is taken for design. Pollution load values are taken based on the CPHEEO manual.
- Selection of sites for sewage treatment plants and pumping stations.
- Determination of STP capacity (whether to use actual per capita water supply or to adopt theoretical per capita water supply based on Manual)
- Lack of skilled staff.

(ii) Problems during planning and design of sewer, and pumping station

- When design and planning is carried out by the contractors, one of the main issues pertains to delay in providing data to contractor resulting in delay in work by the contractor. Land acquisition also causes delay in work completion.
- Submersible pumps become damaged soon due to industrial discharges in sewers.
- Geological strata are very uneven and the data on bore holes logging is different from actual conditions sometimes.
- Undulating areas, narrow streets, soil strata, etc., were found to be challenging as system was to be laid using existing norms and available construction technology.
- In old parts of the city, the presence of several infrastructures (roads, telephone, electricity, etc.) makes it difficult to align sewers.
- Selection of site due to opposition by neighbouring public

(iii) Problems in planning and design of wastewater treatment plant

- Land availability is a problem, and it influences technology adopted for treatment.
- Provision of land for pumping stations and treatment plants is not made in

Development Plan of the city and hence zoning has to be done accordingly.

(iv) Problems during planning and design of sludge treatment facilities and sludge disposal

- At present sludge drying beds are commonly used. There is lack of land in the town and use of dewatering units for sludge treatment would become essential.
- Very difficult to find sites for sludge disposal.
- In many cases, landfill sites are used for disposal of dried sludge, but available area is not sufficient. In future, sludge treatment is planned to be subcontracted and the possibility of using incinerator is also considered.
- Option of centrifuge type of sludge treatment facilities is proposed while planning, in some cases.

(v) Problems in planning and design when recycling treated wastewater and sludge

- Use of recycled water remains an issue. The reuse of treated sewage should be made mandatory.
- Very small amount of treated wastewater is recycled. In some cases, industries take raw wastewater at very low cost and reuse it after treating. In future, some of implementing agencies plan to recycle a part of treated effluent from each STP for gardening and industrial purposes.
- Some implementing agencies are in the process of finding potential buyers in the industrial sector to use recycled water which will be an additional source of revenue.
- Demand for treated sludge is very low.

(B) Current Status of Operation & Maintenance

Operation of sewage treatment plant is subcontracted in many cases and supervision and monitoring are carried out by engineers of implementing agencies. Based on the responses, the following main points have been noted related to operation and maintenance:

- Lack of good sub-contractor for O&M
- Unstable power supply for continuous operation
- Few staff-members have participated in training organized outside or have undergone in-house training.
- Shortage of manpower is a limitation for sparing people for training.
- Lack of training plan at State level, and it is required to encourage planning of State level training.

(i) Problems in the organization and in the operation

- There is lack of good agencies for outsourcing. Available contractors for O&M are not technically sound. There is lack of manpower, if work has to be done by the organization itself.
- Lower level staffs responsible for O&M are subcontracted, and supervision is carried out by the implementing agency.
- Shortage of power supply is experienced. Normal electricity supply is only available for 10-12 hours in some cases.
- In some cases, pumping is carried out by implementing agencies, and cleaning is subcontracted.

(ii) Source and sufficiency of funds received for operation and maintenance

- The fund for O&M is mainly provided by the State Government/Urban Local

Body. The fund provided is sufficient. However, in many cases O&M expenses are provided as subsidy.

- In some cases, fund for O&M is obtained from External Development charges/Land charges collected by Urban Local Bodies. The External Development charges are also used for providing services in the city such as water supply, sewerage, street lighting, horticulture, roads repair, etc.
- Revenue in the form of collected taxes and charges from consumers.

(iii) Number of persons who have undergone training for O&M of sewerage facilities in the last financial year and problems in the training and education of personnel

- In some cases, there is shortage of staff and therefore people cannot be spared for training.
- Training system does not exist and no training has been provided yet.
- No training was organized in last year. Training is needed, and in future, training is planned, by sending trainees to other neighbouring cities.
- Very few personnel have undergone external training in the last year. There is lack of planning for training at state level.
- In some cases, a separate training centre wing headed by a superintending engineer is available (Chennai) and adequate training is given.

(iv) Other problems

- Solid waste in sewers is a major problem resulting in frequent choking.
- The selection of contractors has some defects.
- Staff-members are not familiar with safety equipment.
- Mechanical problems do occur sometimes.

(C) Manual on Sewerage and Sewage Treatment

(i) How to use the existing "Manual on sewerage and sewage treatment" (second edition, 1993, MOUD) and the topics used rarely or the topics used frequently in the Manual.

The manual is used frequently for the design by most of the agencies. Also it is referred to for in house designing or verifying design by sub-contractor. However, specific information related to O&M is not sufficiently included in the manual and therefore it is not used for O&M.

(ii) References other than the existing manual, such as manuals, guidelines, and technical books referred to besides the existing manuals are as follows:

- Departmental Guidelines
- Guidelines from MOEF
- Plant Specific O& M manual
- The books published by AWWA, Metcalf & Eddy Inc., S.R. Qasim, Soli J. Arceivala, R. Pannirselvam, G. L. Karia & RA Christian, M. N. Rao & AK Dutta, and other books such as IS codes are referred for design calculation.
- SPCB standards are followed in some cases.
- European Manual

(iii) Requests and opinions for the contents of the manuals on sewerage and sewage treatment to be formulated and revised in future are as follows:

- Manual has several descriptions on old technologies and processes. However, new equipment and technologies are being adopted. Therefore, the manual should include information on new technologies and processes. The manual should also

include information on trenchless technology. The right of way is gradually getting narrower and the manual should provide information on how to handle such cases.

- Pumps to be used in MPS go out of order frequently, so related information should be included in future manual. Also, power supply is not constant.
- Information on new treatment processes should be included. Information on new specifications for PS, and pipe materials should be included. Information on network analysis using new software should be included.
- Information on construction of manholes that can be easily cleaned should be also included. Sometimes it is difficult to enter into and escape from existing manholes. Information on new technologies such as SBR should also be included.
- Design calculation examples on SBR and other processes should be included. Also, long period survey is needed to prepare good manuals.
- Information on treatment systems for small towns and unplanned areas is needed.
- For single capacity and raw sewage characteristics all the units of the STP and different technologies should be worked out and shown.
- The printing quality and presentation can be improved.

(D) New Technology Recently Adopted

New technologies regarding the sewerage system recently adopted are as follows:

(i) Pipes and Channels

- Trenchless technology to cross structures such as national highways, railway, water supply canal, drain, etc.
- New sewer pipes, such as RCCNP4, 3mmPU coated MS pipes , line coating, GRP lining, CIP , PVC lining

(ii) Facilities and equipment of pumping station

- Submersible pump to reduce head, easy O&M with PLC control, and to reduce noise, and leakage

(iii) Facilities and equipment of sewage treatment and sludge treatment

- Moving Bed Biofilm Reactor (MBBR)
- Sequencing Batch Reactor (SBR)
- UV for disinfection
- Belt press and centrifuge

(iv) Technology for recovering resources from wastewater and sludge

- Tertiary treatment- filtration
- Heavy metals measured

3.2.3 Responses of Consulting Firms to General Questionnaires

In addition to holding discussions with implementing agencies in the sewerage sector, the responses of consulting firms working in water supply and sewerage sector were also obtained on the general questionnaires. The responses from consulting firms were in detail and have been summarized below.

(A) Status of Planning and Designing STPs, and O&M of Sewerage and Sewage Treatment Plants

(i) Problems during formulation of sewerage plan

- Mismatch between the forecast of future growth and development of the project area in the town Master Plan and the actual growth/development of the town during the design period of thirty years
- Population projection in sewerage zones is difficult due to unplanned growth of the town coupled with uncontrolled immigration from rural and semi urban areas.
- Many Indian cities/towns do not have a comprehensive Master Plan for water supply and if available, may not match with the Sewerage Master Plan design years. Again, the water supply zones and sewerage zones differ in many towns. Besides, in actual practice, the rate of water supply (lpcd)/water consumption by residents of different localities of a town varies depending on their life style patterns/water use habits. Also, it is difficult to estimate the actual water supply in a particular locality/town due to installation of many unauthorized tube wells, for which no official record is available.
- A considerable portion of storm water as well as sewage from unauthorized colonies finds their way into the sewer system.
- Untreated effluent from several industries is very often discharged into the sewer system. This leads to disturbance in the treatment process and sometimes damage to process equipment.
- Characteristics of raw sewage for Indian conditions for varying cases of per capita water supply needs to be standardized.
- Deciding the value of per capita sewage generation is difficult due to variation in per capita water supply in different levels of towns.
- Whether ablution water/wastewater from washing clothes should be part of generated sewage
- Selection of simple technology for easy maintenance for the end users
- Guidelines for emerging technology (SBR, FBR, MBBR, MBR, etc.) including life cycle cost are not available.
- Standards for reuse of treated effluent for domestic purposes (other than drinking) are not mentioned in manual.
- The designers of sewerage system sometimes do not get adequate cooperation from the various state agencies/local bodies in sharing some of the basic data and information (available with them) required for design of sewerage system.

(ii) Problems when planning and designing sewers and pumping stations

- Estimation of correct amount of flow is difficult resulting in overdesign and thereby silts deposition in sewers.
- When designing sewers, should crown level matching for diameter change be considered or not?
- Construction of RCC or plastic manholes instead of brickwork manholes
- Minimum cushion over pipes?
- Bedding to be flexible instead of PCC.
- Ventilating shafts for sewers are not allowed.
- Roughness coefficient for plastic pipelines is indicated (120) the same as RCC pipe and needs to be revised.
- Depth of flow in sewer lines as per manual is 0.8 of diameter irrespective of size of sewer which is considered high for small diameter sewer.
- Guidelines on submersible pumps not available.
- Increased depth of manholes for maintaining the self cleansing velocity through the sewers causing maintenance problem.
- If the scope of outsources survey work is not properly defined and the work of the agency is not properly supervised, survey report of inferior quality may be generated.

(iii) Problems during planning and design of sewage treatment plants

- Space constraints
- Type of technology to choose
- Less mechanical equipment from maintenance point of view
- Dedicated power requirement
- Assessment of influent quantity and quality to treatment plant is difficult.
- Selection of an appropriate technology may not be feasible due to factors such as non-availability of adequate land, high operation and maintenance cost, skilled manpower requirement, etc.
- Flows and characteristics of raw sewage vary significantly during 24-hour period and provision of equalization tank should be considered.
- In many cases, STPs do not receive the average discharge for which they are designed probably due to choking of sewer and sewage is finally discharged to nearby storm drains or channels.

(iv) Problems during planning and design of sludge treatment and disposal facilities

- Guidelines on centrifuge or belt press applications are not included in the existing manual.
- Disposal of treated sludge is a major problem in several cities particularly where land is not available. Transportation to a far off place becomes costly.
- Disposable area requirement
- Probable use as landfill material
- Guidelines on obtaining non-conventional energy from sludge are not available.
- Space for storage of dewatered sludge needs to be considered.

(v) Problems during planning and design of recycling facilities for treated sewage and sludge

- For treated sewage reuse is a matter of mindset of the user.
- Use of treated effluent (secondary level) is a problem. Guidelines on tertiary level of treatment are not available.
- Sludge cannot be recycled but can be used as landfill.

(vi) Problems other than above when planning, designing, and recycling treated sewage and sludge facilities

- Main problem is the proper operation and maintenance of the treatment plant. If this is not done properly then the planning & design becomes a theoretical exercise.
- Standard needs to be set for reuse of treated water and sludge depending on the point of disposal and reuse pattern.
- Unplanned development creates problems of capacity assessment particularly in urban areas.

(vii) Current status and main issues in operation and maintenance

- Proper skilled manpower is not available. Salary is low.
- Insufficient budget allocation for O&M
- Power supply (to STP and PS) disruptions occur either frequently or continuously for a long period of time leading to shutdowns of STP & PS. The standby power supply sources like DFG set/DG set are, in many cases, non functional due to lack of proper maintenance or fund.
- Sometimes delay in payment to the contractors causes slackness in their

performance.
- Lack of proper training of personnel
- Lack of proper education
- Structures like bar screen, scrapping mechanisms, pipes for diffusers, surface aerators, etc., get rusted and deteriorated very soon.
- In some cases, the roof of sludge digester deteriorates due to weak materials.
- Presence of solid waste leading to breakdowns and industrial waste leading to corrosion
- Lack of sewer cleaning equipment such as sewage suction and jetting machines.

(B) Manual on Sewerage and Sewage Treatment

(i) How is the existing manual used?

- The existing manual is used frequently as reference. All chapters are used frequently.
- Topics used frequently are assessment of quantity of sewage, pumping capacities, pipe lines carrying sewage, head loss in pumping system, velocities in sewers, etc.
- Topics rarely used are those related to Trickling Filters.
- Topic on design of sewers, storm water drains and treatment plants are frequently used whereas other chapters are rarely used.

(ii) References other than the existing manual

- Wastewater Engineering: Treatment and Reuse; Metcalf & Eddy Inc.
- Wastewater Treatment; Dr. Soli J. Arceivala
- Handbook of Public Health Engineers; Er. Bajwa
- Wastewater Treatment Concept & Design Approach; G.L. Karia and R.A. Christian
- Biological Treatment of Sewage and Industrial Wastes; McCabe J and Eckenfelder W W,
- Wastewater Treatment Technologies, United Nations, New York 2003
- Chemistry for Sanitary Engineers; Sawyer C.N. and McCarty P. L.
- Water Purification and Wastewater Treatment and Disposal; Fair G.M., Geyer J.C and Okun D.A.
- Relevant IS Codes of practices
- Other literature available.

(iii) Do you have any requests and opinions related to the contents of the manuals on sewerage and sewage treatment to be formulated and revised in future?

- Incorporation of new technologies available, subsequent to publication of the manual, as well as inclusion of references and other details of the software available for design of the system is needed.
- The manual states that PVC pipes should not be used in sewers. This should be addressed correctly.
- The manual should give more details of the types of processes referred or are in use.
- Polypropylene pipe should be made usable for sewerage pipes.
- Description on advanced method of sewer laying such as micro-tunnelling should be included.
- Example on selection of sewer laying methodology based on life cycle cost should also be included.

- Values of roughness coefficient to be used in Manning's formula should be reconsidered and modified if needed. Consideration should also be given to minimum suggested diameter for sewers.
- Pumping stations should occupy least space by use of submersible non clog pumps. Details of such pumps with illustrations should be given. The advantages should be clearly explained.
- The sewage treatment processes should be described in more details with mathematical representations especially the newer methods of treatment.
- Sludge treatment (low cost type) should be emphasized and elaborated upon.
- Details on technology for recovering resources from sewage and sludge should be elaborated.
- In the manual on operation and maintenance, typical manpower requirements for types of plants should be elaborated; preventive maintenance 'do's & don'ts' should be listed; cleanliness and housekeeping should be emphasized; minimum laboratory facilities should be elaborated.

(C) New Technologies Adopted

(i) Pipes and channels

- Trenchless technology for laying pipes

(ii) Facilities and equipment of pumping station

- Submersible pump with automatic control

3.2.4 Questionnaire Survey for O&M of Sewage Treatment Plant

The name of cities and plants for which questionnaire on operation and maintenance of STPs was discussed during the first field visit is presented in Table 3-1 above and the list of STPs where questionnaires on operation and maintenance of STPs was discussed in second field visit is listed in Table 3-4.

The result of the questionnaire about STPs showed that water quality analysis of influent and final effluent was being performed. Among these, water quality analysis of the final effluent required for satisfying the established effluent standard was also being performed by all STPs surveyed.

On the other hand, analysis of MLSS, MLVSS and RSSS, which is very important for operation, management and the wastewater treatment control of STPs, was not performed in most of the cases. Also, in most of the cases, measurement was not carried out for the amount of the sludge removed from sewage treatment facility and disposed of after treatment. In the absence of data on these parameters, proper operation and maintenance of STPs is difficult.

Of all the STPs visited in the first field survey, only one STP was observed to carry out proper operation and maintenance. Although data on the concentration of sludge removal was not provided by this STP, it is assumed that data is being recorded. Of the 6 STPs visited during second field survey, 3 STPs were observed to record data on operation and maintenance except the data on the frequency and amount of sludge removed and the concentration.

In case of STPs visited during first field survey, check records of facility, and equipment and apparatus and records of breakdown, etc., were not maintained by most of the STPs. Also, it was observed at these STPs that checking and maintenance activities are insufficient. Probably because these STPs were comparatively new, there was almost no STP which

prepared plans for repair or reconstruction. The results of questionnaires and discussion related to operation and maintenance are summarized in Table 3-8.

On the other hand, out of the 6 STPs visited during the second field survey, 3 STPs maintained records of facility, equipment, checks of machinery, breakdown, etc., and also prepared plans for repair or reconstruction.

The results of questionnaires and discussion related to operation and maintenance carried out during second field survey are summarized in Table 3-9.

Table 3-8 Overview of Results of Questionnaire on the Operation and Maintenance of STPs (First Study)

STP No.	Sewage treatment process	Capacity MLD	Water quality analysis		Drawing out sludge		Inspection of facility and equipment	
			Influent	Effluent	Frequency	Measurement (amount, concentration)	Check records	Plans (Repair, etc.)
1	ASP	45.46	2	2	2	2	2	1
2	ASP, BIOFOR	181.84	2	2	1	1	2	1
3	ASP	204.57	2	2	2	1	2	1
4	R.N.D.P.	15	2	2	1	1	2	1
5	UASB +FPU	40	2	2	2	1	2	1
6	ASP	69	2	2	2	1	2	1
7	UASB +PP	70	2	2	2	1	2	1
8	UASB +PP	34	2	2	2	1	2	1
9	WSP	10	2	2	2	2	2	2
10	Marine Outfall	1,500	2	2	1	1	2	1
11	AL	300	2	2	2	1	2	1
12	SBR	100	4	4	4	1	4	1
13	TF, ASP	17	2	2	2	2	2	1
14	UASB	36	2	2	2	2	2	2

5 Excellent: Required management, inspections, records and repairs according to plan are fully performed.
4 Good: Required management, inspection, records and repairs according to plan are performed mostly.
3 Fair: Required minimum management, inspection, records and repairs according to plan are performed.
2 Poor: A part of required minimum management, inspection, records and according to plan are performed.
1 Very Poor : Required management, inspection, records and repairs according to plan are performed to very little extent.
ASP: Activated Sludge Process, R.N.D.P.: Recycled Nitrification Denitrification Process, UASB: Upflow Anaerobic Sludge Blanket, FPU: Final Polishing Unit, PP: Polishing Pond, WSP: Waste Stabilization Pond, AL: Aerated Lagoon, SBR: Sequencing Batch Reactor, TF: Trickling Filter

Table 3-9 Overview of Results of Questionnaire on the Operation and Maintenance of STPs (Second Study)

STP No.	Sewage treatment process	Capacity MLD	Water Analysis		Drawing out sludge		Inspection of facility and equipment	
			Influent	Effluent	Frequency	Measurement (amount, density)	Check records	Plans (Repair, etc.)
15	ASP	60	2	2	2	1	2	1
16	MBBR	29	2	2	1	1	2	1
17	ASP	75	4	4	2	2	2	1
18	MBR	1.5	4	4	3	1	4	3
19	ASP	54	2	3	3	1	3	4
20	ASP	40	4	4	1	1	4	3

5 Excellent: Required management, inspections, records and repairs according to plan are fully performed.
4 Good: Required management, inspection, records and repairs according to plan are performed mostly.
3 Fair: Required minimum management, inspection, records and repairs according to plan are performed.
2 Poor: A part of required minimum management, inspection, records and according to plan are performed.
1 Very Poor : Required management, inspection, records and repairs according to plan are performed to very little extent.
ASP: Activated Sludge Process, MBBR: Moving Bed Biofilm Reactor, MBR: Membrane Separation Bioreactor

3.2.5 Survey for Selection of Sewage Treatment Plant for Pilot Study

Even if the treatment system is the same, the water temperature, water quality, and inflow pattern of influent of STPs change significantly depending on the location of the STPs. If the water temperature, water quality, and inflow pattern of influent change, corresponding changes are required in the operating conditions for performing proper wastewater treatment control in the STPs. For this reason, it is desirable to include the operating conditions in "operation and maintenance manual", based on the results of the actual operation in the concerned country.

Activated sludge process of sewage treatment is widely used in the world. However, even for the same conventional activated sludge process, the operating conditions for performing proper wastewater treatment control of STPs vary with characteristics of the area where STPs is constructed.

Excluding sedimentation by gravity, the correct O&M conditions for biological treatment vary depending on the fluctuations in water temperature, water quality and flow rate of influent. Moreover, some treatment processes used in India are rarely used in other countries.

To write "Operation & Maintenance Manual," it is important to collect accurate O&M data of all treatment processes presently used in India.

It is clear from the results of first field visit that measurement of the material balance of TSS at STPs, which is important in operation and maintenance, is not being performed. For this reason, how to acquire relevant data to prepare the "operation and maintenance manual" was studied in case of STPs in India.

Due to time constraints, STPs that use the "activated sludge process" for which correct O&M conditions can be easily acquired, and also uses "mechanical dewatering process" which is unaffected by rain, were selected, and studies were carried out to select candidate STPs from which accurate O&M data could be acquired for further study.

Considering these points, attempts were made to acquire operation and maintenance data at STPs in India. During the second field survey, a study was made to select STPs at which the pilot test could be performed to acquire data related to material balance of TSS and BOD for operation and maintenance conditions required for preparation of the manual. For this pilot test, it was decided to select several STPs in India with the aim of collecting the required data in a period of about three months. Three cities recommended by the committee members and MOUD were selected as the target cities for this purpose. In these cities, six STPs which use ASP and have mechanical dehydration equipment were selected for visits. The locations and names of the STPs are listed in Table 3-4 above.

The results of the study were as follows:

(1) Study of 6 STPs in 3 cities was carried out. Results revealed that flowmeters are needed to be installed at 5 to 12 locations in the treatment plants studied.

(2) Equipment or staff-members in all the laboratories were inadequate to determine the material balance of SS and BOD.

(3) Sewage was being drawn out of septic tanks from households and mixed with the influent at the intake in two of the 6 STPs studied. Since the volume and concentration of this sewage from households are not known, independent sampling of influent is not possible, so material balance of SS and BOD cannot be obtained in these cases.

(4) Of the 6 STPs studied, one adopted the membrane bioreactor (MBR). When water is delivered to the reactor, the activated sludge overflows, returns to the pump well and mixes with the wastewater. For this reason, independent sampling of the sewage influent is not possible, and material balance of SS and BOD cannot be obtained.

(5) 2 of the 6 STPs studied make use of sludge drying beds for sludge treatment. Since the dewatering of sludge and the disposal amount are constrained by the rainy season, correct O&M all year round is difficult.

(6) One of the 6 STPs studied also receives influent from the Nala (open drain). It is not possible to study the flow and quality of water from this Nala.

From the results of the study, it can be concluded that to acquire detailed data on operation and maintenance necessary for preparing the "O&M Manual," enormous expenditure would be necessary for temporary improvements, and equipment would be needed to be brought over from Japan. However, it is very difficult to study all the treatment processes used presently in India. From the above, it is concluded that there are no advantages in implementing further studies to acquire O&M data.

The field survey result is shown in Table 3-10. Moreover, the result of the investigation conducted to judge the suitability of 6 STPs for carrying out pilot test implementation are shown in Table 3-11.

Table 3-10 Overview of the Status of Operation and Maintenance of STPs (Second Study)

STP No.	Sewage treatment process	Capacity MLD	Pre treatment process	Treatment process	Sludge treatment process	Electrical Facility	Instrum-entation Facility	Manage-ment of planned facilities	Water Quality of Effluent	TSS material balance
15	ASP	60	2	1	1	2	2	2	1	1
16	MBBR	29	2	1	1	2	2	2	1	1
17	ASP	75	3	3	2	4	3	3	3	1
18	MBR	1.5	3	4	3	4	4	4	4	2
19	ASP	54	3	3	3	3	3	2	3	1
20	ASP	40	1	1	1	2	2	2	1	1

5 Excellent: Required management and operating records are fully performed.
4 Good: Required management and operating records are performed in general.
3 Fair: Required minimum management and operating records are performed.
2 Poor: A part of required minimum management and operating records are performed.
1 Very Poor: Required management and operating records are performed to very little extent.
TSS: Total Suspended Solid, ASP: Activated Sludge Process, MBBR: Moving Bed Biofilm Reactor, MBR: Membrane Separation Bioreactor

Table 3-11 Result of Survey for a Pilot Study

STP No.	Sewage treatment process	Capacity MLD	Mechanical Sludge Dehydrator	Weighing of dehydrated sludge	Required number of flowmeter	Status of analysis Equipment
15	ASP	60	Not available	Not possible	12	Insufficient
16	MBBR	29	Not available	Not possible	6	Laboratory Not Available
17	ASP	75	Exist	Possible	10	Insufficient
18	MBR	1.5	Exist	Possible	5	Insufficient
19	ASP	54	Exist	Not confirmed	10	Insufficient
20	ASP	40	Exist	Not confirmed	9	Insufficient

ASP: Activated Sludge Process, MBBR: Moving Bed Biofilm Reactor, MBR: Membrane Separation Bioreactor

3.2.6 Survey of Pumping Station, Sewer and Others

To understand the condition of operation-and-maintenance of sewers and pumping stations, discussions were held on questionnaires during two field visits. The names of cities which were covered during first field survey are listed in Table 3-3 and the cities where questionnaires were discussed in second field survey are listed in Table 3-6.

For the purpose of making decisions on cleaning and repair of sewers, it is very important to carry out inspection of sewers and maintain records of results. The analysis of recorded results helps in deciding and setting priorities during cleaning activities.

Based on the result of the questionnaire discussion, it was found that only three cities conduct inspection and investigation of sewers and record the results. Also, the number of cities which prepare plans for cleaning sewers, and repair, etc., based on the result of inspection and investigation was observed to be three. Other cities did not carry out sewer inspection, or maintain records of inspection results and accordingly sewer cleaning works were not planned. The results of questionnaire discussion are summarized in Tables 3-12 and 3-13.

Table 3-12 Overview of Results of Questionnaire on the Operation and Maintenance of Sewer Networks (First Study)

Sewer Networks No	Inspection of Sewer networks	
	Check records	Plans (Cleaning, repair, etc.)
1	1	1
2	1	3
3	1	1
4	1	1
5	3	4
6	3	2
7	1	1
8	2	2
9	1	2

5 Excellent : All of required inspection results are recorded. Also cleaning and repairs according to plan are fully performed.
4 Good : Required inspection results are recorded mostly. Also cleaning and repairs according to plan are performed in general.
3 Fair : Required inspection results are recorded. Also cleaning and repairs according to plan are performed.
2 Poor : A part of required minimum inspection results are recorded. Also A part of cleaning and repairs according to plan are performed.
1 Very Poor : Required inspection results are not recorded and also cleaning and repairs according to plan are performed to very little extent.

Table 3-13 Overview of Results of Questionnaire on the Operation and Maintenance of Sewer Networks (Second Study)

Sewer Networks No	Inspection of Sewer networks	
	Check records	Plans (Cleaning, repair, etc.)
10	2	2
11	1	2
12	4	4

5 Excellent : All of required inspection results are recorded. Also cleaning and repairs according to plan are fully performed.
4 Good : Required inspection results are recorded mostly. Also cleaning and repairs according to plan are performed in general.
3 Fair : Required inspection results are recorded. Also cleaning and repairs according to plan are performed.
2 Poor : A part of required minimum inspection results are recorded. Also A part of cleaning and repairs according to plan are performed.
1 Very Poor : Required inspection results are not recorded and also cleaning and repairs according to plan are performed to very little extent.

For appropriate operation and maintenance of pumping stations, it is very important to carry out daily and periodical inspections of equipment and all related components. Plans for cleaning, repair, maintenance or replacement of facilities must be prepared based on the results and records of inspection. To grasp the status of operation and maintenance of pumping stations, the questionnaire was discussed with related agencies in nine cities during the first field survey and in three cities during the second field survey.

Based on the results of the questionnaires, it was observed that of the 12 cities, only 5 cities prepare plans for cleaning, repair and reconstruction in case of pumping station. These results of questionnaire discussion are summarized in Tables 3-14 and 3-15.

Table 3-14 Overview of Results of Questionnaire on the Operation and Maintenance of Pumping Stations (First Study)

Pumping Station No	Inspection of Sewer networks	
	Check records	Plans (Cleaning, repair, etc.)
1	1	1
2	2	1
3	1	1
4	2	1
5	5	3
6	3	1
7	2	1
8	3	2
9	2	3

5 Excellent : All of required inspection results are recorded. Also cleaning and repairs according to plan are fully performed.
4 Good : Required inspection results are recorded mostly. Also cleaning and repairs according to plan are performed in general.
3 Fair : Required inspection results are recorded. Also cleaning and repairs according to plan are performed.
2 Poor : A part of required minimum inspection results are recorded. Also A part

of cleaning and repairs according to plan are performed.
1 Very Poor : Required inspection results are not recorded and also cleaning and repairs according to plan are performed to very little extent.

Table 3-15 Overview of Results of Questionnaire on the Operation and Maintenance of Pumping Stations (Second Study)

Pumping Station No	Inspection of Sewer networks	
	Check records	Plans (Cleaning, repair, etc.)
10	3	3
11	4	3
12	4	5

5 Excellent : All of required inspection results are recorded. Also cleaning and repairs according to plan are fully performed.
4 Good : Required inspection results are recorded mostly. Also cleaning and repairs according to plan are performed in general.
3 Fair : Required inspection results are recorded. Also cleaning and repairs according to plan are performed.
2 Poor : A part of required minimum inspection results are recorded. Also A part of cleaning and repairs according to plan are performed.
1 Very Poor : Required inspection results are not recorded and also cleaning and repairs according to plan are performed to very little extent.

3.3 Problems Existing in Management of Sewerage System

3.3.1 Planning and Design

Through visiting treatment facilities, pumping stations and sewer locations and based on the discussion with the implementing agencies during the first and second field visits in India, the following issues are especially noted from the view of planning and design. These issues are more common.

(A) Sewage Treatment Facilities

Solid wastes flowing along with sewage into sewage treatment plants are separated using screens. If the mechanical screen fails or there is large space between bars of the screen, the solid waste is not fully separated from inflow. In that case, sewage treatment cannot be stabilized because the distribution function is impaired in the distribution tank, or the pipe is choked. Also, at some sewage treatment plants, the mechanical screen has failed a few years after its installation due to corrosion by hydrogen sulphide. Therefore, it is necessary to pay attention to adopt appropriate mechanisms for screen facilities and use corrosion-resistant material.

If there is large fluctuation in flow rate, satisfactory treatment is not possible. Balancing tank for smoothing the flow rate fluctuation is one measure, but very few of the treatment plants have installed such tanks. Thus, it may be necessary to consider the installation of equalization tanks or balancing tanks with the ability to equalize the time variation of sewage flow.

Sewerage networks in many cases are combined system and sometimes flow from drains (Nala) also enters sewers. Therefore, it is difficult to estimate the amount of groundwater contribution to sewage flow.

There are some sewage treatment plants using aerobic treatment in which the power supply

is disrupted for several hours a day. The effluent quality of these STPs is not expected to be good. It is necessary to consider the selection of wastewater treatment systems considering the future trends of power supply.

In the process of sludge treatment, the dried sludge is transported out of the STP during the dry season. Vehicles are used for transportation of dewatered sludge currently. These vehicles are not sealed or covered, and they may give off foul odor or there may be leakage of sludge from the vehicle to the surroundings in the rainy season. As a countermeasure, it is necessary to consider provision of adequate and appropriate space for long term storage of dewatered sludge in the rainy season. Also, attention is to be drawn to the use of enclosed vehicles for transportation of dewatered sludge. Some of the wastewater treatment plants have introduced dewatering facilities. This is probably because of the difficulty in land acquisition required for large sludge drying beds.

There are many STPs that record operation data using a logbook with a few exceptions. Installation of instrumentation equipment and reliable records should be necessary for appropriate operation.

In several STPs, the amount of influent water is represented by the instantaneous value but it should be an accurately accumulated value for the day.

The installation of measuring equipment is indispensable for flow measurements in O&M, but flowmeters have not been installed at the required locations. Moreover, many plants have flowmeters that are not working. Therefore, it is important to raise the awareness of the need for measuring instruments, and carry out installation of flowmeters, and allocate budget for repairs.

(B) Sewer pipes

(i) In many cases, inflow of sewage into treatment plants is less than the designed capacity in areas covered by sewerage networks. The causes are as follows:

- The percentage of connections to sewer pipes from apartment buildings and households is low.
- Solid matter, sand, etc., accumulate in the pipes, and as a result, adequate sectional area flow cannot be obtained, and the design flow rate is not satisfied. There were also instances where sewage from sewers was discharged into storm water drains using pumps at the sewer manhole.

The remedies could be:

- To study the percentage of households connected to installed sewers, and raise public awareness through explanations and advertisements. To provide branch sewers in areas where sewer pipes have not been laid and adopt measures to increase connections.
- To clean the sewer pipes periodically
- To ensure flow rate that does not allow solids, grit, etc., to accumulate, set appropriate gradient of sewer pipe, install relay pumping station at the correct locations. Even if the correct pipe diameter has been determined at the planning and design stage, sometimes, the volume of sewage generated may be more than the volume anticipated initially, and in such cases additional sewer pipes may be laid or existing pipes may be replaced by larger diameter pipes. Considerations for development in future anticipating land use are necessary for planning and design with adequate margin in capacity.

(ii) Even in areas with separate systems where transmission and collection systems

have not been provided, the wastewater was found to be discharged into Nalas. For such cases, it is recommended that interceptor be used.

(iii) No covers were provided on open drains in many cases. It is preferable to install covers considering sanitation and improved living environment.

(iv) Sewers are cleaned only when complaints are received from residents. Scheduled sewer cleaning is required to be implemented, and the required equipment and materials should be adequate. For instance, area should be divided into zones, and lines in which sedimentation occurs repeatedly should be cleaned on priority. Pipe cleaning is generally performed by using bucket machines for removing silt and sediment in manholes and by high pressure cleaning, but the efficiency and performance are unsatisfactory. More efficient cleaning methods considering pipe diameter and vacuum type machine for de-silting should be introduced for cleaning sewers.

(C) Pumping stations

Mechanical screens, conveyor, flowmeter, etc., in pumping stations or influent sewers at treatment plants, have become corroded and are not working within 4 to 5 years after start of operation.

Corrosion occurs in the influent sewers of the pumping station and treatment plant due to development of anaerobic environment and emission of hydrogen sulphide within pipe.

To avoid anaerobic environment in the pipe, basically, the pipe should be cleaned at appropriate frequency in a scheduled manner. Material highly resistant to corrosion should be used in mechanical screens and other appurtenances. If necessary, measures against formation of hydrogen sulphide should be adopted such as installation of equipment for introducing air or oxygen at the relay pumping station or dosing chemicals.

(D) Management

A counter for redressal of grievances of customers is established in Chennai. At the customer services counter, pamphlets are distributed for raising the awareness on sewer connections.

Acquisition of sites for sewerage facilities is difficult because of acquisition costs and opposition by residents to construction of new treatment plants in their area considering foul odor and changes in surrounding environment.

Currently, although there are environmental impact assessment notifications, these are not yet applicable to sewerage facilities. In some cases, environmental impact assessment (EIA) is implemented at the planning stages of the sewerage project. To promote sustainable development and to avoid or minimize the occurrence of negative impacts of sewerage projects on environment and local communities, it is important to pay attention to environmental and social considerations at planning stage of the projects.

The O&M of treatment plants, pumping stations, and sewers, is generally outsourced. Sometimes, the capability of the outsourced O&M subcontractor is inadequate. Therefore, upgrading the ability of the O&M subcontractor is necessary.

During monsoon, cutting of roads is prohibited, and considerable time is required for laying sewer pipes. At a manhole installation site, open cut of less than 2 m was made, but there was no earth-retaining wall. Standard work methods should be suggested according to the depth of the excavation.

The top part of the manhole was buried below the paved road surface. Excavation during cleaning, and restoration after excavation is being performed, but this work is inefficient,

and sometimes results in hindrance to traffic. Sometimes steel manhole covers are being stolen, and in some places, such manhole covers are being replaced by concrete covers. Re-construction of manholes should be done in coordination with the Road Department to be in level with the roads.

3.3.2 Operation and Maintenance

The present "Manual on Sewerage and Sewage Treatment" (Second Edition) has little description related to the operation and maintenance of sewerage facilities (Chapter 8 Maintenance of Sewerage Systems, and Chapter 23 Treatment Plant Operation and Maintenance). In these Chapters, basic description about the operation and maintenance of sewers and treatment facilities is given. In last three decades, the sewerage networks have extended widely in many cities/towns. Also, facilities that were constructed in the initial years have become old.

Methods of judging inspections of the installed sewer, inspection, and storage and utilization of results of sewer inspection must be described in detail. Moreover, cleaning of sewer, the method of dredging, and disposal of earth, sand and sludge that are dredged while cleaning are also to be described in detail. In the new manual, the type and structure of the equipment at pumping station will be given, and details of operation and management of pumping facilities will be described. It is also necessary to describe the removal and disposal of solid waste separated from inflow at the screens installed at the pumping station.

Related to the operation and maintenance of the sewage treatment facility, only basic information is provided in the existing Manual concerning screen, grit chamber, sedimentation tank, aeration tank, trickling filter, sludge digestion tank, sludge drying bed, and stabilization pond. It is necessary to fully describe the operation and maintenance of the reactor or the sedimentation tank, about the activated sludge process, and other treatment processes. Under the activated sludge process, the conventional activated sludge process, extended aeration process, high-rate activated sludge process, and sequencing batch reactor, oxidation ditch process, membrane bioreactor, etc. need to be described. Moreover, the operation and maintenance of disinfection facility and advanced wastewater treatment facility should also be described.

It is necessary to describe the operation management, inspection, and investigation of facilities related to sludge thickening, aerobic digestion, and anaerobic digestion under the management of STPs. Moreover, the description about sludge dewatering equipment, the operation and management of sludge drying bed, the measures to be undertaken at the time of abnormalities, etc. will also be included.

On the whole, through discussion with staff-members related to O&M of sewerage facilities, the following problems were observed to exist:

- Lack of skilled manpower
- Lack of budget in some cases
- Power supply interruption
- Lack of training for human resource development
- Absence of detailed instructions and explanation on O&M in the Manual and no description on O&M of new processes

3.3.3 Onsite Management

The so-called combined treatment facility in India was installed by NGO at a colony for mentally-challenged persons. Here, grey water and black water are being treated

anaerobically and aerobically, and the biogas generated in the anaerobic tank is used for cooking. The treated water was satisfactory. O&M was easy, and no expenses were incurred except electric charges for running the pump for re-use of recycled water. Moreover, the treated water was used for watering the garden, and the sludge was used as compost. According to the NGO representative, about 400 similar plants have been installed in India.

In a standard household of 5-6 persons outside the covered area, the night soil is made to flow into a septic tank of 8 m^3, while grey water is made to flow into a separate tank. The sludge in each of these tanks is disposed at a frequency of 1 to 6 months by a private party (2 persons, tanker). The cost for each of these tasks was reported as 1000 rupees and 500 rupees respectively.

In areas outside the sewer coverage area, septic tank and grey water drain piping system are provided for apartment buildings, etc., but grey water is being discharged into lakes, which is a source of fresh water, and concerns about pollution in such areas have been reported.

Low-cost and easy-to-maintain combined system for treatment of both grey water and wastewater should be made mandatory, and a sludge treatment and disposal system should be constructed.

3.3.4 Summary

Based upon the results of the observations at visited sewage treatment plants and collection system, and discussions with personnel concerned, main issues related to planning and design, operation and maintenance, management of sewerage system and related policy for formulation of respective manuals are categorized in Tables 3-16, 3-17 and 3-18, respectively.

Table 3-16 Issues Related to Planning and Design of Sewerage System and Revision policy of Manual on Sewerage and Sewage Treatment

Categories	Status or Main Issues	Main Revision Policy of Manual on Sewerage and Sewage Treatment
Master Plan	– In collecting basic data and information, full cooperation from local bodies or state agencies was not provided in some cases. – Population projections, estimation of wastewater flow, and calculation of pollution load (the amount of waste water per capita and the amount of industrial wastewater) are difficult. – In 30-year planning period, there are some gaps between actual population projections or urban development and the basic plan of the town. – Population projections in sewer planning areas are very difficult due to limitless population influx to towns from rural areas and unplanned town development. – Inflow of rainwater to the separate sewerage system – Areas for Treatment plants and pump stations are not planned and allocated at the stage of urban planning.	– Roles of the central government, state government, local bodies – Considerations on survey methods and data collection – Sewage volume, pollution load, and useful reference to be included – Estimation method of population projections, planned sewage volume, planned pollution load, and considerations – Review of master plan – Criteria for sewage treatment plant or pumping station location
Sewer	– Inappropriate use of geological survey results for designing – Types and materials of sewer pipe (PVC, polyethylene, etc.) – Grasping the proper amount of sewage is difficult, consequently, sediment and silt	– Considerations on the design using geological survey results – The type of pipe material (selection considering life cycle costs) and the minimum diameter considerations – Sewer design conditions, hydraulics (design

Categories	Status or Main Issues	Main Revision Policy of Manual on Sewerage and Sewage Treatment
	deposit inside the over-designed sewer. – Margin of sewers are uniform regardless of pipe diameter – Review of pipe roughness coefficient by type of pipe – Maintenance-friendly pipe slope – Design of a new pipeline network – Inflow of sewage from commercial establishments or industries which exceed the criteria, corrosion of sewer due to hydrogen sulphide – Adoption of new materials of sewer bedding instead of concrete – The method of pipe joining where pipe diameter changes – Adoption of manhole materials such as PVC which are easy to construct, or to clean – Some manhole covers are buried below the road surface. – Construction of sewers under highways or across rivers and channels – Construction of sewers in undulating areas, narrow roads, and varying soil formations – Construction of sewers along the old town road where water pipes and pipes of electric wire or telecommunication wire pipe are laying complexly under the ground – Limitations of sewer construction in the rainy season – Lack of new information about the planning and design of the pipeline	flow rate, review of sewer margin, calculation of flow rate, velocity and slope, depth of burial, the computer analysis) – Protection of sewers (prevention of corrosion, bedding) – Method of joining sewers – Considerations on the types of manhole and construction methods (Collaboration with the road department) – Pretreatment facility of commercial establishments – Cross drainage works (pumped transmission) – Construction methods (trenchless methods such as small diameter pipe jacking method) – Rehabilitation of sewers and auxiliary facilities, renewal methods, reconstruction
Pumping Station	– Corrosion and breakdown of screens, conveyors, flow meters, etc. and bad odor due to hydrogen sulphide – Frequent failure of main pumps caused by inflow of solid wastes and breakdown of submerged pumps caused by inflow of industrial wastewater – Power supply is not constant – Information on new types of pumps and other facilities is scarce.	– Corrosion prevention and control (principle of corrosion mechanism due to hydrogen sulphide, material selection of screen and other auxiliary facilities, air or chemical dosing) – Description of new types of screens – Selection of pump types and considerations – Measures for power failure / power generator – Additional information on screens, pumps, electrical instrumentation facilities (energy saving, high efficiency, advantages, disadvantages, etc.) – Reconstruction and rehabilitation of pumping stations
Sewage Treatment Plant	– Lack of land for treatment plant – Corrosion and breakdown of screens, conveyors, flow meters, etc. and bad odor due to hydrogen sulfide – Failure of facilities and choking of pipes caused by inflow of solid wastes, water treatment performance degradation due to uneven flow – Measures for big temporal fluctuation of inflow volume – Performance may be lower in the treatment plants that employ the aerobic treatment process in areas where power failure occur frequently for many hours. – If the anaerobic treatment method is used, performance may be lower in some cases.	– Corrosion prevention and control (principle of corrosion mechanism due to hydrogen sulphide, material selection of screen and other auxiliary facilities), selection of the appropriate screens – The need for flow equalization tank – New sewage treatment method (SBR, FBR, MBBR, MBR, etc.) and fundamental principles – Selection of treatment methods and criteria(discharge standard,, power situation, easy maintenance, land constraints, life cycle cost) – New sludge treatment methods – Selection of sludge treatment and criteria (power situation, efficiency, easy

Categories	Status or Main Issues	Main Revision Policy of Manual on Sewerage and Sewage Treatment
	– Selection of treatment method maintained with ease – For land-constrained cities, it is necessary to adopt mechanical dewatering facilities instead of sludge drying bed which needs a vast land. – Sludge carrying out from STP is limited in the rainy season. – Roof material deterioration of sludge digestion tank – Detailed description of low-cost sludge treatment methods – Sludge disposal is the main problem especially for the cities that lacks appropriate landfill sites. – Information on new sewage treatment methods, sludge treatment methods, measurement equipments, and other facilities is scarce. – Lack of detailed description of the test facility with minimal requirements	maintenance, land constraints, life cycle cost) – Effective use of sludge (materials for reclamation) – Dewatered sludge storage facility – Need for and type of measuring devices such as flow meter – Measures for energy saving in sewage treatment and sludge treatment – Considerations for surrounding environment – Reconstruction and rehabilitation of treatment plant – Facility for water quality analysis
Reuse of treated water and sludge	– Some sewerage sectors are finding out potential buyers of treated water for industrial use or for landscaping, etc – Less demand for sludge – No standards of treated water reuse in cities other than drinking purposes – No description of energy recovery from sludge – No guidelines for tertiary treatment methods with relation to the use of treated water – Standards for reuse of treated water and sludge are needed in accordance with reuse or disposal pattern. – Less information on the new technologies on reuse of treated water and sludge	– Research and considerations regarding the reuse of treated water, sludge and biogas – Detailed description of reuse of treated water and effective use of sludge – Description of the standard for reuse of treated water to cities other than drinking purposes – Recovery of bio-methane and energy – Description of tertiary treatment technologies – Detailed description of sewage and sludge recycling technologies
Onsite System	– Lack of information on new Onsite System	– Description of new onsite technologies
Others		– Examples of design calculations on new sewage treatment and sludge treatment technologies – Information sources useful for planning and design

Table 3-17 Issues related to Operation and Maintenance of Sewerage System and Formulation policy of Manual on Operation and Maintenance of Sewerage System

Categories	Status or Main Issues	Main Formulation Policy of Manual on O&M of Sewerage System
General	– There is very few description on operation and maintenance in the existing manual. – Untreated industrial wastewater is discharged into sewers.	– Laws and regulations regarding operation and maintenance, purpose, importance, outline, and organization of operation and maintenance, disaster management, need for preparation of sewerage ledger – Industrial wastewater monitoring – Standard organization of operation and maintenance (according to treatment capacity, treatment method, etc.)

Categories	Status or Main Issues	Main Formulation Policy of Manual on O&M of Sewerage System
Sewer	– Description of O&M of sewers is scarce in the existing manual. – Little records of inspection and examination – Planning of sewer cleaning or sewer repair based on the results of inspection and examination is scarce. – Lack of pipe cleaning machineries and equipments – Choking of sewer	– General O&M of sewers and auxiliary components – Inspection, examination – Method of judging inspection and examination results – Method of cleaning and dredging – Pipe cleaning machineries, maintenance equipments – Disposal of dredged sediment and sludge – Repairs, safety practices, trouble shooting
Pumping Station	– For the O&M of pumping station, only few descriptions of pumps and electrical equipments are made in the existing manual. – Little records of inspection and examination – Few plans of cleaning or reconstruction – Failure of pumps, corrosion and deterioration of machineries and equipments – In many pumping stations, flow meters are not installed or out of order which is required to collect valuable data on operation and maintenance.	– General O&M of pumping station facilities and auxiliaries – Preventive maintenance (method of judging inspection and examination results) – Types and structure of pumping station – Operation and maintenance of pumping station – Treatment and disposal of screen debris – Maintenance of flow meters – Repairs, safety practices, trouble shooting
Sewage Treatment Plant	– There are very few description about the operation and maintenance of sewage treatment facilities in the existing manual. – In many STPs, flow meters, DO meters, pH meters, etc. are not installed or out of order which are required to collect valuable data on operation and maintenance. Repair of these equipments are not carried out when they break. – Operation control index such as MLSS, RSSS and MLVSS, which are important for operation and water quality control, are not analyzed. – Mostly, volume and concentration of sludge withdrawn from sewage treatment facilities are not measured. – Records of inspection or failure of facilities, equipments and devices are hardly maintained, actually, maintenance and inspections are not practiced adequately.	– General O&M of treatment plant facilities and auxiliaries – Preventive maintenance (method of judging inspection and examination results) – O&M of primary treatment facility – Operation, inspection and maintenance of activated sludge process (reaction tanks and sedimentation tanks of conventional activated sludge process or extended aeration process) – Operation, inspection and maintenance of new treatment technology processes (reaction tanks of high rate activated sludge process, sequential batch reactor, oxidation ditch process and membrane bioreactor) – Operation and maintenance of disinfection facilities and advanced treatment facilities – Operation, inspection and maintenance of sludge treatment facilities (sludge thickening, aerobic digestion, anaerobic digestion, dewatering equipments. and sludge drying bed) – Beautification of site – Water quality analysis – Measures for abnormality – Planning for rehabilitation and reconstruction – Energy conservation, environmental protection, disaster recovery
Onsite System	– Lack of information on O&M of new Onsite System	– Operation and maintenance related to new Onsite System

Table 3-18 Main Issues related to Management of Sewerage System and Formulation policy of Manual on Management of Sewerage System

Categories	Status or Main Issues	Main Formulation policy of Manual on Management of Sewerage System
Legal Aspect	– In collecting basic data and information, full cooperation from local bodies or state agencies does not be provided in some cases – Delay in tender of data to planning and design contractors – Occurrence of inefficiency due to delay of payment to contractors	– Roles of central government, state governments, and local bodies – Legal Compliance
Financial Aspect	– In many cases, operation and maintenance funds will be often provided as grants from state governments and local bodies – External costs of urban development and costs of land collected by local bodies are allocated for operation and maintenance – Taxes and sewage fees collected – Delay of land acquisition for STPs and pumping stations – Lack of O & M budget allocation	– Budgets – Funding – Financial management (taxation, sewage fees, billing systems, etc.) – Public private partnerships
Human Development	– Lack of skilled workers (including contractors) in planning, design, and operation and maintenance – Unable to attend training due to lack of maintenance staffs – No training system – Lack of state-level training plan – Less competent maintenance contractors	– Needs of human resource development and training – Training methods, training content – Technical training, leadership training – Short-term training, long-term training – Training Programme – Training Institutions
Community Participation	– Public sometimes oppose the construction of treatment plant and pumping station in nearby sites. – Pamphlets for pipe connection are distributed in some cases	– Public participation in planning – Publicity to residents
Asset Management	– Asset Management is not practiced adequately	– Basic concepts and needs of asset management – Asset management methods for STPs, pumping stations, sewer systems
Information Management	– Rapid response to complaints – Management and use of information	– Needs for management information systems(MIS) – Organization structure, management indicators and its use, computerized MIS, marketing management

CHAPTER 4 NEW TECHNOLOGY

4.1 Introduction

Sewerage facilities have a vital role to play in ensuring a hygienic and comfortable life by improving the living environment and preserving a satisfactory water environment through appropriate treatment of sewage and rain water.

However, large amount of energy and enormous resources are necessary for the construction, operation and maintenance of sewerage systems that contribute to preserving such a comfortable living environment and satisfactory water environment. Moreover, environmental loads are also imposed, such as generation of greenhouse gases.

India too needs to take steps to prevent global warming, achieve sustainable development and build up a recycling-oriented society. This necessitates energy and resource conservation within the sewerage system itself, which in turn requires the introduction of new technologies.

Considering the increase in sewerage systems in India and the present status, technology is needed to spread sewerage systems efficiently and effectively across the country. Introduction of technologies that facilitate use of facilities at economic construction cost and O&M cost is demanded. Furthermore, introduction of technology for recycling treated effluent as a measure against deficient water resources, effective utilization of sludge and energy recovering technology for building up a recycling-based society, space-saving technology in urban areas with limitations related to available land area for sewerage facilities, and introduction of other technologies are also necessary.

In this Chapter, new technologies that meet the stated objectives and their overview are described under the following three fields:

1) Management of sewerage system
2) Sewerage facilities
3) Operation and maintenance of sewerage facilities

Considering the sewerage facilities under abovementioned three fields, application of new technologies are needed in India to achieve the following advantages. For each advantages, some names of new technology are listed which are described briefly hereinafter.

- ✓ Reduce construction cost, and operation and maintenance cost

  New technologies which reduce construction cost (including land acquisition cost) and O&M cost are needed to be used in sewerage systems across the country in India. Some new technologies which reduce construction cost and O&M cost are listed below.

  e.g., Shield tunnelling method, Pipe jacking method, New SPR system, etc.

- ✓ Improve treatment functions

  During the site visit, in some of the STPs in India, it was observed that inefficient sewerage facilities, equipments and apparatus are the causes of poor performance of facilities, and also their durability was not so good as to exercise their function for a long time. From this viewpoint, efficient and durable sewerage facilities, equipments and apparatus are to be adopted to improve treatment functions in future. Application of these facilities, equipment

and apparatus will result in reduction of O&M cost.

e.g., CFV pump, SPV pump, KKD pump, Fine bubble diffuser, Oxidation ditch, DHS, MBR, SBR, Fibre media rapid filtration, Carrier-added activated sludge system, Egg type digestion tank, Layered multi-disc screw press, etc.

- ✓ Improve operation and maintenance capability

  The availability of trained and skilful staff for the O&M of sewerage facilities is scarce in India, hence, it is necessary that sewerage facilities be operated and maintained as easily as possible. New technologies which enable easy operation and maintenance of sewerage facilities are listed below.

  e.g., Submerged level detector, Sludge density meter (dual scattered-light), Optical dissolved oxygen meter, Monitoring system for small region, Corrosion control measures, etc.

- ✓ Re-use treated effluent

  Considering the rapid increase in population and accelerated development of country, water resources are running short, and treated sewage effluent need to be reused as valuable water resources in urban areas in India. Some new technologies that facilitate the reuse of treated sewage effluent are listed below.

  e.g., Ceramic membrane filtration system, BIOPAC system, etc.

- ✓ Effectively use sludge

  In the existing condition, at many sewage treatment plants in India, sludge treatment and disposal is not practiced adequately. From the viewpoint of effective resource utilization, sludge could be utilized as soil conditioner, fertilizer, fuel, etc. The application of some new technologies that enable utilization of sludge are listed below.

  e.g., Sludge drying system, Sludge carbonization system, BITREC system, Value composting system, etc.

- ✓ Recover resources and energy

  Sewage treatment plants are reservoirs of resources and energy in the form of biogas and biomass. By recovering resources and energy from treatment process and reusing them, the O&M cost could be reduced because energy cost is one of the largest components of O&M costs of STPs. However, many STPs in India have not begun to put in serious effort to recover resources and energy. Some new technologies to recover resources and energy are listed below.

  e.g., Compact size digestion gas engine generator, Micro gas turbine co-generating system, Micro hydropower generating equipment, etc.

These technologies are being described here for explanation purposes. However, inclusion of any of these items, and other new technologies not described here, in the Manuals will depend on discussion with the Expert Committee for Revision of Manual on Sewerage and Sewage Treatment, the Expert Committee for Preparation of Manual on Operation and Maintenance of Sewerage System, and the Working Groups in next Phase of the Project. New technologies picked up here contain the present technologies which adopt new control or instrumentation technology, and which are not commonly practiced in India at present but are effective to construct, operate and maintain sewerage system efficiently.

4.2 Management

Sewerage system is an essential part of urban infrastructure and needs to be carefully planned, designed, constructed, operated and maintained in a rational, sustainable and scientifically based manner. Poor management may cause negative impact on sewerage systems in terms of lack of well-defined objectives, inappropriate planning, insufficient budget for establishment and operation and maintenance, lack of sustainability, etc., and all these finally lead to poor services for the residents and poor living environment in urban and rural areas.

The level of sewerage services is changing with needs and accordingly, the management system is also required to be modified. Several new technologies are being introduced in many parts of the world to improve the performance of management agencies responsible for providing sewerage services in urban and rural sectors.

The establishment of efficient management system is essential to enable managers/engineers to measure results in terms of performance indicators, take corrective actions, formulate new indicators, and distribute new resources.

Management information system is one of the tools that support the managers at various levels in decision making.

4.2.1 Management Information System

A management information system (MIS) is a set of procedures that collects data, compiles and processes collected information, stores, and provides information in various forms (reports, online access) to manage system effectively. To handle huge set of database and to make available accurate and relevant information to decision makers at all levels of organization, in recent practices, computer-based MIS are generally applied. It primarily serves the functions of planning, controlling and decision making at the management level in order to achieve objectives of the organization (in this case to provide appropriate sewerage services and to preserve land and water environment). It is important to design MIS to help management to make decisions/take corrective actions and also to understand overall position of the sewerage system at any time.

The application of MIS in sewerage sector includes the following fields:

- project management (planning, design, and establishment)
- financial management (establishment and operation)
- human resources management (planning, recruitment, and training)
- material management (inventory and purchase)
- operation and maintenance management, and
- customer relationship management.

As an example, the main content of the MIS for operation and maintenance of facilities could include:

- Database format for activities of operation and management of sewerage system, including inflow quantity and quality, effluent quality, pumping station operation, treatment facilities operation, sewer cleaning and maintenance, amount of sludge generated and mode of disposal, etc.

- Check list for regular and reactive maintenance of facilities
- Database format for laboratory activities
- Database for customers, tariff collection, income and expenses, balance sheet, etc. to carry out financial management smoothly

Application of geographic information system and supervisory control and data acquisition systems could be incorporated for effective and efficient planning and management of sewerage system. A brief introduction on these applications is described below.

(A) Geographic Information Systems for Sewerage Management

Geographical Information System (GIS) is an excellent tool for supporting Management Information Systems and making spatial decisions depending on the datasets/projects requirements.

GIS applications that are of particular importance to sewerage sector professionals are:

- Mapping
- Monitoring
- Modelling, and
- Maintenance.

GIS technology integrates common database operations such as query and statistical analysis with the unique visualization and geographic analysis benefits offered by maps. These abilities distinguish GIS from other information systems and make it valuable to a wide range of public and private enterprises for explaining events, predicting outcomes, and planning strategies.

Following are the advantages of GIS applications:

- Saves time and money for performing routine works, such as keeping records of maintenance work or customer complaints more efficiently, and making more informed decisions.
- Helps utility to analyze the spatial information about customers and assets to improve planning, management, operation, and maintenance of facilities.
- Provides integrated solutions in the areas of planning and engineering, operation and maintenance, and even finance and administration.
- Provides uniformity of data usage and the flexibility to test and evaluate multiple scenarios.
- Provides effective communication tools for better communication and cooperation among various stakeholders through use of maps (Figure 4-1).
- GIS can be used to develop hydrologic and hydraulic computer models for sewerage system.

Figure 4-1 Example of Map showing Sewerage Network

Tokyo Bureau of Sewerage introduced GIS for sewerage management in 1985 in the form of SEMIS (Sewerage Mapping and Information System) to deal with massive numbers of drawings accumulating from its growing sewerage infrastructure. In April 2009, the Bureau introduced TAIMS (Tokyo Advanced Information Management System) based on SEMIS, that allows access of all sewer information to related agencies.

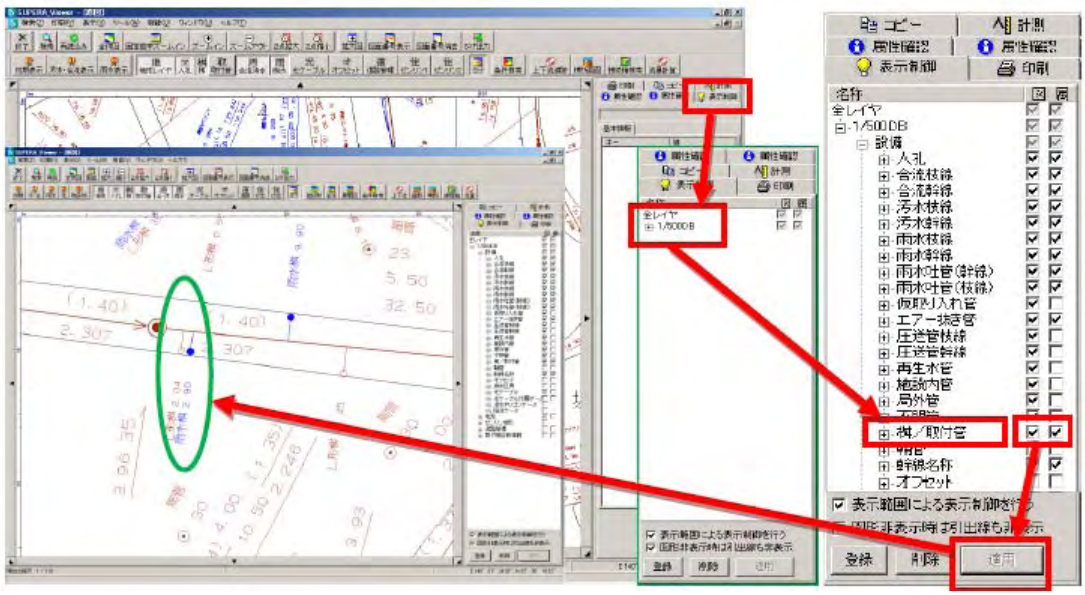

Figure 4-2 View of SEMIS Functions

(B) Supervisory Control and Data Acquisition in Sewerage

Presently, the control and monitoring of operational activities at existing sewage treatment plants and pumping stations is carried out manually in most of the cases. Gradually, with the expansion of the urban areas, the sewerage networks are becoming extensive and delayed control and monitoring could cause problems such as wastewater overflow from manholes, shock load, etc.

Supervisory Control and Data Acquisition (SCADA) is a useful component in sewerage schemes, providing operators with timely and sufficient information as well as remote control capability for operating the entire scheme in a safe, secure and economic manner. Therefore, possibility of application of SCADA for monitoring and operation of sewerage services should be given due attention in near future. Through the application of SCADA, it will be possible to monitor the flow conditions in the network in an automatic fashion. Also, any breakdown in the network can be readily identified, evaluated and rectified. This will also assist the operation and maintenance agency to determine the most appropriate response to unusual operating conditions. SCADA system consists of:

- Remote terminal units (RTUs)
- Communications (telemetry transmission)
- A master station or main control centre

In few of the new STPs, the application of SCADA was observed for control and data acquisition. In future, for proper management of sewerage system, application of SCADA needs to be considered.

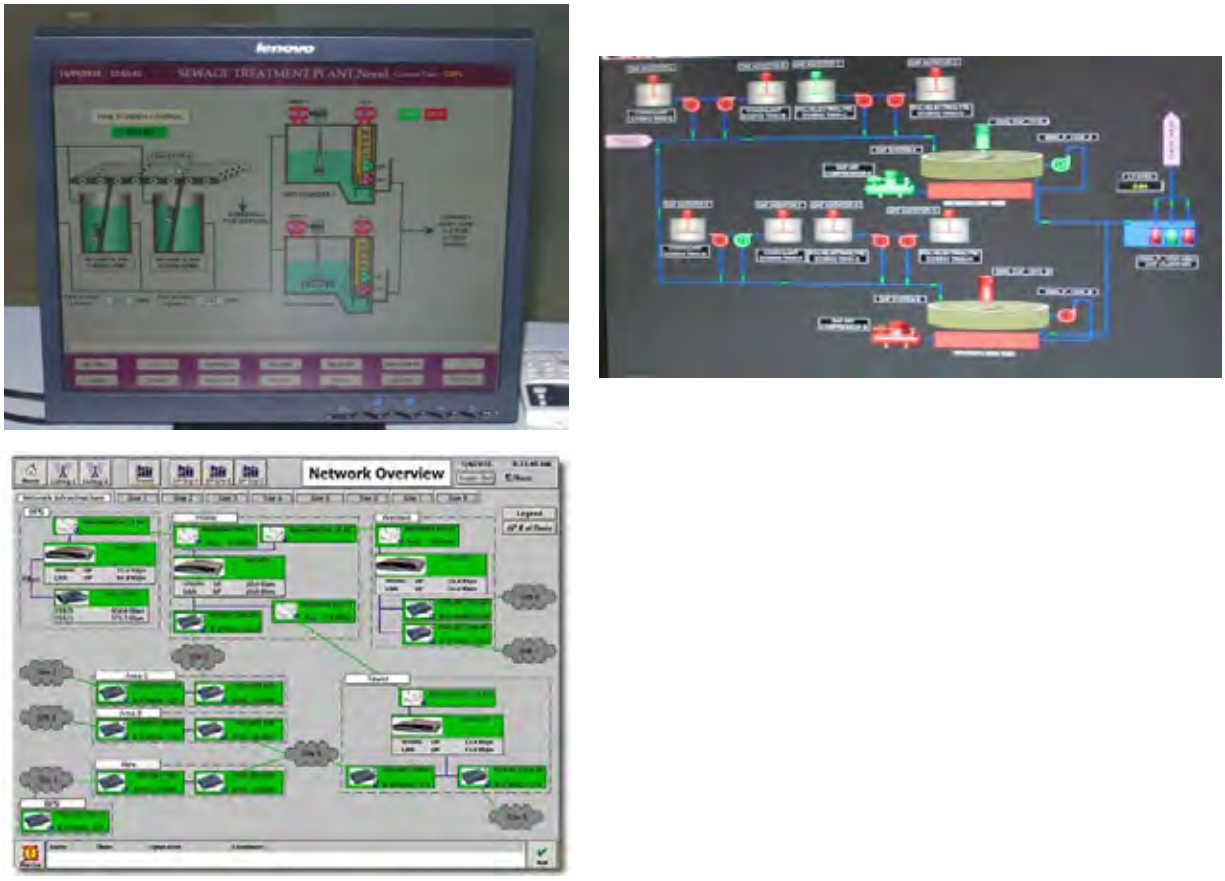

Figure 4-3 Photograph showing Application of SCADA

4.2.2 Asset Management and Preventive Maintenance

Asset management is defined as managing infrastructure capital assets to minimize the total cost of owning and operating them while providing satisfactory level of services to customers.

Asset management system is typically composed of following components:

- *Facilities inventory*: describes each system element in an asset group
- *Condition assessment*: categorizes each asset according to its capability to perform the intended function
- *Valuation*: assigns a financial value to inventory assets
- *Operation, maintenance, repair, and replacement management:* tracks and records data about work orders and customer complaints, issues and tracks preventive and predictive maintenance schedules, and generates crew assignments and work-site maps
- *Analysis and evaluation:* prioritizes work effort, analyzes cost-effectiveness, and optimizes asset performance.

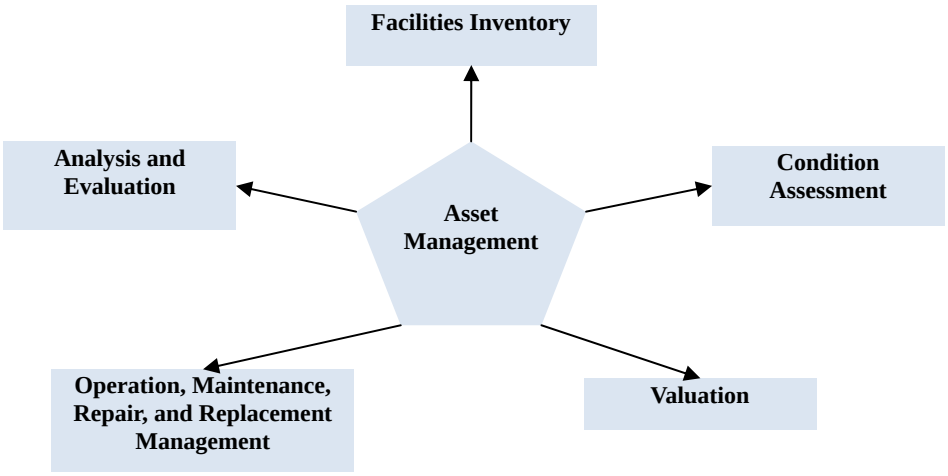

Figure 4-4 Components of Asset Management

An asset management system helps predicting the future condition of assets and major rehabilitation costs for planning purposes. An effective asset management system can reduce the cost of system operation and maintenance. Some examples of sewerage asset management tools include CARE-S (Computer-Aided Rehabilitation of Sewer Networks) and Hydroplan (Belgium).

4.3 Facilities

For the technical classification into the 11 sewerage facilities listed below, an overview of the new technologies for each facility is described hereafter. For details, please refer to Appendix A4-1.

a. Pumping facility

b. Wastewater treatment facility

c. Advanced treatment facility

d. Disinfection facility

e. Facility for re-use of treated effluent

f. Sludge treatment facility

g. Facility for effective reuse of sludge

h. Electrical machinery

i. Sewer pipe laying methods

j. Sewer repair methods

k. Corrosion protection of sewerage facilities.

4.3.1 Pumps

Many types of pumps are used in a sewerage system, but a pump that does not clog because of foreign matter, has good durability and corrosion resistance, is easy to operate and maintain, and which is compact is demanded.

(A) CFV Vertical Volute Casing Pump

This pump is a vertical shaft volute casing pump. Compared to a centrifugal pump, the number of blades of the impeller is smaller, so the clogging by foreign matter is less frequent. Compared to the vertical mixed flow pump, the corrosion is less, and operation and maintenance are easier. The space required for installation is also compact.

(B) SPV Vertical Mixed-Flow Pump

This is a vertical mixed flow pump. Its main feature is that the variation in discharge rate is small corresponding to the variation in lift. The material of each part of this product can be selected according to the objectives of the application.

(C) KKD Pump

This is a vertical shaft mixed flow pump. By speeding up the flow velocity within the pump, the weight of the pump and the mass of water contained in the pump can be reduced. By increasing the speed of rotation, the discharge rate can be increased although the pump is small. Thus, lighter weight, higher speed, and larger capacity can be achieved through newer technology.

4.3.2 Sewage Treatment Facilities

(A) Grinder

This product can effectively grind solid matter in sewage, thereby preventing clogging of sewer pipes and damage to the facilities. It also enables operation and maintenance cost and human resources to be reduced.

(B) Diffuser, Aerator

Fine bubble diffusers and high-density installation type air diffusers used in carrier-added activated sludge systems have been developed as new technological products for efficient operation of diffusers used in a biological treatment facility. Moreover, efficient submerged aerators and agitators have also been developed.

(C) Oxidation ditch (OD)

The oxidation ditch system has a reactor, which is an elliptical or circular shaped channel with mechanical aeration devices. Generally, no primary sedimentation tank is installed. It is a treatment method wherein activated sludge treatment is performed at low load and solid-liquid separation is carried out in the final sedimentation tank. The mechanical aeration device supplies the oxygen required for treatment, and mixes and agitates the activated sludge and influent in the reactor, gives flow velocity to the mixed liquor, and circulates the liquid in the reactor. At the same time, the device ensures that the activated sludge does not settle down. The main characteristics of this treatment method are:

- Stable treatment is possible even if the water temperature drops (about 5˚C) or influent sewage flow rate and water quality vary with time because of the low-load operation.
- Nitrification reaction progresses since the treatment is at a low-load condition. Nitrogen can be removed by setting anoxic conditions in the reactor.
- The sludge generated is about 75% of the influent SS, which is smaller, compared to the conventional activated sludge process.
- The hydraulic retention time is prolonged, and large area treatment site is necessary because the water depth is generally low (2 to 3 m). However, oxidation ditch with larger water depths (5 to 6 m) have also been developed.

Mechanical aeration devices include longitudinal shaft, horizontal shaft, screw shaft, axial flow pump and propeller type aeration devices with diffuser plate.

(D) DHS-Biotower

This technology has been developed as a post stage treatment method for UASB plants where the treated water quality is not as good as that of the activated sludge process, so that treated water quality same as that in the activated sludge process can be obtained by the UASB treatment method.

The DHS Biotower makes use of aerobic bio-media sponge, the mechanism is simple and operation and maintenance are easy.

(E) Non-Aeration Wastewater Treatment System

This is a water treatment system in which aeration is not necessary. It uses the UASB method and comprises an anaerobic reactor and an aerobic reactor. The quality of treated effluent is improved by installing an aerobic reactor in the post stage of the anaerobic process for finishing treatment. The system consists of an anaerobic reactor using anaerobic self-granulating bacteria (granules) divided into two parts - a fixed bed section using a carrier and a suspended sludge section. The fixed bed section using carrier captures the SS and the granules; as a result, the treatment time is shortened and the treated effluent quality is improved.

(F) Membrane Bioreactor (MBR)

This technology is a kind of activated sludge process. The solid-liquid separation by gravity settling in the final sedimentation tank in conventional activated sludge process is performed here using microfiltration membrane (MF membrane) with pores of diameter 0.1 to 0.4 microns which is immersed in a bioreactor. Aeration is performed from below the membrane, the surface of the membrane is cleaned by the gas-liquid mixed flow, and filtration is performed by pump suction or gravity while preventing fouling of the membrane.

The features of the facility are:

- Primary sedimentation tank, final sedimentation tank, disinfection facilities are not required
- Since MLSS concentration is high, excess sludge can be directly drawn from the bioreactor and dehydrated. In this case, the sludge thickening tank can be omitted.
- A flow regulating tank is necessary to cope with variation in the influent volume.
- To protect the filtration membrane, the influent to the bioreactor must be pre-processed by fine-mesh screen of 1-mm size.
- The site area required is small, and the facility can be installed in a small and compact area.

The features related to treatment are:

- Since there is no limitation on solid-liquid separation at the final sedimentation tank, the MLSS concentration in the bioreactor can be maintained at a high value and treatment can be performed over a long period.
- SS is not detected in the treated effluent, and practically no coliform groups are detected.
- Since the solids retention time (SRT) is prolonged, nitrification reaction is likely to occur in the treatment stages.
- Nitrogen can be removed by biological nitrification and denitrification
- Advanced phosphorous removal is possible by addition of coagulants
- Since SRT is prolonged, the volume of excess activated sludge generated is small.

The filtration membrane used in this method may be broadly divided into the flat sheet membrane and the hollow fibre membrane; the respective modules for each membrane have been developed by the manufacturers.

(G) Sequencing Batch Reactor (SBR)

This is a wastewater treatment method in which the functions of a reactor and a final sedimentation tank are included in a single bioreactor. Processes including reaction due to activated sludge and sedimentation of mixed liquor, drainage of supernatant (treated effluent), and drawing out of settled sludge, are cyclically performed.

Normally, the inflow of sewage is stopped during the time zones of sedimentation of activated sludge and outflow of treated effluent; therefore, multiple bioreactors are installed.

The main features of this reactor are:

- By combining bioreactor and sedimentation tank in a single tank, the construction of the system is simplified; the facility is more compact compared to the conventional activated sludge process, building cost is more economical and operation and maintenance are easy.
- The time for aeration and sedimentation can be freely set according to the quality and quantity of the influent.
- Anaerobic state occurs during intake of wastewater and during sedimentation;

therefore, removal of nitrogen and phosphorous may be anticipated.

With the features mentioned above, the SBR can be used for small-scale sewage treatment.

4.3.3 Advanced Treatment Facilities

(A) Continuous Upflow Sand Filter

This is a moving bed upflow sand filtration process wherein the filter media at the bottom of the filter that captures suspended substances is cleaned while lifting it up using a pipe located at the centre of the filtration tank by air lift. The design of the upper part of the filter is such that the filter media and washing water drain are naturally separated. The filter media are circulated all the time, and washing is performed simultaneously so that filtration is continuous.

However, the wash water drain is more than in other systems; moreover, a blower or a compressor is necessary for the air lift.

(B) Fibre Media Rapid Filtration

This is an upflow fibre media rapid filtration system that uses specially processed floating fibre media. The solids capture rate is improved, and energy savings realized because of low pressure loss.

The main features of this system are:

- Rapid filtering is achieved by using fibre media; equipment can be made compact, moreover, the footprint is small.
- The pressure loss is reduced since fibre media with high void ratio is used. Low-head pump can be used, which contributes to energy conservation.
- The construction is simple and fully automatic; operation and maintenance are easy.

(C) Carrier-added Activated Sludge System

In this system, solid carrier is added to the bioreactor of the activated sludge system. Micro-organisms are retained in this carrier, and the concentration of micro-organisms in the reactor is maintained at a high level. The reactor capacity can be reduced, and the retention time of the reactor can also be shortened. Generally, this system is used in biological nitrogen removal process which needs long retention time, but sometimes it may be used with the objective of removal of organic matter.

By retaining nitrification bacteria with delayed growth rate in the carrier in the biological nitrogen removal process, the nitrifying bacteria can be maintained at a high concentration in the reactor, and the treatment time can be curtailed.

The shape, size and material of the carrier vary depending on the manufacturer. The shape may be spherical, cylindrical, rectangular, cubic, etc.; while the size, that is, the diameter or one of the sides may have a length between 3 and 10 mm. The material may be synthetic organic high polymer such as polypropylene, polyethylene glycol, and so on.

(D) Step-feed Multistage Denitrification-nitrification Process

This is a biological nitrogen removal process using two to three stages of combined units consisting of completely mixed type multistage anoxic tanks and aerobic tanks in series. The influent to the STP or the effluent from the primary sedimentation tank is fed to each anoxic tank in each stage uniformly, and the load per unit MLSS in each stage is made uniform so that the nitrogen removal becomes more efficient and the operation and

maintenance work is simplified.

In this process, increasing the number of stages of step feed of influent corresponds to increasing the nitrified liquor circulation rate in the recycled nitrification-denitrification process. A high nitrogen removal rate can be obtained while reducing the power cost of the circulating pump. Furthermore, the average MLSS concentration throughout the reactor can be increased to a high level by step feeding the influent, so the capacity of the reactor can be reduced.

4.3.4 Disinfection

(A) Ultraviolet Disinfection System

The ultraviolet disinfection system radiates ultraviolet rays generated from the lamp into the water, which renders inactive the bacteria and viruses in the water.

Since ultraviolet disinfection is carried out without any dosage of chemical substances, there are no residual substances. For this reason, there is no effect on the receiving water body, and thus, it is a safe disinfection system.

(B) Ozone Disinfection System

The ozone disinfection system is a system in which ozone is dosed in water, and the viruses and bacteria are killed because of the strong oxidizing power of ozone.

Ozone has a better disinfecting effect on viruses and bacteria than chlorine. Moreover, ozone decomposes quickly, so that harmful substances do not remain in water. There is no need to re-grow micro-organisms after ozone disinfection. The dissolved oxygen concentration in water increases, and the effect on the river at the effluent delivery end is good.

4.3.5 Water Reuse Facilities

(A) Ceramic Membrane Filtration System

This is a system for obtaining recycled water from secondary treated water. It combines the use of a ceramic membrane with ozone treatment and coagulant treatment.

The ceramic membrane attains a high filtration rate, and the equipment footprint is small. Ceramic membrane has excellent durability and the membrane does not break. Moreover, since fully automatic operation through remote monitoring is possible, operation and maintenance are relatively easy. The service life of the ceramic membrane for sewage is about 10 years. After its life, the membrane can be re-used as ceramic raw material, and need not become waste because it is made of environmentally friendly material.

(B) BIOPAC System

This system is a biofilm filtration treatment system taking secondary treated effluent as the raw water for water reuse. If high quality of water for reuse is required, then ozone treatment can be added.

The biofilm filtration method uses a fixed bed of media for attachment of micro-organisms. In the same treatment tank, biological treatment (BOD removal) and filtration (SS removal) are carried out in the aerobic state, and physical treatment is performed simultaneously with biological treatment. Therefore, not only SS, but also BOD, COD, foul odor, colour and the number of coliform groups can be reduced. Moreover, footprint, running cost, and ease of operation and maintenance are practically the same as the conventional gravity sand filtration method.

4.3.6 Sludge Treatment Facilities

(A) Egg Type Digestion Tank

The digestion tank is egg-shaped; therefore, dead space within the tank is eliminated. Mixing and agitation can be performed uniformly, so sludge digestion and gas generation in this tank are efficient. Very little scum is generated since the water surface area in the tank is small. Furthermore, the mechanical agitator consumes approximately 30% less power than the conventional gas and pump agitators.

(B) Layered Multi-disc Screw Press

The main unit consists of accumulated moving rings, fixed rings and screw. The accumulated rings work as filter. Solids and liquids are separated by the pressure caused by the screw. The screw pushes the internal edges of the moving rings (the internal diameter of the moving ring is smaller than the diameter of the screw.). Therefore, the moving rings move continuously with in the gaps between the fixed rings when the screw rotates, and clean the gaps thereby preventing clogging.

Power consumption is small, and initial and running costs are low.

(C) Continuous Pressurizing Dehydrator

The rotary outer cylinder-type screw press ISGK is a continuous pressurizing dehydrator which reduces sludge volume efficiently.

Compared to the conventional dehydrator that used filter cloth, this dehydrator has very few consumable parts, and the quantity of washing water used is also smaller, so the operation and maintenance work of the dehydrator is easy. Power consumption is also small, and vibration and noise do not occur.

(D) Decanter Centrifuges

The decanter centrifuge can efficiently dewater low concentration sludge and sludge that is difficult to dehydrate. Its treatment capacity is also large. It is easy to operate and can be easily automated. The operation can be fully enclosed so measures to prevent odor can be easily adopted. Decanter centrifuges that are cost effective from operation and maintenance aspects have been developed.

4.3.7 Sludge Reuse Facilities

(A) Sludge Drying System

This sludge drying system performs conversion of sludge to biosolids with a low level heat source of 200˚C. The system converts sludge into sticks and dries them on a belt; as a result, very little dust is generated.

(B) Sludge Carbonization System

This system thermally decomposes sewage sludge under oxygen-depleted condition and generates granular carbide. The carbonized sludge consists of carbon and inorganic components and has many more advantages compared to activated carbon. The carbonized sludge is light in weight and odourless, has no pathogens. It has high porosity and high adsorption capacity. It can be used as a fuel like charcoal.

(C) BITREC System

This system can produce electrical energy, compost and construction materials by mixing dehydrated sludge, municipal wastes and excreta utilizing methane fermentation technology.

In addition, existing wastewater treatment plants can be easily upgraded to value producing plants since this system can be installed in existing plants.

(D) Value Composting System

Value composting System produces high quality compost from sludge. This compost can be utilized for fertilizing soil and for cultivating plants.

4.3.8 Electrical Facilities

(A) Compact Size Digestion Gas Engine Generator

This is a gas engine generator manufactured by altering the commercially available engine generator so that it can run on biogas. For this reason, it is economical and has a small footprint.

The power required for its operation is supplied by built-in batteries, so commercial power supply is not necessary.

(B) Micro Gas Turbine Co-generation System

This is a Micro Gas Turbine Co-generation System (MGT) using digested gas as fuel. It is provided with excess gas burner and boiler functions. It can simultaneously generate power, supply heat and burn gas. Unused energy can be effectively utilized by this system leading to reduction in energy costs.

It can also handle wide ranging fluctuations in heat generated from the digested gas; it does not have limitations in the fluctuation range as in the case of gas engines.

(C) Micro Hydropower Generating Equipment

Micro Hydropower Generating Equipment can utilize hydraulic energy of low head and of small-scale water resources.

The installation cost can be reduced because of the small and compact package. It can also be installed at locations where the head is as low as 2 m.

(D) Weir and Parshall Flume-Type Flow Meter

This device continuously measures the flow rate in open conduit channels. The head of water in a weir or a Parshall flume is detected by the submerged level detector. The level/flow converter outputs instantaneous flow and cumulative pulses.

This apparatus accurately detects water heads of 0 m to 0.1 m.

(E) Submerged Level Detectors

Submerged level detectors measure water depth by detecting water pressure.

These detectors can monitor water levels, and perform automatic control of pumps and gates.

The sensor employs a differential transformer. The robust structure offers high shock resistance. Since the detector is installed underwater, it is not affected by surface water conditions such as floating objects, ice, and unsettled water surfaces caused by high winds. Moreover, the pressure receiving section employs a sludge-resistant structure that protects the detector from sludge.

(F) Sludge Density Meters (Dual scattered-light)

This type of density meter can continuously measure a wide range of sludge types from

crude sludge, excess sludge to thickened sludge of sewage treatment plants without the influences of voids or sludge colour variation. It can be used for the control of chemicals injection for sludge treatment and for online continuous monitoring of sludge concentration.

(G) Optical Dissolved Oxygen Meter

This instrument is used for measurements of dissolved oxygen in aeration tanks such as in sewage treatment plants and factory wastewater plants. An optical sensor is used instead of the conventional diaphragm type sensor. This sensor has excellent stability and good response.

The part to be replaced is only the sensor cap. Electrobath is not necessary. Maintenance is easy.

(H) Monitoring System for Small Region

This system can monitor and control the relay pump station, manhole pumps, wastewater treatment plants scattered over a wide area regardless of location, time, and size of the plant by using the personal computer with WEB browser.

Recent developments in information technology have brought about development of social infrastructure such as networks, Internet service, lower prices and social penetration of personal computers and diffusion of cellular phones. This system can be used to construct appropriate and simplified operations by using network technology even if the monitoring area is wide and complex.

4.3.9 Sewer Construction

(A) Shield Tunnelling Method

The Shield Tunnelling Method is a construction method used for constructing tunnels without excavating the ground surface. The tunnelling machine for excavation is enclosed in a steel tube that prevents the collapse of soil around it. The rotating cutter gradually scrapes out the earth at the front face, and the machine advances with the hydraulic jack for a distance equal to the scraped-out distance. Later, concrete and steel frames called segments are assembled at the rear end as the tunnel construction progresses.

The shield tunnelling method was designed for digging tunnels under urban areas made of soft earth and not for tunnelling through a mountain made of hard base rock. This technology is mostly used for the construction of sewers in cities. As of today, many types of shield construction methods have been developed.

(B) Pipe Jacking Method

The pipe jacking method is used in the construction of sewers. Two shafts are located at two ends – a starting shaft and an arrival shaft. A tunnel boring machine is pushed into the ground through the starting shaft using hydraulic jacks. Following the tunnel boring machine are ready-made pipe sections that are sequentially joined, and the pipe train is pushed through until the tunnel boring machine system reaches the arrival shaft.

The distance over which sewers can be laid is smaller than that in the shield tunnelling method. However, in recent years, pipe jacking method over long distances is being used.

4.3.10 Sewer Rehabilitation

(A) New SPR system

This is a system that uses technology to regenerate conduit functions. Conduits are formed by hard polyvinyl chloride profiles inside old existing sewer pipes, back-filling material is

filled in the clearance, and very strong composite pipe is formed by integrating existing pipe, back-filling material and profiles.

This method can also be implemented using "trenchless method without a stop of water flow in sewers regardless of cross sectional shape." The effects on the lifestyle of citizens and traffic are minimal, and both work period and costs compared to open-cut method can be curtailed significantly. Therefore, this is an optimum construction method for today's socioeconomic environment.

4.3.11 Corrosion Control Measures for Structures in Sewerage Facilities

It is important to select and combine appropriate technologies to prevent and protect concrete corrosion and apply them facilities subjected to various corroding conditions.

Unlike newly constructed facilities, for repairing existing facilities, it is important to diagnose corrosion and deterioration, remove corroded and deteriorated parts (chipping), recover the chipped face, set up temporary facilities and consider the operating method for existing facilities during the construction period.

Measures against concrete corrosion are as follows:

Table 4-1 Measures against Concrete Corrosion

Classification of Measures	Strategies	Practical Methods
Corrosion prevention	– Inhibiting sulphide formation – Inhibiting hydrogen sulphide production – Inhibiting sulphide acid production.	– Prevention of anaerobiosis by injecting air, etc. – Construction of appropriate structure to prevent disturbances in flow – Oxidation and immobilization of sulphide by chemical addition – Inhibition of bacterial activity by chemicals
Corrosion protection	– Perfection concrete from sulphuric acid by lining. – Using materials highly resistant to sulphuric acid.	– Coat type lining, sheet lining, buried frames, etc. – Sulphate resisting cement mortar and concrete*

*JS has conducted joint research with private companies since 2000.

4.4 Operation and Maintenance

4.4.1 Pipe, Pumping station, and STPs

In Japan, the internal parts of a sewer are checked and inspected using a television camera and light which are attached at the tip of a stick which can expand and contract. This unmanned method is used in order to avoid hazards due to emission of hydrogen sulphide gas. These days, the use of self propelled television camera for inspection of the internal parts of sewers having varying range of diameters has increased. Also in India, this method is considered to be an effective in preventing accidents at the time of sewer inspection.

The application of automatic control and tele-control is becoming indispensable for efficient operation and management of the pumping stations that are widely distributed throughout the city, and for prevention of human error. Automatic control is also effective for preventing human error in the operation and management of STPs. To use automatic controls in the O&M of STPs, it is necessary to install flow meters for measuring the amount of influent, return sludge, and removed sludge.

In addition, it is necessary to install sensors, such as a pH meter and DO meter, at several

locations in the reactor.

By installing these equipment and through the application of automatic control, early detection of the breakdown of machines and preventive measures become possible.

4.4.2 Water quality analysis

In India, advanced wastewater treatment facility aiming for biological nitrogen removal process is already being used. In order to perform a proper wastewater treatment control in such plants, it is necessary to control the supplied air flow, and SRT, and always grasp the concentration of inorganic nitrogen compounds, such as ammonia nitrogen, nitrite nitrogen, and nitrate nitrogen. However, tools and equipment available in the laboratory at the existing STPs are few in number for such analyses under the present circumstances, the area of laboratory is not sufficient. Also, the knowledge and skill of laboratory experts responsible for water quality tests and analysis are not adequate.

In order to compensate this, a simplified analysis is effective. Of course, there are limitations of using a simplified analysis for unclean samples, such as influent. Many parameters can be measured using simplified absorption spectrophotometry such as ammonia nitrogen, nitrite nitrogen, and nitrate nitrogen, total nitrogen, total phosphorus, cyanide, fluorine compound, cadmium, zinc, iron, copper, hexavalent chromium, lead, COD, etc.. Simplified analysis includes application of test paper, detector tube and pack test. Pack tests are divided roughly into the simplified colorimetric determination and simplified absorption spectrophotometry which compares the depth of colour and hue. Among these types, the use of simple colorimetric assay method is limited. The method of simplified absorption spectrophotometry uses a small spectrophotometer for exclusive use in many cases.

Although the sensitivity is not very high, the advantage of using simplified absorption spectrophotometry are quick measurement and use of the packed reagents by even unskilled analysts.

It is necessary to consider installation of such newly developed simplified analysis tools at STPs in order to obtain quick results.

CHAPTER 5 MANUAL PREPARATION PLAN

5.1 Proposed Composition of Manuals

The composition of the revised and new manuals related to sewerage and sewage treatment, the basic policy for describing the manuals and the table of contents for the manuals are proposed in this section.

5.1.1 Composition of Manuals

The new manuals related to sewerage and sewage treatment will consist of the three manuals listed below.

- Part A Engineering (Planning and Design Manual)
- Part B Operation and Maintenance Manual
- Part C Management Manual

The basic policy for the manuals is as described below.

(A) Engineering (Planning and Design)

1) The Planning and Design Manual will be offered as guidelines, and will present standard concepts. Independent concepts may be added depending on the circumstances of each region.

2) The volume of the Planning and Design Manual will be about the same as in the existing manual (1993 edition).

3) Parts that overlap with the existing manual will basically be limited to describing the gist; details will be referred to the relevant manual.

4) The gist of important policies (or items) from the sewerage and environmental policies considered necessary especially in the Planning and Design Manual will be described in general remarks in the manual or in associated chapters.

5) Personnel in the sewerage sector mainly in the urban area fall under the scope of the Planning and Design Manual.

6) The users of the Planning and Design Manual are assumed to be employees, designers, students and other concerned personnel in the sewerage sector.

7) Regarding the treatment of new and obsolete technologies in the Planning and Design Manual, basically technologies that are generally prevalent and widely used are described here. New technologies with clear design procedures that have been technically assessed but are not widely used will be described. Obsolete technologies may be removed.

8) The Planning and Design Manual will be written in an easily understandable manner with wide-ranging content so that it serves as a practical desk-side (reference) book for the sewerage system engineer.

9) The Planning and Design Manual will include as many references for design and planning as possible. Data that has become obsolete will be replaced by new data.

(B) Operation and Maintenance

1) All those parts in the O&M chapter of the existing manual that are relevant to the new O&M Manual will be reproduced in the new O&M Manual.

2) In principle, the O&M methods will be described for the existing sewage treatment processes.

3) The new O&M Manual will generally be aimed at Assistant Engineer/Junior Engineer/Technician class employed in O&M work in the sewerage system.

4) The new O&M Manual will be written in an easily understandable manner with wide-ranging content so that it serves as a practical desk-side (reference) book for the abovementioned sewerage system personnel.

5) The new O&M Manual may be likely to be a textbook-style manual if relevant data on operation and management of sewerage facilities in India cannot be obtained.

6) There is a possibility that sewage treatment processes for which data cannot be obtained may not be included in the O&M Manual.

7) The Manual will not be limited to daily operational management of sewerage facilities, but will also describe planning and efficient maintenance from the long-term view. “Inspections”, “Examinations”, and “Recording properly the results of operational management including repairs of sewerage facilities and actively making conscious use of their contents” will be described in the new O&M Manual.

(C) Management

1) The Management Manual will be offered as guidelines, and will present standard concepts.

2) The gist of important policies (or items) from the sewerage and environmental policies considered necessary especially in the Management Manual will be described in general remarks in the manual or in associated chapters.

3) The users of the Management Manual are assumed to be personnel responsible for management in the sewerage sector.

4) The Management Manual will be written in an easily understandable manner with wide-ranging content so that it serves as a practical desk-side (reference) book for the sewerage sector personnel.

5) The Management Manual will include as many information resources as possible that can be used as references for management.

5.1.2 Contents of Manuals

Three Expert Committee meetings were organized during this Study to explain the activities undertaken as a part of this Study, findings of the field visits, and to discuss the Table of Contents of Parts A, B, and C of the Manual at the levels of Chapters, Sections and Sub-sections. Outcomes of these meetings are summarized in Appendices A5-1 and A5-2. Based upon detailed discussion, the Table of Contents of Parts A, B, and C have been finalized and presented in the following sections.

(A) Engineering (Planning and Design)

Table of contents of manual on part A Engineering (Planning and Design), modified based on the discussion in Third Expert Committee meeting, is shown in Table 5-1.

Related Chapter or Section in the existing manual is mentioned in second column of this Table.

Table 5-1 Table of Contents of Part A Engineering

New Manual	Existing Manual
CHAPTER 1 INTRODUCTION	Chap. 1
1.1 Preamble	
1.2 Overview	
1.2.1 Sewerage Development Policy	
1.2.2 Status of Sewerage	
1.2.3 Technology of Sewerage	
1.3 Objectives (include both sewerage and onsite part)	1.1
CHAPTER 2 PLANNING	Chap. 1, 3
2.1 Basic Considerations	1.2, 1.3, 1.4, 1.5
2.1.1 Need for Planning	
2.1.2 Design Period	
2.1.3 Design Area	
2.1.4 Type of Collection System	
2.1.5 Reuse and Disposal (High Water Level of Receiving Water)	
2.1.6 Layout, Structure and Function of Sewerage Facilities (Hydraulic Profile)	
2.1.7 Legislations and Regulations	
2.1.8 Roles and Responsibilities of Urban Local Bodies	
2.1.9 Guidelines on House Connections	
2.2 Survey and Data Collection	1.8
2.2.1 Basic Philosophy of Survey	
2.2.2 Survey on Natural Conditions (Topographic survey, Climate, Existing Water Quality, etc.)	
2.2.3 Survey on Related Plans	
2.2.4 Survey on Pollution Load and Receiving Bodies	
2.2.5 Survey on Existing Sewerage Facilities	
2.2.6 Survey on Resources for Sewerage System and Its Utilization	
2.2.7 Survey on Treated Sewage, Sludge and Biogas Utilization	
2.3 Planning of Sewage Treatment	
2.3.1 Basic Philosophy of Sewage Treatment	
2.3.2 Design Population	
2.3.3 Design Sewage Flow	

New Manual	Existing Manual
2.3.4 Design Pollution Load and Sewage Influent Quality	
2.3.5 Design Effluent Quality	
2.3.6 Planning of Sewer System	
2.3.7 Planning of Pumping Station	
2.3.8 Planning of Sewage Treatment Plant	
2.4 Planning of Sludge Treatment	
2.4.1 Basic Philosophy of Sludge Treatment	
2.4.2 Design Sludge Generation	
2.4.3 Planning for Sludge Reuse	
2.4.4 Integrated Sludge Treatment	
2.4.5 Transportation and Disposal of Sludge	
2.5 Planning of Sewerage Facilities (Building Bylaws, Aircraft Act, etc.)	
2.5.1 Basic Philosophy of Facility Planning	
2.5.2 Effective Facility Planning	
2.5.3 Combination of Facilities	
2.5.4 Review of Planning	
2.6 Planning of Utilization of Resources and Space	
2.6.1 Planning of Effluent Utilization	
2.6.2 Planning of Sludge Utilization	
2.6.3 Planning of Utilization of Space in Sewage Treatment Plant and Pumping Station (Examples of space utilization)	
2.7 Planning for Reconstruction	
2.7.1 General Aspect of Reconstruction Planning	
2.7.2 Reconstruction Planning of Sewer	
2.7.3 Reconstruction Planning of Sewage Treatment Plant and Pumping Station	
2.8 Environmental Preservation and Beautification	1.3.2
2.8.1 Basic Philosophy of Environmental Preservation	
2.8.2 Environmental Preservation Measures of Sewage Treatment Plant and Pumping Station	
2.8.3 Environmental Preservation Measures of Surrounding Area	
2.9 Design Criteria	
2.9.1 General Structure of Sewerage Facilities	
2.9.2 Design Criteria for Facilities	
2.9.3 Materials, Machinery and Apparatus	
2.10 Engineering Reports and Facility Plans	1.9
2.10.1 General	
2.10.2 Engineering Report of Facility Plan	
2.11 Engineering Plans and Specifications	
2.11.1 Plans and Support Documents	

New Manual	Existing Manual
2.11.2 Specifications	
2.11.3 Revisions to Approved Plans	
CHAPTER 3 DESIGN AND CONSTRUCTION OF SEWERS	Chap.3, 4, 5, 6, 7
3.1 General	
3.2 Types of Collection System	
3.2.1 Separate Sewer System	
3.2.2 Combined Sewer System	
3.2.3 Pressurized Sewer System	
3.2.4 Vacuum Sewer System	
3.2.5 Small Bore System	
3.3 Types and Materials of Sewers	5.2
3.3.1 Types and Materials of Sewers	
3.3.2 Shape and Size of Sewers	
3.3.3 Minimum Size of Sewers	
3.4 Hydraulics	3.4
3.4.1 Design Flow and Design Capacity	
3.4.2 Margin of Sewers	
3.4.3 Calculation of Flow Rate	
3.4.4 Flow Velocity and Gradient	
3.4.5 Location and Depth of Sewers	
3.4.6 Sewer Network Design (including use of computers)	
3.5 Protection and Bedding of Sewers	
3.5.1 Corrosion Prevention and Control	
3.5.2 Protection of Sewers	6.2, 6.3, 6.5
3.5.3 Bedding of Sewers (under and above ground)	
3.6 Connection and Joint of Sewers	
3.6.1 Connection of Sewers	4.4
3.6.2 Joint of Sewers	
3.7 Types and Shape of Open Conduit	
3.7.1 Types of Open Conduit	
3.7.2 Shape of Open Conduit	
3.7.3 Freeboard of Open Conduit	
3.8 Inspection Chamber and House Connection Pipe	4.4
3.8.1 Inspection Chamber	
3.8.2 House Connection Pipe	
3.8.3 Appurtenances	
3.8.4 Pretreatment Facilities for Commercial Establishments	
3.9 Manholes	4.2
3.9.1 Layout of Manholes	
3.9.2 Types, Shapes and Structures of Manholes	

New Manual	Existing Manual
3.10 Cross Drainage Works	
3.10.1 Gravity Transmission (Inverted Siphons)	3.4.5, 4.3
3.10.2 Pumped Transmission	
3.11 Protection of Water Supply Pipes	
3.11.1 Prevention of Cross Connection	
3.11.2 Relation to Water Works Structure	
3.11.3 Relation to Water Mains	
3.12 Laying of Sewers	
3.12.1 Open Cut Methods	
3.12.2 Trenchless Methods (very detail)	
(Shield Tunnelling Method, Pipe Jacking Method)	
3.13 Sewer Rehabilitation (very detail)	
3.13.1 Bypass Sewers	
3.13.2 Relief Sewers	
3.13.3 Methods of Sewer Rehabilitation	
CHAPTER 4 DESIGN AND CONSTRUCTION OF SEWAGE PUMPING STATIONS	Chap.3, 9, 11, 25
4.1 General	9.1, 9.2, 9.3, 9.4, 9.5
4.1.1 Design Flow	
4.1.2 Location and Configuration	
4.1.3 Measures of Safety, Environmental Protection	
4.1.4 Design Suction Water Level	
4.1.5 Design Discharge Water Level and Pumping Water Level	
4.1.6 Selection of Power Source	
4.2 Screen and Grit Chamber	11.1, 11.2
4.2.1 Gate	
4.2.2 Screen	
4.2.3 Amount of Screenings	
4.2.4 Configuration and Number of Grit Chamber	
4.2.5 Structure	
4.2.6 Overflow Rate	
4.2.7 Average Flow Rate, Retention Time, Water Depth	
4.2.8 Grit Collector	
4.2.9 Amount of Grit	
4.2.10 Treatment of Screenings and Grit	
4.2.11 Machinery Room	
4.2.12 Measures against Odor	
4.3 Pumps	9.7
4.3.1 Types and Selection of Pump	
4.3.2 Suction-Lift Pump Stations	

New Manual	Existing Manual
4.3.3 Submersible Pump Stations	
4.3.4 Screw Pump Stations	
4.3.5 Number of Pump	
4.3.6 Wet Well	
4.3.7 Pump Diameter	
4.3.8 Head Loss Calculation	
4.3.9 Total Pump Head	
4.3.10 Pump Submergence	
4.3.11 Shaft Power	
4.3.12 Prime Mover	
4.3.13 Output of Prime Mover	
4.3.14 Surging of Pump	
4.3.15 Water Hammer of Pump	
4.3.16 Piping and Valve	
4.3.17 Appurtenances and Auxiliary Equipments (Actuators)	
4.3.18 Dry Well	
4.3.19 Automatic Operation of Pumps	
4.3.20 Equipments for Automatic Operation	
4.3.21 Protective Equipments	
4.4 Selection of Electric Motors	9.8, 9.9, 9.10
4.4.1 Types and Selection of Electric Motor	
4.4.2 Starting Methods (VFD also)	
4.4.3 Transmission Methods	
4.4.4 Protection Devices	
4.5 Auxiliary Power Devices	
4.5.1 Types of Generator (Diesel, Dual Fuel Engines)	
4.5.2 Output of Generators	
4.5.3 Exhaust Pipe, Silencer and Measures ageist Exhaust Gas	
4.5.4 Power Transmitter	
4.5.5 Auxiliary Devices	
4.6 Alarm Systems	
4.7 Flow Measurement	25.1, 25.2, 25.3,
4.7.1 Introduction	25.4
4.7.2 Methods of Flow Measurement	
4.7.3 Direct Discharge Methods	
4.7.4 Velocity-Area Methods	
4.7.5 Electromagnetic Devices (Level Sensors)	
4.7.6 Ultrasonic	
4.7.7 Tracer Techniques	
4.8 Rising Mains	3.4.7

New Manual	Existing Manual
4.8.1 Design of Rising Mains (Economical diameter)	
4.8.2 Water Hammer of Force Mains	
4.9 Corrosion Prevention and Control	
4.10 Reconstruction/Rehabilitation of Pumping Station	
4.10.1 Reconstruction/Rehabilitation of Pumping Station	
4.11 Intermediate Lift Stations	
CHAPTER 5 DESIGN (AND CONSTRUCTION) OF SEWAGE TREATMENT FACILITIES	Chap.10, 11, 12 Chap.13, 14, 15 Chap.16, 24
5.1 General	10.1, 10.2, 10.3, 10.4, 10.5
5.1.1 Guidelines for Design of Sewage Treatment Facilities	
5.1.2 Design Sewage Flow	
5.1.3 Raw Sewage Characteristics	
5.1.4 Effluent Water Quality	
5.1.5 Layout and Structure of Facilities	
5.1.6 Hydraulic Profile	
5.2 Fundamental Principle of Biological Treatment	10.9
5.2.1 Activated Sludge Processes (Principle, Type and Feature, Design Parameters, Operation)	
5.2.2 Fixed Media System (Principle, Type and Feature, Design Parameters, Operation)	
5.2.3 Moving Media System (Feature, Type of Immobilization Carrier, Design Parameters, Operation)	
5.2.4 Stabilization Ponds (Principle, Type and Feature, Design Parameters, Operation)	
5.2.5 Anaerobic Treatment Systems (Principle, Type and Feature, Design Parameters, Operation)	
5.3 Selection of Sewage Treatment Processes	10.10
5.3.1 Criteria for Selection of Treatment Processes (Design Effluent Quality, Influent Flow and Quality, Treated Water reuse, Sludge Treatment Method and Reuse, Area Requirement, Cost of Land, Ease of O&M, Environmental Aspects, Net Present Value, Life Cycle Cost)	
5.3.2 Selection of Treatment Processes	
5.3.3 Additional Treatment Processes	
5.4 Plant Location	
5.4.1 Criteria for Plant Location (Considerations for Selection of Site -Sewage Collection Route, Condition of Receiving Water body, Difficulty of Land Acquisition, Site Environment)	

New Manual	Existing Manual
5.5 Quality of Effluent	10.1
5.5.1 Regulation of Effluent Quality	
5.5.2 Target Water Quality of Receiving Water body	
5.6 Design	10.1, 10.2, 10.3, 10.4
5.6.1 Plant Location	
5.6.2 Quality of Effluent	
5.6.3 Type of Treatment	
5.6.4 Required Engineering Data for New Process and Application Evaluation	
5.6.5 Design Period	
5.6.6 Design Loads	
5.6.7 Conduits	
5.6.8 Arrangement of Units	
5.6.9 Flow Division Control	
5.7 Plant Details	
5.7.1 Installation of Mechanical Equipment	
5.7.2 Unit Bypasses	
5.7.3 Unit Dewatering	
5.7.4 Flotation Protection, and Plugging	
5.7.5 Construction Materials	
5.7.6 Coating and Painting	
5.7.7 Operating Equipment	
5.7.8 Erosion Control During Construction	
5.7.9 Grading and Landscaping	
5.8 Plant Outfalls	
5.8.1 Discharge Impact Control	
5.8.2 Protection and Maintenance of Outfalls	
5.8.3 Sampling Provisions	
5.9 Essential Facilities	
5.9.1 Emergency Power Facilities	
5.9.2 Water Supply	
5.9.3 Sanitary Facilities	
5.9.4 Flow Measurement	
5.9.5 Sampling Equipment	
5.10 Control Facilities	
5.10.1 Control building	
5.10.2 Lighting Equipment	
5.10.3 Air Conditioning and Ventilation System	
5.11 Safety	
5.11.1 General	

New Manual	Existing Manual
5.11.2 Hazardous Chemical Handling	
5.11.3 Hazardous Chemical Container Identification (Containment Materials, Secondary Containment, Liquefied Gas Chemicals, Splash Guards, Piping, Labelling, Coupling Guards, Location, Protective Clothing and Equipment, Warning System and Signs, Dust Collection, Eyewash Fountains and Safety Showers)	
5.12 Laboratory	24.1, 24.2
5.12.1 General	
5.12.2 Location and Space	
5.12.3 Formation and Arrangement	
5.12.4 Specification	
5.12.5 Equipment	
5.13 Screening, Grit Removal and Flow Equalization	11.1, 11.2
5.13.1 Screening (Coarse Screen, Medium Screen, Fine Screen, Comminutor, Quantity of Screenings)	
5.13.2 Grit Chamber (Grit Removal Equipment, Quantity of Grit, Treatment of Screenings and Grit, Housing of Machinery, Provision for Odor)	
5.13.3 Flow Equalization (Location, Type, Shape and Number of Basin, Structure, Mixing, Effluent Facility)	
5.14 Settling	12.1, 12.2, 12.3, 12.4
5.14.1 Primary Sedimentation Tank (Type and Number of Tank, Structure, Overflow Rate, Effective Depth, Freeboard, Baffle Wall, Scum Collector, Effluent Facility, Sludge Collector, Sludge Withdrawal equipment)	
5.14.2 Final Sedimentation Tank (Type and Number of Tank, Structure, Overflow Rate, Effective Depth, Freeboard, Baffle Wall, Scum Collector, Effluent Facility, Sludge Collector, Sludge Withdrawal equipment)	
5.14.3 Multi-storey Sedimentation Tank (Type, Structure, Overflow Rate, Effluent Facility, Sludge Withdrawal Pipe)	
5.15 Sewage Treatment	13.1, 13.2, 13.3, 13.4
5.15.1 Activated Sludge Processes -Conventional Activated Sludge Process -Extended Aeration Process, -Oxidation Ditch Process -Sequencing Batch Reactor	

New Manual	Existing Manual
-Oxidation Pond	
5.15.2 Attached Growth Systems	14.1, 14.2, 14.3
-Trickling Filters/Biotower (Plastic Fixed Media)	
-Biological Aerated Filter	
-Contact Aeration Process	
-Rotating Biological Contactor	
5.15.3 Treatment Methods Using Immobilization Carrier (refer WEF Manual)	
-Microorganism Immobilized Carrier Process	
-Microorganism Attached Carrier (Sponge) Process	
-Microorganism Attached Carrier (Polypropylene) Process	
-Microorganism Attached Carrier (Polyurethane) Process	
5.15.4 Stabilization Ponds	15.1, 15.2, 15.3,
-Aerobic, Anaerobic, Facultative	15.4
5.15.5 Anaerobic Treatment	16.1, 16.2, 16.3,
-Anaerobic Contact (AC) Process	16.4, 16.5
-Anaerobic Filter (AF) Process	
-Anaerobic Fixed Films Reactor (AFF) Process	
-Fluidized and Expanded Bed (FB) Reactor	
-Upflow Anaerobic sludge Blanket (UASB) Reactor	
5.16 Disinfection Facilities	
5.16.1 Chlorine Disinfection	
-Type (Chlorine Gas, Hypochlorite solution, Hypochlorite Tablet)	
-Contact Period and Tank	
-Dosage	
-Containers	
5.16.2 Dechlorination	
(Problems related to use of chlorine and alternative option)	
-Toxicity of Chlorine Residuals	
-Type (Sulphur dioxide gas or aqueous solutions of sulphite or bisulphite),	
-Contact Period and Tank	
-Dosage	
-Containers	
5.16.3 Ultraviolet Radiation Disinfection	
-Equipment	
-Radiation Dosage	
-Type of Ultraviolet Lamp	
-Type of Tank (Open Channel, Closed Chamber)	
5.16.4 Ozone Systems for Disinfection	
-Ozone Reactor	

New Manual	Existing Manual
-Ozone Dosage	
-Ozone Generator	
-Exhaust Ozone Treatment Facility	
-Ozone Meter Equipment	
5.16.5 Merits and Demerits of Disinfection Processes	
5.17 Electrical and Instrumentation Facilities	
5.17.1 General	
5.17.2 Power Receiving and Transforming Equipment	
5.17.3 Motor Controllers (Starter, Capacitor, Electric Protect, Speed Control of Motor)	
5.17.4 Generator	
5.17.5 Uninterruptible Power Supply (Battery, Inverter)	
5.17.6 Instrumentation Facilities (Flow meter, Level Meter, Water Quality Meter)	
5.17.7 Supervisory Control and Data Acquisition System (SCADA)	
5.17.8 Electricity Room and Generator Room	
5.18 Corrosion Prevention and Control	
5.19 Rehabilitation of Sewage Treatment Facilities	
5.19.1 Criteria for Rehabilitation of Sewage Treatment Facilities (Degree of Aging, Earthquake-Proof, Degradation of Function, Ease with Maintenance, Environment)	
5.19.2 Up-gradation of Facilities	
5.19.3 Energy Saving Measures	
5.20 Energy Conservation (Fuel Cells, Turbines, Solar Cells, Viable Sources)	
5.21 Carbon Credit	
CHAPTER 6 DESIGN AND CONSTRUCTION OF SLUDGE TREATMENT FACILITIES	Chap.17, 18
6.1 General	
6.1.1 Sludge Treatment Methods	
6.1.2 Sludge Utilization	
6.1.3 Sludge Disposal	
6.1.4 Integrated Sludge Treatment	
6.1.5 Cooperative Sludge Treatment	
6.2 Process Selection	
6.2.1 Considerations for Selection of Treatment Processes (Local Land Use, System Energy Requirement, Cost Effectiveness, Equipment Complexity and Staffing Requirement)	
6.2.2 Adverse Effects of Heavy Metals and Other Sludge Components upon	

New Manual	Existing Manual
the Unit Processes	
6.2.3 Sludge Digestion or Stabilization Requirements including Appropriate Pathogen and Vector Attraction Reduction	
6.2.4 Side Stream or Return Flow Treatment Requirements (e.g., digester or sludge storage facilities supernatant, dewatering unit filtrate, wet oxidation return flows)	
6.2.5 Sludge Storage Requirements	
6.2.6 Methods of Ultimate Disposal	
6.2.7 Back-up Techniques of Sludge Handling and Disposal	
6.3 Sludge Pumps and Piping	18.1, 18.2, 18.3,
6.3.1 Sludge Pumps	18.4, 18.5, 18.6,
(Capacity, Duplicate Units, Type, Minimum Head, Sampling Facilities, Sludge Pumps Pit, Sludge Storage Tank)	18.7, 18.8
6.3.2 Sludge Piping	
(Size and Head, Slope and Flushing Requirements, Supports)	
6.4 Sludge Drying Bed	17.3.1
6.4.1 Applicability	
6.4.2 Unit Sizing	
6.4.3 Percolation Type Bed Components (Gravel, Sand, Underdrains, Additional Dewatering Provisions, Seal)	
6.4.4 Walls	
6.4.5 Sludge Removal	
6.5 Sludge Thickener	17.2
6.5.1 Gravity Thickening	
(Capacity, Shape and Number, Structure, Appurtenances)	
6.5.2 Centrifugal Thickening	
(Centrifugal Thickener, Sludge Feed Pump, Appurtenances , Chemical Feeder)	
6.5.3 Air Floatation Thickening	
(Capacity, Shape and Number, Structure, Sludge Skimmer and Collector, Bubble Injection and Mixing Equipment, Chemical Feeder , Appurtenances)	
6.5.4 Belt Type Thickening	
(Capacity, Shape and Number, Structure, Chemical Feeder, Appurtenances)	
6.6 Anaerobic Sludge Digestion	17.4.1
6.6.1 General	
6.6.2 Digestion Types (Single stage, Multistage, Low Rate, High Rate),	
6.6.3 Tank Capacity	
6.6.4 Sludge Loading Rate	

New Manual	Existing Manual
6.6.5 Sizing	
6.6.6 Structure	
6.6.7 Mixing System	
6.6.8 Heating System	
6.6.9 Sludge Inlets and Draw-offs	
6.6.10 Supernatant Withdrawal and Treatment	
6.6.11 Gas Collection and Storage	
6.6.12 Piping	
6.6.13 Appurtenance	
6.6.14 Corrosion Prevention	
6.6.15 Gas Utilization	
6.7 Aerobic Sludge Digestion	17.4.2
6.7.1 General	
6.7.2 Tank Capacity	
6.7.3 Sludge Loading Rate	
6.7.4 Sizing, Structure	
6.7.5 Mixing System, Air Requirement	
6.7.6 Supernatant Separation	
6.7.7 Scum and Grease Removal	
6.7.8 Aerobic Digestion Sludge Production	
6.7.9 Digested Sludge Storage Volume	
6.8 Sludge Dewatering	17.3
6.8.1 General	
6.8.2 Features	
6.8.3 Dewatering Principle	
6.8.4 Sludge Conditioning	
6.8.5 Screw Press	
6.8.6 Rotary Press	
6.8.7 Belt Press	
6.8.8 Filter Press	
6.8.9 Centrifugal Dehydrator	
6.8.10 Vacuum Filter	
6.8.11 Comparison of Dewatering Systems	
6.9 Sludge Disinfection (Drying, Heating, Composting, etc.)	
6.10 Sludge Disposal	17.5
6.10.1 Sludge Storage (Tank Volume)	
6.10.2 Sludge Disposal (Sanitary Land filling, Sludge Lagoons for Disposal)	
6.11 Corrosion Prevention and Control	

New Manual	Existing Manual
6.12 Reconstruction/Rehabilitation of Sludge Facilities	
6.12.1 General	
6.12.2 Considerations for Reconstruction/Rehabilitation of Sludge Facilities (Degree of Aging, Earthquake-Proof, Degradation of Function, Ease with Maintenance, Environment)	
6.12.3 Up-gradation of Facilities	
6.12.4 Energy Saving Measure	
6.13 Biomethanation and Energy Recovery (Carbon Credit)	
6.13.1 General	
6.13.2 Digestion Gas Utilization	
6.13.3 Power Generation Using Digestion Gas	
6.13.4 Utilization of Dried Sludge and Carbonized Sludge as Fuel	
CHAPTER 7 RECYCLING AND REUSE	Chap.17, 19, 20
7.1 Treated Water Reclamation and Reuse Facilities	19.5, 19.6, 19.7,
7.1.1 Multipurpose Reuse (Agricultural, Industrial, Flush Toilet, Landscape, Recreational, Sprinkling, Cooling Water, Target Quality of Treated Water, Treatment Method, Design Flow and Intake Point)	20.3, 20.4, 20.5, 20.6, 20.7, 20.8
7.1.2 Reuse in Treatment Plant (Design Flow, Intake Point and Number of Series, Selection of Equipment-Mechanical Strainer, Rapid Filtration)	
7.2 Sludge Utilization	17.5
7.2.1 Estimation of Sludge Volume	
7.2.2 Investigation of Utilization Method	
7.2.3 Agricultural Use	
7.2.4 Energy Use	
CHAPTER 8 ONSITE METHODS	Chap.21
8.1 Background	21.2
8.2 Septic Tank (including improved version)	21.2
8.2.1 Design	
8.2.2 Construction Details	
8.2.3 Sludge Withdrawal and Disposal	
8.2.4 Secondary Treatment and Disposal of Effluent	
8.3 Pour Flush Water Seal Latrines	21.3
8.3.1 Design and Materials	
8.3.2 Construction Details	
8.3.3 Pollution Safeguard	
8.4 Overview of Other Alternative Onsite Methods	21.4
8.4.1 Bucket/Dry Latrine	

New Manual	Existing Manual
8.4.2 Trench Latrine (Shallow Type)	
8.4.3 Bore Hole Latrine	
8.4.4 Dug Well Latrine	
8.4.5 Aqua Privy	
8.4.6 Ventilated Improved Pit Latrine (VIP Latrine)	
8.5 Night Soil Digesters (from Japan)	21.5
8.5.1 Design Criteria	
8.6 Decision Making	
(Onsite/Decentralized Sewage Treatment Systems not connected to a centralized Sewage Treatment plant)	
8.6.1 General	
8.6.2 Problems with Existing Onsite Systems	
8.6.3 Elements of Successful Program	
(Public education, Technical guidelines)	
8.6.4 Establishing Treatment System Performance Requirements	
(Estimating sewage characteristics, Estimating sewage flow, Minimizing sewage flows and pollutants)	
8.6.5 Transport and Fate of Sewage Pollutants in the Receiving Environment	
8.6.6 An Overview of New Onsite Sewage Treatment Technologies	
・ Jokaso System(Combined Household Sewage Treatment Facility)	
・ Continuous-Flow, Suspended-Growth Aerobic Systems (CFSGAS)	
・ Fixed-film processes	
・ Sequencing batch reactor systems	
・ Effluent disinfection processes	
・ Stabilization ponds, Free Water Surface (FWS) constructed wetlands, and other aquatic systems	
・ Intermittent sand/media filters - intermittent sand bed septic systems	
・ Recirculating sand/media filters - recirculating sand bed septic systems	
・ Land treatment systems	
・ Renovation/restoration of subsurface wastewater infiltration systems (SWIS)	
8.6.7 Mini Package Treatment Plants	21.6
(For Multi-Storied Buildings, Housing Complexes and Hospitals in Unsewered Area)	
CHAPTER 9 EMERGING TRENDS	Chap.3, 17, 22, 26
9.1 General	
9.2 Supplemental Treatment Processes	
9.2.1 Duckweed Pond Technology	26.2
9.2.2 Vermiculture Technology	26.3

New Manual	Existing Manual
9.2.3 Land Treatment System (Tree Plantation, Root Zone Technology,)	26.4, 26.5
9.3 Tertiary/Advanced Treatment Technologies	
9.3.1 Coagulation, Flocculation and Sedimentation	
9.3.2 Filtration (Sand, Dual Media, Multimedia, Membrane)	
9.3.3 Recycled Nitrification/Denitrification Process	
9.3.4 Phosphorus Removal	
9.3.5 Wuhrmann Process	
9.3.6 Step-Feed Multistage Biological Nitrogen Removal Process	
9.3.7 Advanced Oxidation Ditch Process	
9.3.8 Anaerobic-Oxic Activated Sludge Process	
9.3.9 Anaerobic-Anoxic-Oxic Process	
9.3.10 Membrane Bioreactor	
9.3.11 Sequencing Batch Reactors(SBR)	
9.3.12 Moving Bed Biofilm Reactor (MBBR)	
9.3.13 Downflow Hanging Sponge(DHS)	
9.4 Sludge Treatment Technologies	
9.4.1 Sludge Drying	17.3.3
9.4.2 Sludge Incineration	17.3.4
9.4.3 Sludge Melting	
9.4.4 Sludge Carbonization	
9.4.5 Sludge Composting	
9.4.6 Sludge storage Lagoons (Location, Seal, Access, Supernatant Disposal)	

(B) Operation and Maintenance

Table of contents of manual on Part B Operation and Maintenance, modified based on the discussion in Third Expert Committee meeting, is shown in Table 5-2.

Related Chapter or Section in the existing manual is mentioned in the second column of this Table.

Table 5-2 Table of Contents of Part B Operation and Maintenance

New Manual	Existing Manual
CHAPTER 1 GENERAL	Chap. 8
1.1 Introduction	8.3
1.2 Basic Considerations	
1.2.1 Laws and Regulations related to O&M of Sewerage System	
1.2.2 Effluent Standards related to treatment plants	
1.2.3 Environmental considerations	
1.2.4 Problems with Industrial Effluent (monitor, case studies, etc.)	

New Manual	Existing Manual
1.3 Outline of Operation and Maintenance	8.2
1.3.1 Overview and contents of O&M	
1.3.2 Management of facilities (Proper housekeeping, aesthetics, gardening)	
1.3.3 Schedule of O&M	
1.3.4 Response to accidents	
1.3.5 Management of buildings and sites	
1.4 Organization for Operation and Maintenance	8.4
1.4.1 Description of O&M work	
1.4.2 Deployment of Manpower (example)	
1.4.3 Subcontracting work (example)	
1.4.4 Training	
1.5 Community Awareness (including Citizen Charter)	
1.5.1 Public relations and public opinion related to sewerage works	
1.5.2 Complaint and Redressal	
1.5.3 Do's and Don'ts for Community (solid waste, storm water, puncture sewers, dead animals, etc.)	
1.6 Disaster Management	
1.6.1 Provision of disaster prevention systems	
1.7 Sewerage Ledger	
1.7.1 Preparation of Sewerage Ledger	
1.7.2 Management and use of Sewerage Ledger	
CHAPTER 2 SEWER SYSTEMS	Chap. 8
2.1 Introduction	
2.2 Inspection and Examination	8.12, 8.13
2.2.1 Importance of inspections and examinations	
2.2.2 Guidelines for Inspections and Examinations	
2.2.3 Maintenance of Records and Follow up Action	8.16
2.3 Sewer Cleaning	8.7, 8.8
2.3.1 Cleaning (Subsections for each equipment to be added 4th level, Maintenance of cleaning machinery and apparatus)	
2.3.2 Disposal of Silt and sludge	
2.3.3 Cleaning records and their utilization	
2.4 Sewer Rehabilitation	8.14
2.4.1 Rehabilitation method	
2.4.2 Maintenance of machinery and apparatus for rehabilitation (to be discussed in the working group)	
2.5 Protection of Sewer Systems	
2.5.1 Protection of facilities	
2.5.2 Measures against damage	
2.6 Protection Against Infiltration and Exfiltration	

New Manual	Existing Manual
2.6.1 Measures against infiltration of rainwater	
2.6.2 Measures against exfiltration of untreated sewage	
2.7 Manholes and Appurtenances	
2.7.1 Inspections and examinations	
2.7.2 Judgment of examination results	
2.7.3 Cleaning	
2.7.4 Rehabilitation	
2.8 Cross Drainage Works	
2.8.1 Inspection	
2.8.2 Examination	
2.8.3 Criteria for judging examination results	
2.8.4 Cleaning	
2.8.5 Rehabilitation	
2.9 Pressure sewer	
2.9.1 O&M system and implementation plan	
2.9.2 Pressure-type sewage transport system	
2.9.3 Vacuum-type sewage collection system	
2.9.4 Pressure-type sewage collection system	
2.10 House Service Connection	8.6
2.10.1 Inspection	
2.10.2 Examination	
2.10.3 Criteria for judging examination results	
2.10.4 Cleaning	
2.10.5 Rehabilitation	
2.11 Safety Practices	8.9, 8.10, 8.11,
2.11.1 Accidents related to sewer facilities	8.15
2.11.2 Measures against accidents	
2.11.3 Information to prevent accidents and records	
2.12 Troubleshooting	
CHAPTER 3 PUMPING STATIONS	
3.1 Introduction	
3.2 Types and Structure of Pumping Stations	
3.2.1 Types	
3.2.2 Configuration of pumping stations	
3.2.3 Operation and Management of pumping stations	
3.3 Gates, Valves and Actuators	
3.3.1 Gates	
3.3.2 Valves	
3.3.3 Actuators	
3.4 Screen	

New Manual	Existing Manual
3.4.1 Overview	
3.4.2 Manual screen	
3.4.3 Mechanical Screen (Intermittent and Continuous)	
3.4.4 Rotary Drum Screen	
3.4.5 Accessories (Conveyors)	
3.4.6 Disposal of screenings	
3.5 Grit Chamber	
3.5.1 Overview	
3.5.2 Management of grit chamber	
3.5.3 Types of grit chamber (Channel Type, Detritors (Square Type), Aerated, Vortex)	
3.6 Grit Removal Equipment	
3.6.1 Overview	
3.6.2 Grit collector (Scraper)	
3.6.3 Grit lifter (bucket conveyor type grit collector)	
3.6.4 Grit pump	
3.6.5 Grit classifier (Inclined rake, and screw type)	
3.6.6 Disposal of grit	
3.7 Dry well	
3.7.1 Overview	
3.7.2 Types of dry well	
3.8 Wet Well	
3.8.1 Overview	
3.8.2 Types of wet well	
3.9 Pump Equipment	
3.9.1 Centrifugal pump	
3.9.2 Submersible pump (centrifugal impeller, screw impeller)	
3.9.3 Immersible pump	
3.9.4 Screw pump	
3.9.5 Vertical-shaft pump	
3.9.6 Horizontal-shaft pump	
3.9.7 Accessories	
3.10 Intermediate Lift Station	
3.11 Flow Measuring Devices	
3.11.1 Overview	
3.11.2 Electromagnetic flowmeter	
3.11.3 Ultrasonic flowmeter	
3.12 Preventive Maintenance (Including civil structures, Do's and Don'ts)	
3.13 Safety Practices	

New Manual	Existing Manual
3.14 Troubleshooting	Chap. 9, 9.7.10
CHAPTER 4 SEWAGE TREATMENT FACILITIES	Chap. 23
(Technologies same as in Design Manual)	
4.1 Introduction	
4.2 Pump Equipment	
(Refer to Chapter 3)	
4.2.1 Centrifugal pump	
4.2.2 Submersible pump (centrifugal impeller, screw impeller)	
4.2.3 Immersible pump	
4.2.4 Screw pump	
4.2.5 Vertical-shaft pump	
4.2.6 Horizontal-shaft pump	
4.2.7 Accessories	
4.3 Fine Screen and Grit Chamber	
4.3.1 Manual screen	
4.3.2 Intermittent screen	
4.3.3 Continuous screen	
4.3.4 Grit chamber management	
4.4 Oil and Grease Removal	
4.4.1 Manual Process	
4.4.2 Floatation Process	
4.5 Equalization	
4.5.1 Equalization Tank	
4.6 Primary Treatment	
4.6.1 Primary sedimentation tank management	
4.7 Activated Sludge Process (ASP)	
4.7.1 Conventional Activated Sludge Process	
4.7.2 Extended Aeration Process	
4.7.3 Activated Sludge Process – Chemical Aided Flocculation and Tertiary Sedimentation	
4.7.4 High Rate Activated Sludge Process	
4.7.5 Sequencing Batch Reactor (SBR)	
4.8 Aerated Lagoon	
4.9 Oxidation Ditch	
4.10 Fluidized Bioreactors	
4.10.1 Moving Bed Bioreactor	
4.11 Biotower	
4.11.1 Trickling Filter	
4.11.2 Synthetic Media Filter	
4.12 Membrane Bioreactor	

New Manual	Existing Manual
4.13 Upflow Anaerobic Sludge Blanket Reactor (UASB) (Including post treatment 'Downflow Hanging Sponge, FPU, Duckweed Pond')	
4.14 Waste Stabilization Pond (Including Aerobic, Anaerobic, Facultative anaerobic and Maturation ponds)	
4.15 Farm Forestry	
4.16 Fish Pond	
4.17 Integrated Nutrient removal	
4.18 Disinfection facility (Chlorine disinfection, Chlorination chamber)	
4.19 Advanced Treatment (Pressure Filtration, Dual Media Filtration, Micro Filtration, Reverse Osmosis)	
4.20 Aeration Equipment	
4.20.1 Blower	
4.20.2 Diffuser	
4.20.3 Surface Aerator	
4.20.4 Submersible Aerator	
4.20.5 Air Piping – Valves and Actuators	
4.21 Preventive maintenance (Including civil structures, Do's and Don'ts)	
4.21.1 Routine inspection	
4.21.2 Periodic inspection and rehabilitation	
4.21.3 Planned reconstruction	
4.21.4 Equipment Ledger and its utilization	
4.22 Safety Practices	
4.23 Troubleshooting	
CHAPTER 5 SLUDGE TREATMENT FACILITIES	Chap. 23
5.1 Introduction	
5.2 Sludge Thickening	
5.2.1 Gravity thickening	
5.2.2 Configuration of equipment	
5.2.3 Operation and management	
5.2.4 Inspection and maintenance	
5.2.5 Measures during abnormality	
5.3 Aerobic Digestion	
5.3.1 Aeration equipment	
5.3.2 Operation and management	
5.3.3 Inspection and maintenance	
5.3.4 Measures during abnormality	

New Manual	Existing Manual
5.4 Anaerobic Digestion	
5.4.1 Agitator	
5.4.2 Digester gas equipment	
5.4.3 Gas Scrubbers	
5.4.4 Gas power generator	
5.4.5 Operation and management	
5.4.6 Inspection and maintenance	
5.4.7 Measures during abnormality	
5.5 Sludge dewatering (cover all equipment of design part)	
5.5.1 Chemical dosing equipment	
5.5.2 Centrifugal dewatering equipment	
5.5.3 Belt press dewatering equipment	
5.6 Sludge Drying Bed	
5.6.1 Operation and management	
5.6.2 Measures during abnormality	
5.7 Preventive Maintenance	
(Including civil structures, Do's and Don'ts)	
5.7.1 Routine inspection	
5.7.2 Periodic inspection and rehabilitation	
5.7.3 Planned reconstruction	
5.7.4 Equipment Ledger and its utilization	
5.8 Safety Practices	
5.9 Troubleshooting	
CHAPTER 6 ELECTRICAL AND INSTRUMENTATION FACILITIES	Chap. 9, 9.11
6.1 Introduction	
6.2 Power Supply Facilities	
6.2.1 Supply and Interruption	
6.2.2 Receiving equipment (HT panel, Transformer, LT panel, Bus-bar)	
6.2.3 Control equipment (power factor control, capacitor panel, stabilizer for small intermediate pumps)	
6.2.4 Inspection and Maintenance	
6.2.5 Dual fuel engine	
6.2.6 Gas Engines	
6.3 Standby Power Supply (Generator)	
6.3.1 Overview	
6.3.2 AC generator	
6.3.3 Diesel generator	
6.4 Prime Movers	
6.4.1 Overview	
6.4.2 Induction motor	

New Manual	Existing Manual
6.4.3 Starters	
6.4.4 Test measurements	
6.4.5 Speed control equipment (VFD, etc. in detail)	
6.4.6 Protection equipment	
6.5 Instrumentation Facility	
6.5.1 Measuring equipment (Ultrasonic, Electromagnetic, etc. in more detail)	
6.5.2 Monitoring and control equipment	
6.5.3 Automatic control equipment (HMI human machine interface, PLC)	
6.6 SCADA	
6.7 Cables	
6.8 Energy Audit	
6.9 Management of records	
6.9.1 Record of Operation and Maintenance	
6.9.2 Record of Operation and Maintenance and Its utilization	
6.10 Preventive Maintenance	
(Including civil structures, Do's and Don'ts)	
6.10.1 Routine inspection	
6.10.2 Periodic inspection and rehabilitation	
6.10.3 Planned reconstruction	
6.11 Safety Practices	
6.12 Troubleshooting	Chap. 9, 9.12
CHAPTER 7 QUALITY ANALYSIS	Chap. 24
7.1 Introduction	
7.2 Sampling	24.3
7.2.1 Overview	
7.2.2 Independent and mixed samples	
7.2.3 Sampling method	
7.2.4 Selection of sampling location	
7.2.5 Quantity and storage of samples	
7.2.6 Precautions during sampling.	
7.3 Relevance of Parameters	
(Contents of Analysis Parameters)	
7.4 Analysis Parameters and Frequency (liquid, sludge, and gas)	24.4
7.4.1 Items and frequency of daily tests and weekly tests	
7.4.2 Items and frequency of diurnal Examinations	
7.5 Quick and approximate measurement methods	
7.5.1 Test paper method	
7.5.2 Detector tube method (Transparency tube, BOD tube (UK))	
7.5.3 Pack test	
7.5.4 Cylinder Test	

New Manual	Existing Manual
(Including simplified colorimetric determination and simplified absorption spectrophotometry)	
7.6 Data Analysis	
(Accuracy and Precision)	
7.6.1 Processing water quality test data	
7.6.2 Accuracy of measured values	
7.6.3 Frequency management	
7.7 Up-keeping of Plant Laboratory (equipment)	
CHAPTER 8 ENVIRONMENTAL CONSERVATION	
8.1 Introduction	
8.2 Measures against Odour	
8.2.1 Odours	
8.2.2 Odour measurement	
8.2.3 Deodorizing methods	
8.3 Measures against air pollution	
(Measures against aerosols including bioaerosols)	
8.4 Measures against Noise and Vibration	
8.4.1 Noise and vibration	
8.4.2 Measurement of noise and vibration	
8.4.3 Measures to prevent noise and Vibration	
8.5 Measures against Soil Contamination and Groundwater Pollution	
8.5.1 Soil and groundwater	
8.5.2 Measurement of pollutants	
8.5.3 Measures against pollutants	
8.6 Measures against Natural Calamities	
(Earthquake, Flood, etc.)	
8.7 Regulation of Global Warming Gas	
(Effective use of biogas)	
8.8 Carbon Credit Record	
8.9 Plant Beautification and Landscaping	
CHAPTER 9 SAFETY AND HEALTH MANAGEMENT	
9.1 Introduction	
9.2 Safety Organization	
(Labour safety and welfare organization)	
9.3 Management Method	
9.4 Workers' Welfare, Safety and Health Measures	
CHAPTER 10 ONSITE SYSTEMS	
10.1 Water-less Systems	
10.2 Water-based Systems	
10.3 Combined Systems (Ecosan)	

New Manual	Existing Manual
CHAPTER 11 BUDGET ESTIMATES FOR OPERATION AND MAINTENANCE 11.1 Calculation of O&M costs (Based on man power requirement, energy requirement, chemicals, repairs, based on the size of the sewerage system) 11.2 O&M budget (including sewers and PSs) 11.3 Cost Recovery	

(C) Management

Table of contents of manual on Part C Management, modified based on the discussion in Third Expert Committee meeting, is shown in Table 5-3.

Related Chapter or Section in the existing manual is mentioned in second column of this Table.

Table 5-3 Table of Contents of Part C Management

New Manual	Existing Manual
CHAPTER 1 GENERAL	2.1, 2.2, 2.3, 2.4, 2.5
CHAPTER 2 INSTITUTIONAL FRAMEWORK	Chap. 2
2.1 Legal Aspect	2.4
(Regulatory Framework)	
2.1.1 General	
2.1.2 Water (Prevention and Control of Pollution) Act in 1974	
2.1.3 Water (Prevention and Control of Pollution) Cess Act in 1977	
2.1.4 Environment (Protection) Act in 1986	
2.1.5 Designated-Best-Use by Bureau of Indian Standard and Central Pollution Control Board in 1981	
2.1.6 General Standard for Discharge of Environmental Pollutants under the Environment Protection Rules in 1989	
2.2 Financial Aspect	2.5
2.2.1 General	
2.2.2 Scope	
2.2.3 Capital and Revenue	
2.2.4 Sources for Raising Capital	
2.2.5 Method of Raising Revenue	
2.2.6 Financial Appraisal	
2.2.7 Statutory Water and Sanitation Boards	
2.3 Human Resources Development	2.3
(Worker Welfare)	
2.3.1 Need for Human Resources Development	
2.3.2 Job Description	

New Manual	Existing Manual
2.3.3 Training Needs Assessment	
2.3.4 Training for Enhancement /Refreshing Skills	
2.3.5 Training of Trainers	
2.3.6 Training in Outside Institutions	
2.3.7 Long-Term Training Needs	
2.3.8 Short-Term Training Needs	
2.3.9 On-the-Job Training	
2.3.10 Quantification of Training	
2.3.11 Incentives for Efficient Performance	
2.3.12 Training Schedule and Yearly Programme	
2.3.13 Training Institutions	
2.3.14 Need for Training Budget	
2.4 Training Institution	2.3
2.4.1 International Training Network	
2.4.2 National Education/Training Facilities	
CHAPTER 3 FINANCIAL MANAGEMENT	2.5
3.1 Introduction	
3.2 Categories of Consumers	
3.3 Charges (Fixation, Levy, Billing, Collection, Defaults)	
3.4 Financial Resource Generation	
3.5 Computerised Sewage Billing System	
CHAPTER 4 COMMUNITY PARTICIPATION	3.2.5
4.1 Community Awareness Programme	
4.2 Formation of Public Relation Unit	
4.3 Public Redressal System	
CHAPTER 5 PUBLIC PRIVATE PARTNERSHIP (PPP)	
5.1 Introduction	
5.2 Need and Advantages of PPP	
5.3 Constraints of Public Private Partnership	
5.4 Legal Framework (Regulatory)	
5.5 Subsidies to the Poor	
5.6 Competitive Bidding	
5.7 Issues in Public Private Partnership (Risks and Responsibilities)	
5.8 Suitability of Private Sector Partnership Contracts	
5.9 Conclusion	
CHAPTER 6 ASSET MANAGEMENT	
6.1 Introduction	
6.2 Ageing Infrastructure Impact the Society	

New Manual	Existing Manual
6.3 Basic Concept of Asset Management	
6.4 Asset Management for Sewage Treatment Plant and Pumping station	
6.5 Asset Management for Sewer	
CHAPTER 7 MANAGEMENT INFORMATION SYSTEM (MIS)	3.2
7.1 Organization Structure	
7.2 Management Level	
7.2.1 Senior Management	
7.2.2 Middle Management	
7.2.3 Operational Management	
7.3 Size of Organization and Scale of Operations	
7.4 Centres for Decision Making	
7.5 Management Indicators	
7.5.1 Limitations	
7.5.2 How to use the indicators	
7.6 Computerised MIS	
7.6.1 Information Systems Division	
7.6.2 The Technology	
7.6.3 The environment	
7.7 Various Main/Sub System for MIS in Sewer System	
7.7.1 Financial Management Information system	
7.7.2 Project Management Information system	
7.7.3 Human Resource Management Information System	
7.7.4 Material Management Information System	
7.7.5 Operation and Maintenance Management Information System	
7.7.6 Marketing Management Information System	

5.2 Proposed Scope of Work of Phase 2 Study

This section presents a draft scope of work for Phase 2, in which the actual preparation of drafts of the manuals is carried out.

5.2.1 Objectives of Phase 2 Study

The objectives of the Study are:

i) To draft the manuals for the sewerage and sewerage treatment

ii) To provide technical transfer to the counterparts

During the Study, drafts of manuals will be prepared under guidance of the Expert Committees. The drafts will be revised by the Indian side appropriately and then CPHEEO will constitute them.

5.2.2 Manuals to be prepared

Based on the agreement of the first Expert Committee, the study will prepare drafts of following 3 volumes of manuals:

- Part A Engineering (Planning and Design) Manual
- Part B Operation and Maintenance Manual
- Part C Management Manual

5.2.3 Study Flow

Draft preparation will be carried out in steps as follows:

i) Preparation of 1st draft based on the contents in 5.1.2 of this report by Study Team

ii) Discussion on description with Indian working groups

iii) Finalization of the 1st draft

iv) Presentation to and discussion with the Expert Committees of 1st draft

v) Modifications based on discussion with the Expert Committees to prepare 2nd draft

vi) Discussion on 2nd draft with Indian working groups

vii) Presentation to and discussion with the Expert Committees of 2nd draft

viii) Modifications based on discussion with the Expert Committees to prepare final draft

ix) Approval of final draft by the Expert Committees

5.2.4 Manner of Draft Preparation

Draft will be prepared in the following manner:

i) Engineering (Planning and Design) Manual will be prepared as a revision of the existing Manual on Sewerage and Sewage Treatment with the necessary additions and updates.

ii) Operation and Maintenance Manual and Management Manual will be prepared as new manuals. However, the corresponding contents in the existing Manual on Sewerage and Sewage Treatment will be transferred with necessary additions and updates.

iii) Description shall incorporate actual practices in India as far as possible.

iv) However, in case where quantitative data/information related to the Indian actual practice are not available, description will refer to references such as manuals/guidelines of other countries, text books and reference books.

5.2.5 Organization

(A) Study Team

i) Team Leader

ii) Management

iii) Planning and Design (Civil)

iv) Planning and Design (Sewer)

v) Planning and Design (Electrical/Mechanical)

vi) Operation and Maintenance (STPs)

vii) Operation and Maintenance (Sewer)

viii) Operation and Maintenance (Electrical/Mechanical)

ix) On Site Sanitation

x) Coordinator

(B) Indian Working Group

i) Planning and Design

ii) Operation and Maintenance

iii) Management

(C) Expert Committee

i) Planning and Design

ii) Operation and Maintenance

iii) Management

5.2.6 Work Schedule

Tentative time schedule of the Study is presented in Figure 5-1 below.

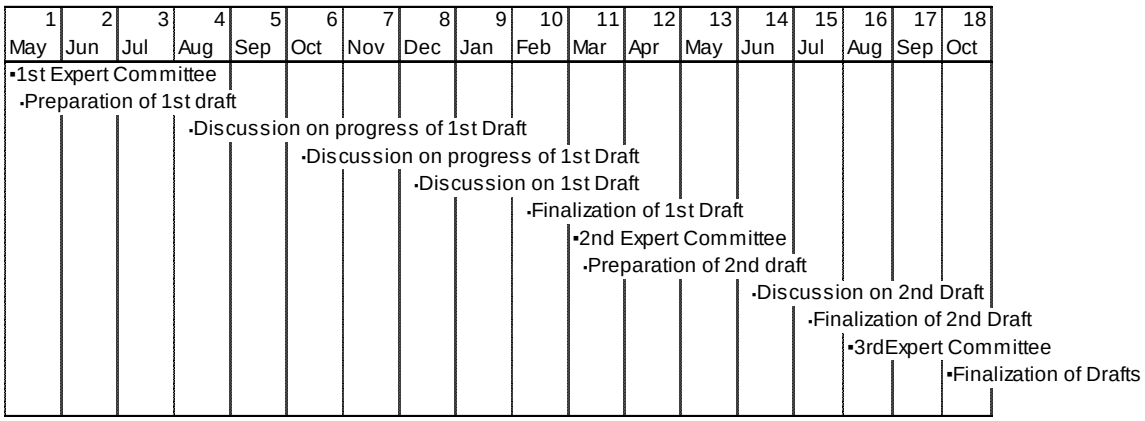

Figure 5-1 Tentative Work Schedule for Second Phase

5.2.7 Training

In Phase 2 of Study, training will be organized for members of Expert Committees to study and observe the sewerage system in Japan.

APPENDIX – A1-1

Participants of Expert Committee Meetings

Table 1 Participants of First Expert Committee Meeting on Revision of Manual on Sewerage and Sewage Treatment held on 26 August 2010

S. No.	Name	
1	Ms. E.P. Nivedita Director (WS), Ministry of Urban Development	Chairperson
2	Dr. S.R. Shukla, Former Adviser (PHEE) , CPHEEO	Co-Chairman & Member
3	Dr. Arvind K. Nema Associate Professor, IIT, Delhi	Member
4	Mr. B.B. Uppal, Former Dy. Adviser (PHE), CPHEEO	Member
5	Mr. D.P. Singh, Chief Engineer (Ganga), U.P. Jal Nigam	Member
6	Dr. Absar Ahmed Kazmi, Associate Professor, IIT, Roorkee	Member
7	Er. C. Lallunghnema, Superintending Engineer, PHED, Mizoram	Member
8	Dr. S. Sundaramoorthy, Retd. Engineering Director, CMWSSB	Member
9	Er. S.T. Gopalram, M.E. (PH), Joint Chief Engineer (P&D), TWAD Board	Member
10	Dr. Vinod Tare, Professor, IIT, Kanpur	Member
11	Dr. G.R. Pophali, Scientist, NEERI, Nagpur	Member
12	Mr. Nazimuddin, Senior Environmental Engineer, Central Pollution Control Board	Member
13	Mr. D.K. Agarwal, Scientist F, Bureau of Indian Standards (BIS)	Member
14	Mr. V.K. Chaurasia, Deputy Adviser (PHE), CPHEEO	Member
15	Mr. M. Dhinadhayalan, Deputy Adviser (PHE), CPHEEO	Member Secretary
16	Mr. M. Sankara Narayanan, Deputy Adviser (PHE), CPHEEO	

Table 2 Participants of First Expert Committee Meeting on Preparation of Manual on Operation and Maintenance of Sewerage System held on 27 August 2010

S. No.	Name	
1	Ms. E.P. Nivedita Director (WS), Ministry of Urban Development	Chairperson
2	Dr. S.R. Shukla, Former Adviser (PHEE), CPHEEO	Co-Chairman & Member
3	Mr. S.V. Ahuja, Project Director, Gujarat Water Supply and Sewerage Board	Member
4	Mr. G. Elangovam, Engineering Director CMWSS Board, Chennai	Member
5	Mr. J.P. Mani, Project Manager, Ganga Pollution Control Unit, U.P. Jal Nigam, Allahabad	Member
6	Dr. Absar Ahmed Kazmi, Associate Professor, IIT, Roorkee	Member
7	Dr. S. Sundaramoorthy, Retd. Engineering Director, CMWSSB	Member
8	Mr. S.M. Jejurikar, Chief Engineer (M&E) Municipal Corporation of Mumbai	Member
9	Mr. Sumit Dutta, Chief Engineer (S&D), Kolkata Metropolitan Development Authority	Member
10	Mr. Dilip Kumar Padhi, Chief Engineer, Member Secretary, Orissa Water Supply and Sewerage Board	Member
11	Mr. J.S. Bahra, Executive Engineer, Punjab Water Supply and Sewerage Board	Member
12	Mr. M. Satyanarayanan, Director Projects, Hyderabad Metropolitan Water Supply & Sewerage Board	Member
13	Mr. J.B Ravindar, Assistant Adviser (PHE)	Member
14	Mr. M. Sankara Narayanan, Deputy Adviser (PHE), CPHEEO	Member
15	Mr. M. Dhinadhayalan, Deputy Adviser (PHE), CPHEEO	Member Secretary

Table 3 Participants of Second Expert Committee Meeting on Revision of Manual on Sewerage and Sewage Treatment held on 27 October 2010

S. No.	Name	
1	Dr. S.R. Shukla, Former Adviser (PHEE) , CPHEEO	Co-Chairman & Member
2	Dr. Absar Ahmed Kazrni, Associate Professor, IIT, Roorkee	Member
3	Er. C. Lallunghnema, Superintending Engineer, PHED, Mizoram	Member
4	Dr. S. Sundaramoorthy, Retd. Engineering Director, CMWSSB	Member
5	Er. S.T. Gopalram, M.E. (PH), Joint Chief Engineer (P&D), TWAD Board	Member
6	Dr. Vinod Tare, Professor, IIT, Kanpur	Member
7	Dr. G.R. Pophali, Scientist, NEERI, Nagpur	Member
8	Mr. V.K. Chaurasia, Deputy Adviser (PHE), CPHEEO	Member
9	Mr. M. Dhinadhayalan, Deputy Adviser (PHE), CPHEEO	Member Secretary
10	Dr. Hemant C. Landge, Chief Engineer, Maharashtra Jeevan Pradhikaran, Thane-400603	Member
11	Dr. R.K. Singh, Assistant Chief (Projects) Housing and Urban Development Corporation Ltd.	
12	Dr. Ramakant, CPHEEO	
13	Mr. S. Arun Kumar	
14	Mr. Mihir Sorti	

Table 4 Participants of Second Expert Committee Meeting on Preparation of Manual on Operation and Maintenance of Sewerage System held on 28 October 2010

S. No.	Name	
1	Dr. S.R. Shukla, Former Adviser (PHEE), CPHEEO	Co-Chairman & Member
2	Mr. G. Elangovam, Engineering Director CMWSS Board, Chennai	Member
3	Mr. J.P. Mani, Project Manager, Ganga Pollution Control Unit, U.P. Jal Nigam, Allahabad	Member
4	Dr. Absar Ahmed Kazmi, Associate Professor, IIT, Roorkee	Member
5	Dr. S. Sundaramoorthy, Retd. Engineering Director, CMWSSB	Member
6	Mr. S.M. Jejurikar, Chief Engineer (M&E) Municipal Corporation of Mumbai	Member
7	Mr. Sumit Dutta, Chief Engineer (S&D), Kolkata Metropolitan Development Authority	Member
8	Mr. Dilip Kumar Padhi, Chief Engineer, Member Secretary, Orissa Water Supply and Sewerage Board	Member
9	Mr. M. Dhinadhayalan, Deputy Adviser (PHE), CPHEEO	Member Secretary
10	Dr. Ramakant, CPHEEO	
11	Mr. Rangadhamaiah	

Table 5 Participants of Third Expert Committee Meeting on Revision of Manual on Sewerage and Sewage Treatment held on 19 January 2011

S. No.	Name	
1	Ms. E.P. Nivedita Director (WS), Ministry of Urban Development	Chairperson
2	Dr. S.R. Shukla, Former Adviser (PHEE) , CPHEEO	Co-Chairman & Member
3	Dr. Absar Ahmed Kazrni, Associate Professor, IIT, Roorkee	Member
4	Mr. Nazimuddin Senior Environmental Engineer, CPCB	Member
5	Er. C. Lallunghnema, Superintending Engineer, PHED, Mizoram	Member
6	Mr. D.P. Singh Chief Engineer (Ganga), U.P. Jal Nigam	Member
7	Dr. S. Sundaramoorthy, Retd. Engineering Director, CMWSSB	Member
8	Dr. Vinod Tare, Professor, IIT, Kanpur	Member
9	Dr. A.K. Dussa Director (UWE), Ministry of New & Renewable Energy	Member
10	Dr. Arvind K. Nema Associate Professor, IIT, Delhi	Member
11	Mr. D.K. Agrawal Scientist F, BIS	Member
12	Mr. R. Sethuraman Former Joint Adviser (PHEE), CPHEEO	Member
13	Mr. B.B. Uppal Former Deputy Adviser (PHE), CPHEEO	Member
14	Mr. V.K. Chaurasia, Deputy Adviser (PHE), CPHEEO	Member
15	Mr. J.B. Ravindar Assistant Adviser (PHE), CPHEEO	
16	Dr. Ramakant, Assistant Adviser, CPHEEO	Special Invitee

Table 6 Participants of Third Expert Committee Meeting on Preparation of Manual on Operation and Maintenance of Sewerage System held on 20 January 2011

S. No.	Name	
1	Dr. S.R. Shukla, Former Adviser (PHEE), CPHEEO	Co-Chairman & Member
2	Mr. K.L. Swara Director (Planning and Design), PWSSB	
3	Mr. S.M. Jejurikar, Chief Engineer (M&E) Municipal Corporation of Mumbai	Member
4	Mr. Dilip Kumar Padhi, Chief Engineer, Member Secretary, Orissa Water Supply and Sewerage Board	Member
5	Dr. Absar Ahmed Kazmi, Associate Professor, IIT, Roorkee	Member
6	Mr. J.P. Mani, Project Manager, Ganga Pollution Control Unit, U.P. Jal Nigam, Allahabad	Member
7	Dr. S. Sundaramoorthy, Retd. Engineering Director, CMWSSB	Member
8	Mr. G. Elangovam, Engineering Director CMWSS Board, Chennai	Member
9	Mr. M. Sankara Narayanan, Deputy Adviser (PHE), CPHEEO	Member
10	Mr. R. Sethuraman Former Joint Adviser (PHEE), CPHEEO	
11	Mr. J.B. Ravindar Assistant Adviser (PHE), CPHEEO	Member
12	Dr. Ramakant, Assistant Adviser, CPHEEO	Special Invitee

APPENDIX – A2-1

Status of Sewerage in India

Status of Sewerage in India

The following is the status of sewerage in India extracted from the report which is "Status of Water Supply, Sanitation and Solid Waste Management in Urban Areas, June 2005" sponsored by Central Public Health and Environmental Engineering Organisation (CPHEEO), Ministry of Urban Development, Government of India, and prepared by National Institute of Urban Affairs, June 2005.

EXECUTIVE SUMMARY

Providing water and sanitation to India's millions is a challenging task. With over 20 millionpeople without access to safe water supply and 100 million without safe sanitation, the sheer numbers indicate the massive effort required to provide these basic services to the people of the country. Just providing access, however, will not solve the problem unless the issues of quality and adequacy are also addressed. The minimum needs should be met and the quality of the services provided should be acceptable.

The present study assesses the status of three basic services - water supply, sanitation and municipal solid waste management. It covers over 300 cities and towns in the country including all metropolitan cities and selected Class I and Class II urban centres. The study covers all the states and union territories including the capitals, excepting Patna and Gandhinagar. The study was commissioned in 1999 and the data collection work took about a year.

The main objectives of the study were to a) assess the status of water supply, sanitation and solid waste management; b) analyse the revenue receipts and revenue expenditure of these services; and c) estimate the additional capital investment requirements for full coverage of population by these services from 1999 to 2022 (at five yearly intervals). The study covers the physical and financial aspects of all the three services selected for the study. A conscious decision was taken in the study to cover only the municipal area of the urban centres and not the areas falling within the jurisdiction of other authorities such as development authorities, cantonment boards, railways etc. This was done due to the time-frame of one year for the study which did not permit data collection from different agencies for the same service. The study gives the status of these services as provided by the public agencies and does not cover private provision.

A study of this magnitude can be successful only with the cooperation of the local agencies, which gave information on various aspects of the selected services. While every effort was made to collect as accurate a data as possible, it was not always possible to check it with the records of the agency. Records are often not computerised or kept properly, making data authentication difficult. However, wherever other data sources were available, attempts were made to cross-check the data collected and verify the authenticity of figures. Despite these problems, the data provided by this study does give a broad picture of the overall situation with respect to these services in the country.

(The descriptions of parts on water supply is omitted.)

Summary of Findings

Overall, the study confirms the normal notion that the metropolitan cities are better provided for than the other size class of urban centres. The coverage of population with basic services is higher for metropolitan cities than for other size class of urban centres. The investment levels are higher in the metropolitan cities due to large concentration of population in them. This could be one of the reasons for more people flocking to metropolitan cities – due to better provision of basic amenities.

The water supply situation, though much better in metropolitan cities at an aggregate level, is reasonably good in many Class I and Class II urban centres too. The situation with respect to wastewater management is much worse in smaller urban centres than in metropolitan cities. A similar situation is obtained in respect of solid waste management where the metropolitan cities fare much better than the other size class of urban centres. Financially also, the metropolitan and larger urban centres fare much better than the smaller ones. However, there are large variations in the status of individual urban centres with respect to these services. The study found that in some cases the smaller urban centres showed much better service provision than others. These isolated instances would be exceptions than the rule.

Sewerage and Sanitation

Wastewater disposal and treatment is a very major problem in most Indian cities. Non-collection of wastewater and discharge of untreated wastewater into low-lying areas or various water bodies causes sever water and land pollution problems. This situation reduces the availability of usable water for water supply.

The study indicates that while all the metropolitan cities have a sewerage system, a third- of the Class I cities and less than one-fifth of the smaller sized urban centres have a sewerage system. However, the coverage of population by the sewerage system is partial in all these urban centres.

Wastewater generation is calculated at a minimum of 80 per cent of water supplied. However, since people use their own sources of water, additional amounts of wastewater may be generated, which have been taken into account in the present study. Wastewater collection in most urban centres with sewerage system usually does not exceed about two-thirds of that generated. However, the wastewater treatment situation is quite alarming. While the smaller sized urban centres with sewerage system treat less than one-fourth of the wastewater generated, even the metropolitan cities treat only about two-fifths of the wastewater generated. Wastewater disposal is done both on land and in water body by most urban centres. Proximity to water body, local conditions and financial constraints determine the place and method of wastewater disposal.

Recycling/ reuse of wastewater is practised in very few urban centres and wherever it is done, it is mostly used for agriculture or horticultural purposes. Recycling/ reusing wastewater will reduce the demand for fresh water, thereby also postponing the capital investment requirements for water augmentation.

There is no fixed mechanism for charging for wastewater collection and disposal. The charging may be through property tax, a charge on water closet or an additional charge on water supplied.

Wastewater is not charged for in all urban centres, therefore, the cost recovery is generally very low from this service with even the metro cities showing a very small recovery rate. The situation is even worse in urban centres of smaller size. In most cities where the recovery rate has been very good, the reasons have been either due to provision of new connections (connection charges) or due to levying of sewerage/ drainage tax.

The additional capital investment required for providing safe sanitation to all in the coming years many is thousands of crores, which would be very difficult to finance. Private sector participation as well as citizen’s contribution can help provide some of the additional capital investment requirements.

Recommendations

1. Rehabilitation of sewerage systems must be taken up in all the cities where the

sewerage system exists but has become non-functional.

2. Wastewater treatment must be made mandatory for all sizes of urban centres. The smaller urban centres could use less capital-intensive technologies to reduce capital cost as well as maintenance cost of treatment.

3. Pollution of land or water body with untreated wastewater should be made punishable with fine.

4. Recycling/ reuse of wastewater must be encouraged. Technical and financial assistance must be provided for this, if required.

5. All agencies dealing with wastewater must prepare plans for cost recovery from this service. Private sector participation could be encouraged in managing this service to reduce public expenditure.

6. Successful examples of people's participation in contributing to the cost of construction of sewerage system (e.g. Alandur) must be examined and adopted in other urban centres of the country.

The following are the various data which shows the status of sewerage in India. These are extracted from the report which is "Status of Water Supply, Sanitation and Solid Waste Management in Urban Areas, June 2005"

STATUS OF SEWERAGE IN INDIA

1. COVERAGE BY SEWERAGE SYSTEM

- **Urban Centres Covered**

Table – 3.1: Sampled urban Centers with Sewerage System – 1999

Sewerage system	Number of sampled cities / towns by size class				
	Metropolitan	Class I	Class II	Total	%
Yes	22	57	21	100	34
Not functional	-	12	2	14	4
No	-	88	86	174	58
n.a.	-	7	6	13	4
Total	22	164	115	301	100

Source: NIUA Survey, 1999

Table – 3.2: Sampled Cities with Type of Sewerage System – 1999

Type of sewerage system	Metropolitan cities	Class I cities	Class II towns	Total	%
Separate	16	31	13	60	60
Combined with drainage	6	25	7	38	38
n.a.	0	1	1	2	2
Total	22	57	21	100	100

Note: In two Class I cities and one Class II town the sewerage system is not functional, while in two Class I cities the system is under construction.

Source: NIUA Survey, 1999 See Statistical Volume – II, Table B – 2 for details

- **Population Covered**

Table – 3.3: Population Covered by Sewerage System – 1999

Cities / Towns	No. of urban centers		% population covered	
	Total sample	With sewerage system*	In total sampled urban centers	In urban centers with sewerage system
Metropolitan	22	22	63	63
Class I	164	57	26	48
Class II	115	21	11	51
Total	301	100	45	58

*Sampled urban centers with functional sewerage system.

Source: NIUA Survey, 1999 See Statistical Volume – II, Table B – 1 for details

2. WASTEWATER GENERATION, COLLECTION AND DISPOSAL

- **Generation and Collection**

Table – 3.4: Volume of Wastewater Generated, Collected and Treated – 1999

Waste water volume	Metropolitan cities*	Class I cities	Class II towns	Total
Wastewater generated (mld)	10,907.0	3,298.2	208.3	14,413.5
Wastewater collected (mld)	6,707.0	1,703.7	135.8	8,546.6
Wastewater treated (mld)	4,424.3	826.1	23.6	5,274.0
Wastewater discharged untreated (mld)	6,482.7	2,472.1	184.7	9,139.5
% collected to generated	61	52	65	59
% treated to collected	66	48	17	62
% treated to generated	41	25	11	37
No. of cities / towns	21	57	21	100

*Excludes Lucknow for which information on quantity of waste water treated was not available

Source: NIUA Survey, 1999 See Statistical Volume – II, Table B –2 for details

Table – 3.5: Wastewater Collection Efficiency – 1999

(no. of cities / towns)

% waste water collected to generated	Metropolitan cities	Class I cities	Class II towns	Total	%
< 25	2	12	2	16	16
> 25 to 50	6	17	2	25	25
> 50 to 75	11	17	12	40	40
> 75 to 99	3	11	5	19	19
100	0	0	0	0	0
n.a.	0	0	0	0	0
Total no. of urban centers	22	57	21	100	100
Average (%)	61	52	65	59	

Source: NIUA Survey, 1999 See Statistical Volume – II, Table B –2 for details

- **Discharge of Wastewater**

Table – 3.6: Discharge Wastewater – 1999

(No. of cities / towns)

Discharge of waste water into	Metropolitan cities	Class I cities	Class II towns	Total	%
Land	3	19	0	22	22
Water body	9	20	7	36	36
Land and water body	10	18	13	41	41
n.a.	0	0	1	1	1
Average (%)	22	57	21	100	100

Source: NIUA Survey, 1999 See Statistical Volume – II, Table B –2 for details

- **Recycling/Reuse of Wastewater**

Table – 3.7: Recycling of Wastewater – 1999

(No. of cities / towns)

% Recycle / reuse of sewage for agriculture / horticulture	Metropolitan cities	Class I cities	Class II towns	Total	%
< 10	4	2	0	6	14
10 - 25	2	1	0	3	7
25 – 50	3	6	0	9	20
> 50	2	16	8	26	59
Total	11	25	8	44	100
Average (%)	26	55	100	30	

Source: NIUA Survey, 1999 See Statistical Volume – II, Table B –4 for details

3. WASTEWATER TREATMENT

- **Treatment**

Table – 3.8: Wastewater Treated to Collected – 1999

(No. of cities / towns)

% waste water treated to collected	Metropolitan cities	Class I cities	Class II towns	Total	%
0	3	29	15	47	47
1 to 25	1	2	1	4	4
25-50	2	5	0	7	7
50-75	5	5	0	10	10
75-99	0	5	0	5	5
100	10	11	5	26	26
n.a.	1	0	0	1	1
Total no. of urban centers	22	57	21	100	100
Average (%)	66	48	17	62	

Source: NIUA Survey, 1999 See Statistical Volume – II, Table B – 2 for details

- **Type of Treatment**

Table – 3.9: Type of Wastewater Treatment – 1999

(No. of cities / towns)

Type of wastewater treatment	Metropolitan cities	Class I cities	Class II towns	Total	%
Primary	9	8	2	19	19
Primary and Secondary	9	24	5	38	38
None	3	26	14	43	43
n.a.	1	1	0	2	2
Total	22	57	21	100	100

Source: NIUA Survey, 1999 See Statistical Volume – II, Table B – 3 for details

- **Treatment Process**

Table – 3.10: Wastewater Treatment Process – 1999

(No. of cities / towns)

Wastewater treatment process	Metropolitan cities	Class I cities	Class II towns	Total	%
Extended aeration	10	19	4	33	33
Activated sludge process	4	4	1	9	9
Stabilization pond	1	2	0	3	3
Up – flow anaerobic sludge blanket (UASB)	0	5	0	5	5
Others*	3	0	2	5	5
n.a.	1	1	0	2	2
None	3	26	14	43	43
Total	22	57	21	100	100

Source: NIUA Survey, 1999 See Statistical Volume – II, Table B – 3 for details

*Others include cases where there is a combination of 2 treatment processes or a different process from the choices given.

- **Sewage Treatment Plants**

Table – 3.11: Sewage Treatment Plants – 1999

(no. of cities / towns)

	With Sewage Treatment Plant	Without Sewage Treatment Plant	Total
Metropolitan cities	18	4	22
Class I cities	29	28	57
Class II towns	4	17	21
Total	51	49	100

Source: NIUA Survey, 1999 See Statistical Volume – II, Table B – 3 for details

4. CHARGING FOR WASTEWATER

Table – 3.12: Sources of Revenue Wastewater Management – 1999

Metropolitan Cities	Rate (percentage of property tax)
Delhi	5% of arv
Greater Mumbai	25% of arv
Jaipur	20% of arv
Kanpur	4% of arv
Luc know	3% of arv
Pune	4% of arv

Other Cities	Rate (percentage of property tax)
Allahabad	4% of arv
Bareilly	4% of arv
Bhind	1.5 % to 2.5% of arv
Bhuj	6% of arv
Ghaziabad	2.5% of arv
Hardwar	2% of arv
Kolhapur	1.5% to 2.5% of arv
Muzapur	2.5% of arv
Morena	3% of arv
Navsari	6% of arv
Rajkot	9% of arv
Roorkee	5% of arv
Solapur	1% of arv
Tiruchirapalli	1.5% of arv

arv: Annual Rental Value

City	Rate (per water closet - domestic)
Ambala	Rs. 60 per wc / yr.
Bhubaneswar	Rs. 120 per wc / yr.
Dhule	Rs. 200 per wc / yr.
Eluru	Rs. 24 per wc / yr.
Guntur	Rs. 60 per wc / yr. & Rs. 120 per wc / yr. (non-domestic)
Gurgaon	Rs. 60 per wc / yr.
Hissar	Rs. 60 per wc / yr.
Hoshiarpur	Rs. 120 per wc / yr.
Kaithal	Rs. 60 per wc / yr.
Karnal	Rs. 60 per wc / yr.
Mansa	Rs. 120 per wc / yr.
Rewari	Rs. 60 per wc / yr.
Rohtak	Rs. 60 per wc / yr.
Sangrur	Rs. 120 per wc / yr.
Thanesar	Rs. 60 per wc / yr.
Vijayawada	Rs. 120 per wc / yr. & Rs. 192 per wc / yr. (non-domestic)

City	Rate (charge on water)
Bangalore	30% of water charges
Chennai	25% of water charges
Hyderabad	35% of water charges
Ajmer	20% of water charges

City	Rate
Calcutta	80% of water tax (amount fixed based on ferrule size)
Mangalore	Rs. 2 per sq. ft (dom) & Rs.5 per sq. ft. (non-domestic)

per wc/yr: per water closet per year

Source: NIUA Survey, 1999 See Statistical Volume – II, Table B – for details

5. REVENUE RECEIPTS AND REVENUE EXPENDITURE

- **Revenue Receipts**

Table – 3.13: Percentage Revenue Receipts from Sewerage / Drainage Tax – 1997 – 98

(No. of cities / towns)

% Revenue Receipts	Metropolitan cities	Class I cities	Class II towns	Total	%
< 50	2	3	1	6	6
50 – 90	1	8	0	9	9
90 – 99	3	8	3	14	14
100	2	5	0	7	7
0	7	17	13	37	37
Combined (n.a.)	5	1	1	7	7
n.a.	2	15	3	20	20
Total	22	57	21	100	100
Average	94	82	95	94	

Source: NIUA Survey, 1999 See Statistical Volume – II, Table B – 9 for details
'combined (n.a.)'. represents those sample cities / towns where data on waste water receipts are combined with water supply receipts

Table – 3.14: Percentage Revenue Receipts from Connection Charges – 1997 – 98

(No. of cities / towns)

% Revenue Receipts	Metropolitan cities	Class I cities	Class II towns	Total	%
< 25	3	13	5	21	21
25 – 50	1	3	1	5	5
50 – 75	1	0	0	1	1
75 – 99	0	2	1	3	3
100	3	7	8	18	18
0	7	16	2	25	25
Combined (n.a.)	5	1	1	7	7
n.a.	2	15	3	20	20
Total	22	57	21	100	100
Average	22	27	52	24	

Source: NIUA Survey, 1999 See Statistical Volume – II, Table B – 9 for details
'combined (n.a.)'. represents those sample cities / towns where data on waste water receipts are combined with water supply receipts

- **Cost Recovery**

Table – 3.15: Percentage Revenue Receipts to Revenue Expenditure – 1997 – 98

(No. of cities / towns)

% Receipts to Expenditure	Metropolitan cities	Class I cities	Class II towns	Total	%
0	0	11	2	13	13
0 – 25	6	22	8	36	36
25 – 50	3	5	2	10	10
50 – 75	0	4	3	7	7
75 – 100	2	1	1	4	4
> 100	4	7	1	12	12
Combined (n.a.)	5	1	1	7	7
n.a.	2	6	3	11	11
Total	22	57	21	100	100
Average (%)*	146	29	35	127	
Average (%)**	15	14	2	15	

Source: NIUA Survey, 1999 See Statistical Volume – II, Table B – 11 for details

'combined (n.a.)'. represents those sample cities / towns where data on waste water receipts are combined with water supply receipts

3.7 PRIVATISATION

Table – 3.16: Privatization in Wastewater Management – 1999

Sl. No.	City / town	Function	Activity privatized	Mode used	Year Privatized	No. of contractors	Cost before Privatization (Rs.)	Cost before Privatization (Rs.)
1	Chennai	O&M	Pumping stations	Contract	1996	3	2,700,000	1,440,000
2	Hyderabad	O&M	STPs	Contract	1999	2	n.a.	n.a.
3	Rajkot	O&M	Pumping stations	Contract	1998	3	n.a.	n.a.
4	Bhavnagar	O&M	n.a.	Contract	1994	1	n.a.	40,000
5	Nashik	O&M	STPs	Contract	1995	1	n.a.	952,000
6	Chandigarh	O&M	Pumping stations	n.a.	1999	1	n.a.	n.a.

Source: NIUA Survey, 1999 See Statistical Volume – II, Table B – 6 for details

6. CAPITAL EXPENDITURE

While a majority of the cities do not have underground drainage systems, only a few unsewered cities have indicated capital investment in sewerage related works. Most of the capital works are Capital expenditure on sewerage related works has been undertaken in only about 21 per cent of the sampled cities. The expenditure has been incurred mainly for augmentation (12% cities), improving existing systems (4% cities) and adding new pipelines (5% cities). The components of expenditure also include treatment plants (3% cities), pumping stations and creating treatment facility such as lagoons.

7. SEPTIC TANKS AND LOW COST SANITATION

Table – 3.17: Population Dependant in Septic Tanks and LCS

(no. of cities / towns)

% Population	Metropolitan cities	Class I cities	Class II towns	Total	%
< 25	8	46	15	69	26
25 – 50	10	26	26	62	23
50 – 75	0	27	30	57	22
< 75	0	28	24	52	20
Data not available	4	15	5	24	9
Total	22	142	100	264	100
Average (%)	25	41	55	34	

Source: NIUA Survey, 1999 See Statistical Volume – II, Table B – 12 for details

8. ADDITIONAL CAPITAL INVESTMENT REQUIREMENTS

- **Projection Methodology**

Table – 3.18: Class wise Projection of Urban Population* in Different Years

(in million)

Year	Metro	I**	II	III	IV	V	VI	Total
1991(% Population)	23.00	33.67	13.33	16.35	9.77	3.43	0.45	100.00
1999	64.10	93.84	37.15	45.57	27.23	9.56	1.25	278.70
2002	69.34	101.51	40.19	49.29	29.45	10.34	1.36	301.48
2007	79.11	115.82	45.85	56.24	33.61	11.80	1.55	343.97
2012	89.58	131.14	51.92	63.68	38.05	13.36	1.75	389.48
2017	101.11	148.02	58.60	71.88	42.95	15.08	1.98	439.61
2022	114.16	167.13	66.17	81.16	48.50	17.03	2.23	496.37

Note: The proportion of population in each size class is for the individual cities and towns and not for urban agglomerations and the proportions are assumed to be constant for the projected period i,e., up to 2022.

Source for proportion of population in each size class : Census of India 1991, Series 1 : India, General Population Tables Part II : A (ii) Towns and Urban Agglomerations 1991 with their Population 1901 : 1991, Statement : 3, p 32.

Source for size class : wise population distribution : Projections based on Census of India's Populations for India States 1996 : 2016, Registrar General, India, New Delhi, 1996.

Populations as on 1 July of the respective years. **Class I cities exclude metropolitan cities.

Table – 3.19: Additional Population to be Covered in Different Years by Size Class

(in million)

Year	Metro	I**	II	III	IV	V	VI	Total
Backlog 1991	21.63	52.08	24.80	30.42	18.18	6.38	0.84	154.32
1999 - 2002	9.34	18.77	8.48	10.40	6.21	2.18	0.26	55.67
2002 - 2007	12.89	20.56	8.49	10.41	6.22	2.18	0.26	61.05

2007 - 2012	10.47	15.32	6.07	7.44	4.45	1.56	0.20	45.51
2012 – 2017	11.53	16.88	6.68	8.20	4.90	1.72	0.23	50.13
2017 - 2022	13.05	19.11	7.57	9.28	5.55	1.95	0.26	56.76
Total	78.91	142.73	62.08	76.14	45.50	15.97	2.10	423.43

Source: Derived from Table3.18 Calculations till 2002 are based on 75% coverage of population

Table – 3.20: Coverage of Population by Safe Sanitation - 1999

(used for calculating the backlog)

Size class of cities / towns	% Population covered	% Population not covered
Metro	59	41
I	70	30
II	65	35
III	50	50
IV	50	50
V	50	50
VI	50	50

Source: NIUA Survey, 1999 See Statistical Volume – II, Table B – 6 for details

- **Projected Additional Investment Requirements**

Table – 3.21: Task Forces' Per Capita Investment Cost for Sanitation
(Estimates at 1998-99 prices)

(in Rs. per capita)

Type of technology	City size by Population		
	Pop. 1 Lakh+	50,000-1 Lakh	< 50,000
Sewerage system	1,622	1,637	1,534
Sewage treatment (Plant)	240	818	480
Septic tank (household)	995	1,103	1,107
Pit latrine	647	691	627

Table – 3.22: HUDCO's Per Capita Investment Cost for Sanitation
(HUDCO estimates at 1998 - 99 prices)

Item	Rs. / per capita
Sewerage augmentation	1,620
Conventional treatment	162
Septic tank with soak pit	4,050
Twin pit without superstructure	
5 users	648
15Users	377.5

Table – 3.23: Additional Investment Requirements for Providing Safe Sanitation to Population (Using Task Forces' per capita cost estimates)

(Rs. in crores – at 1998 – 99 prices)

Year	Metro	I**	II	III	IV	V	VI	Total
Backlog 1991	4,028.19	7,528.07	2,223.61	2,727.38	1,629.75	400.20	52.50	18,589.71
1999 - 2002	1,738.86	2,713.69	760.15	932.37	557.14	136.81	17.95	6,856.98
2002 - 2007	2,254.48	2,746.51	697.95	856.07	511.55	125.62	16.48	7,208.64
2007 - 2012	1,948.88	2,214.83	543.95	667.18	398.68	97.90	12.84	5,884.25
2012 – 2017	2,146.91	2,439.88	599.22	734.97	439.19	107.85	14.15	6,482.17
2017 - 2022	2,430.81	2,762.51	678.45	832.16	497.26	122.11	16.02	7,339.32
Total	14,548.14	20,405.48	5,503.32	6,750.14	4,033.57	990.48	129.95	52,361.07

Table – 3.24: Additional Investment Requirements for Providing Safe Sanitation to Population (Using HUDCO's per capita cost estimates)

(Rs. in crores – at 1998 – 99 prices)

Year	Metro	I**	II	III	IV	V	VI	Total
Backlog 1991	3,855.13	10,461.69	5,824.97	7,144.65	4,269.31	413.48	54.25	32,023.48
1999 - 2002	1,664.15	3,771.19	1,991.30	2,442.45	1,459.49	141.35	18.54	11,488.48
2002 - 2007	2,157.61	3,816.80	1,828.34	2,242.57	1,340.05	129.78	17.03	11,532.18
2007 - 2012	1,865.15	3,077.92	1,424.92	1,747.75	1,044.37	101.15	13.27	9,274.54
2012 – 2017	2,054.67	3,390.68	1,569.71	1,925.34	1,150.50	111.42	14.62	10,216.95
2017 - 2022	2,326.37	3,839.04	1,777.28	2,179.94	1,302.63	126.16	16.55	11,567.96
Total	13,923.08	28,357.33	14,416.53	17,682.70	10,566.36	1,023.33	134.26	86,103.59

Note: Rs. 1 crore = Rs. 10,000,000

APPENDIX – A2-2

Table of Contents of Guidelines on Planning and Design of Sewerage Facilities, 2009, Japan

Table of Contents: Guidelines on Planning and Design of Sewerage Facilities, 2009, Japan

APPENDIX – A2-3

Table of Contents of Guidelines on Operation and Maintenance of Sewerage Facilities, 2003, Japan

Table of Contents: Guidelines on Operation and Maintenance of Sewerage Facilities, 2003, Japan

APPENDIX – A2-4

Problems regarding Planning & Design and Operation & Maintenance based upon Remarks made in CPCB Study for STPs

Table -1 Clarification of Problems related to Planning & Design and Operation & Maintenance based upon Remarks observed by CPCB Study for Sewage Treatment Plants

S. No	STP , City/Town , State	Technology of STP	Conformity to Standards for discharge	Remarks observed by CPCB Study for Sewage Treatment Plants	Problems regarding	
					Planning & Design	Operation & Maintenance
1	35 MLD STP Beur, Patna, Bihar	ASP	Conformable	i) Plant was receiving very low strength sewage and most of the treatment was achieved in primary stage itself. ii) Plant faces problem of power failures and there is no standby arrangement. iii) Plant faces problem of shortage of funds for operation and maintenance. iv) Sludge scrapper of final clarifier is not functioning since January 2005. v) One more final clarifier is required as SOR is high for the present final clarifier. vi) The gas generated in sludge digester is not utilized. vii) One aeration tank and one final clarifiers are proposed in GAP	○ ○	○
2	45 MLD STP Saidpur, Patna, Bihar	ASP	Conformable	i) Plant was receiving low strength sewage that is effectively treated in primary units before feeding to subsequent activated sludge process. The activated sludge process receives very low organic loading owing to low inlet BOD (40 mg/L) and low flow (50% of design flow). This condition may allow operation of few aerators instead of all just to fulfil the aeration and mixing requirements that will help reducing operation costs. ii) Plant faces problem of power failures and there is no standby arrangement. iii) Sludge scrapper of final clarifier is not functioning since January 2005. iv) One more final clarifier is required. v) The gas generated in sludge digester is not utilized. vi) One aeration tank and one final clarifier are proposed in GAP.	○ ○	○ ○ ○
3	25 MLD STP Pahari, Patna, Bihar	AL+FP	Conformable	i) Plant was receiving very low strength sewage. ii) Plant faces problem of power failures and there is no standby arrangement. iii) One lagoon was not functioning due to repairing of aeration system. iv) Accumulation of sludge is less but desludging may be needed once in few years.	○	○ ○
4	30 MGD STP Mohali (Diggiyan), Chandigarh	ASP +Tertiary	Unconformable (BOD,TSS)	i) Primary clarifiers of the first stream are not performing at optimum efficiency both in terms of percentage TSS removal (only 62%) and TSS in effluent (117 mg/L). ii) Secondary treatment (ASP) unit of first stream providing 68% individual efficiency in terms of BOD reduction is not performing at the expected efficiency for a conventional ASP iii) Secondary treatment (ASP) unit of second stream providing 81% individual efficiency in terms of BOD reduction is also not performing at the required		

S. No	STP , City/Town , State	Technology of STP	Conformity to Standards for discharge	Remarks observed by CPCB Study for Sewage Treatment Plants	Problems regarding	
					Planning & Design	Operation & Maintenance
				efficiency for discharge of sewage in streams. If it is an extended aeration type ASP, as indicated by absence of primary treatment unit, then the observed efficiency is also less than expected from such systems. iv) The two streams of secondary treated sewage of 5 MGD and 15 MGD are not conforming to the discharge standards individually. These streams are combined and further mixed with 15 MGD untreated sewage and the total 35 MGD combined sewage is discharged into a drain. v) 10 MGD tertiary treated sewage conforming to the standards		
5	1.25 MGD (5.68MLD)STP, Raipur,Khurd, Chandigarh	ASP	Conformable	i) Plant mostly serves urban villages and mixing of organic load of animal dung is expected. ii) Treated effluent is utilised for irrigation. iii) Overall performance of the plant is good.		
6	46 MLD STP Kutelbhata village, Bhilai, Chhatisgarh	OP	Unconformable (TSS)	i) Plant was receiving low BOD sewage but COD/BOD ratio (10.2) is very high indicating possible mixing of industrial effluents. ii) Plant is able to achieve prescribed norms in terms of BOD, COD and TSS.	○	
7	14 MLD STP Risali village, Bhilai, Chhatisgarh	OP	Conformable	i) Plant was receiving low BOD sewage but COD/BOD ratio (8.5) is very high indicating possible mixing of industrial effluents. ii) Plant is able to achieve prescribed norms in terms of BOD, COD and TSS.	○	
8	9 MLD STP Bhillai House, Bhilai, Chhatisgarh	OP	Conformable	i) Plant was receiving very low BOD sewage but COD/BOD ratio (8.5) is very high indicating possible mixing of industrial effluents. ii) Plant is able to achieve prescribed norms in terms of BOD, COD and TSS.	○	
9	106 MLD STP Pirana, Ahmedabad, Gujarat	UASB+FL	Unconformable (COD)	i) Plant generates 17,000 Kg/d sludge. Biological sludge is sold to farmers and is used as manure. ii) UASB unit of the plant generates about 2,000-4,000 m3/d biogas. This gas is used for electricity generation in dual fuel engines. iii) Effluent COD (118 mg/L) is higher than the limit (100 mg/L) prescribed by Gujarat Pollution Control Board. Other parameters are within the prescribed limits. iv) Individual performance of UASB unit and facultative ponds cannot be commented upon as sample has not been collected at intermediate point.		

S. No	STP , City/Town , State	Technology of STP	Conformity to Standards for discharge	Remarks observed by CPCB Study for Sewage Treatment Plants	Problems regarding	
					Planning & Design	Operation & Maintenance
10	126 MLD STP Vasna, Ahmedabad, Gujarat	UASB+CL	Unconformable (BOD,COD,TSS)	i) Plant generates 25,000 Kg/d sludge. Biological sludge is sold to farmers and is used as manure. ii) UASB unit of the plant generates about 2200 m3/d biogas. This gas is used for electricity generation in dual fuel engines. iii) Effluent BOD, COD and SS exceed the limits prescribed by Gujarat Pollution Control Board. BOD exceeds even the general standards prescribed under the Environmental Protection Rules. iv) Individual performance of UASB unit and the tertiary sedimentation cannot be commented upon as sample has not been collected at intermediate point.		
11	44.5MLD STP Rajkot, Vadodara, Gujarat	FL+ASP	Unconformable (BOD,COD,TSS)	i) Effluent BOD, COD and TSS exceed the limits prescribed by Gujarat Pollution Control Board. BOD and TSS exceed even the general standards prescribed under the Environmental Protection Rules. ii) Individual performance of Facultative lagoon and ASP unit cannot be commented upon as sample has not been collected at intermediate point. iii) High TSS in final clarifier indicates that it is not operating well. A well performing ASP clarifier is expected to provide TSS< 50 mg/L in effluent.		○
12	86 MLD STP Atladara, Vadodara, Gujarat	UASB +ASP	Conformable	i) Effluent BOD, COD and TSS are well within the limits of 20, 100 and 30 mg/L, respectively, prescribed by Gujarat Pollution Control Board. ii) Individual performance of UASB unit and the tertiary sedimentation cannot be commented upon, as sample has not been collected at intermediate point. iii) Sludge digester unit of the plant generates about 1200 m3/d biogas. This gas is used for electricity generation.		
13	52 MLD STP Tarsali, Vadodara, Gujarat	UASB +ASP	Conformable	i) Effluent BOD, COD and TSS are well within the limits of 30, 100 and 30 mg/L, respectively, prescribed by Gujarat Pollution Control Board. ii) Individual performance of Primary clarifier and ASP unit cannot be commented upon, as sample has not been collected at intermediate point. iii) UASB unit of the plant generates about 1,900 m3/d biogas. This gas is flared. iv) Gas generated in sludge digester is not utilized for lack of any arrangement.	○	
14	66 MLD STP Gajarwadi, Vadodara, Gujarat	UASB +ASP	Conformable	i) Effluent BOD, COD and TSS are well within the limits of 30, 100 and 30 mg/L, respectively, prescribed by Gujarat Pollution Control Board. ii) Individual performance of Primary clarifier and ASP unit cannot be commented upon, as sample has not been collected at intermediate point. iii) UASB unit of the plant generates about 6,000 m3/d biogas. This gas is flared. iv) Gas generated in sludge digester is not utilized for lack of any arrangement.	○	

S. No	STP , City/Town , State	Technology of STP	Conformity to Standards for discharge	Remarks observed by CPCB Study for Sewage Treatment Plants	Problems regarding	
					Planning & Design	Operation & Maintenance
15	82.5MLD STP Anjana, Surat, Gujarat	UASB +ASP	Unconformable (COD)	i) Effluent BOD and TSS are well within the limits of 30 mg/L prescribed by Gujarat Pollution Control Board. However, COD is slightly higher than the prescribed limit because of very high COD in influent. ii) Influent COD/BOD ratio is very high (=8) indicating possible mixing of some industrial effluent that must be investigated and rectified. iii) Individual performance of Primary clarifier and ASP unit cannot be commented upon, as sample has not been collected at intermediate point. iv) UASB unit of the plant generates about 1,500 m3/d biogas. This gas is flared. v) Gas generated in sludge digester is not utilized for lack of any arrangement.	○ ○	
16	120 MLD STP Bhatar, Surat, Gujarat	UASB +ASP	Unconformable (COD,TSS)	i) Effluent BOD is within the limits of 30 mg/L but COD and TSS exceed the limits of 100 and 30 mg/L, respectively, prescribed by Gujarat Pollution Control Board. COD in influent. ii) Individual performance of Primary clarifier and ASP unit cannot be commented upon, as sample has not been collected at intermediate point. iii) UASB unit of the plant generates about 7,000-8,000 m3/d biogas. This gas is flared. iv) Gas generated in sludge digester is not utilized for lack of any arrangement.	○	
17	100 MLD STP Singanapore, Surat, Gujarat	UASB +ASP	Unconformable (COD,TSS)	i) Effluent BOD is within the prescribed limit but COD and TSS exceed the limits of 100 and 30 mg/L, respectively, prescribed by Gujarat Pollution Control Board. ii) Influent COD/BOD ratio is very high (=9.7) indicating possible mixing of some industrial effluent that must be investigated and rectified. iii) Individual performance of Primary clarifier and ASP unit cannot be commented upon, as sample has not been collected at intermediate point. iv) UASB unit of the plant generates about 1,100-1,200 m3/d biogas. This gas is flared. v) Gas generated in sludge digester is not utilized for lack of any arrangement.	○	
18	25 MLD STP Yamunanagar/ Jagadhari, Haryana	UASB+PP	Unconformable (BOD)	i) UASB unit is functioning at suboptimal efficiency in terms of reduction in organic matter. ii) TSS in UASB outlet is also high.		○
19	10 MLD STP Yamunanagar/ Jagadhari,	UASB+PP	Unconformable (BOD)	i) UASB unit is functioning at suboptimal efficiency in terms of COD reduction. TSS in UASB outlet is also high. ii) Polishing pond is effecting about 50% reduction to its inlet BOD/COD.		○

S. No	STP , City/Town , State	Technology of STP	Conformity to Standards for discharge	Remarks observed by CPCB Study for Sewage Treatment Plants	Problems regarding	
					Planning & Design	Operation & Maintenance
	Haryana					
20	40 MLD STP Karnal, Haryana	UASB+PP	Conformable	i) The overall performance of the plant is very good.		
21	8 MLD STP Karnal, Haryana	WSP	Conformable	i) The overall performance of the plant is very good.		
22	35 MLD STP Panipat, Haryana	UASB+PP	Unconformable (BOD,COD)	i) UASB unit is functioning at suboptimal efficiency in terms of COD reduction. ii) Polishing pond is also effecting only marginal reduction in BOD. iii) The overall performance of the plant is not satisfactory.		
23	10 MLD STP Panipat, Haryana	UASB+PP	Unconformable (BOD,COD,TSS)	i) Plant is receiving sewage of exceptionally high strength indicating mixing of industrial effluents in sewerage system. ii) Plant is functioning at an overall BOD/COD removal efficiency of 60-65 %. TSS in Polishing pond outlet is very high. Outlet structure of Polishing pond may be checked. iii) Plant is not able to comply with the discharge standards due to above reasons.	○	○
24	30 MLD STP Sonipat, Haryana	UASB+PP	Unconformable (BOD)	i) UASB unit is functioning at suboptimal efficiency in terms of reduction in organic matter. TSS in UASB outlet is also high. ii) Polishing pond is also effected 44% and 43% reduction in BOD and COD, respectively, which is rather low. iii) All sludge beds were filled with sludge and there was no further space for sludge. iv) Plant is not able to comply with the discharge standards due to above reasons.		○ ○
25	1.35MLD STP Snowdon, Shimla, Himachal Pradesh	APS (Ext. Aer +Tertiary Sed)	Conformable	i) Plant receives very high strength sewage. Its reasons need to be investigated. ii) It is seen that even if the plant was operated at a MLSS level of 4,000 mg/L (or 3,200 mg/L MLVSS) it would run at an F/M ratio 0.43 for the observed influent BOD. Thus the plant can operate as conventional process and not as an extended process. iii) Overall efficiency of the plant is very good. However, it appears that tertiary	○	

S. No	STP , City/Town , State	Technology of STP	Conformity to Standards for discharge	Remarks observed by CPCB Study for Sewage Treatment Plants	Problems regarding	
					Planning & Design	Operation & Maintenance
				sedimentation played a major role in achieving this efficiency. iv) Low MLSS in aeration tank indicates that the biological treatment is not being utilized to its full capacity. Optimum use of biological unit will help reducing chemical costs in tertiary treatment.		○
26	0.76MLD STP Dhalli, Shimla, Himachal Pradesh	APS (Ext. Aer +Tertiary Sed)	Conformable	i) Plant receives high strength sewage. ii) Overall efficiency of the plant was very good. iii) MLSS in aeration tank appear low for an extended aeration process. Use of Extended Aeration ASP to its fullest will help reducing chemical costs in tertiary treatment. iv) A little high TSS value in tertiary sedimentation tank indicates that its performance can also be improved further.		○ ○
27	3.93MLD STP Summer Hill, Shimla, Himachal Pradesh	APS (Ext. Aer +Tertiary Sed)	Conformable	i) Overall efficiency of the plant is very good. ii) MLSS in aeration tank appear low for an extended aeration process. Use of Extended Aeration ASP to its fullest will help reducing chemical costs in tertiary treatment.		○
28	4.44MLD STP Maliana, Shimla, Himachal Pradesh	APS (Ext. Aer +Tertiary Sed)	Conformable	i) Overall efficiency of the plant is very good and ASP is operating in the usual range of F/M ratio for an extended processes. ii) Individual performance of the extended aeration process and the chemical aided tertiary sedimentation cannot be commented upon as intermediate sample was not collected.		
29	5.8 MLD STP North Disposal, Shimla, Himachal Pradesh	APS (Ext. Aer +Tertiary Sed)	Conformable	i) Overall efficiency of the plant is very good. ii) MLSS in aeration tank appear low for an extended aeration process. Use of Extended Aeration ASP to its fullest will help reducing chemical costs in tertiary treatment.		○
30	----MLD STP Madiwala, Bangalore, Karnataka	UASB	Conformable	i) Overall efficiency of the plant is very good.		
31	----MLD STP K & C Valley, Bangalore,	ASP	Unconformable (BOD)	i) Overall efficiency of the plant is not satisfactory as the plant is not able to meet the prescribed standards in terms of BOD.		

S. No	STP , City/Town , State	Technology of STP	Conformity to Standards for discharge	Remarks observed by CPCB Study for Sewage Treatment Plants	Problems regarding	
					Planning & Design	Operation & Maintenance
	Karnataka					
32	----MLD STP V.Vally, Bangalore, Karnataka	Bio-Filter	Unconformable (BOD)	i) Overall efficiency of the plant is satisfactory as the plant is able to meet the prescribed standards in terms of BOD, COD and TSS.		
33	----MLD STP Hebbal, Bangalore, Karnataka	ASP	Conformable	i) Overall efficiency of the plant is satisfactory as the plant is able to meet the prescribed standards in terms of BOD, COD and TSS.		
34	1 MGD STP South T. T. Nagar, Bhopal, Madhya Pradesh	An.Dig.+TF	Unconformable (BOD,TSS)	i) Operation and maintenance of the plant is very poor and it is merely working as a holding tank. More over sewage is passed through the plant only for 6 hour duration every day during peak hours. ii) Plant is not able to meet the prescribed norms.		○
35	2 MGD STP Bherkheda, BHEL, Bhopal, Madhya Pradesh	Bio-filter (TF)	Conformable	i) Operation and maintenance of the plant is good. ii) Overall performance of the plant is satisfactory so that the plant is able to meet the prescribed norms. iii) About 16,000 Ft gas is generated per day from the digester, which is fully utilized. iv) Treated effluent from the plant is utilized for irrigation.		
36	16 MLD STP Adharwadi, Kalyan, Maharashtra	ASP	Unconformable (BOD)	i) Installed capacity of sewage treatment (16 MLD Kalyan + 14 MLD Dombivali) is negligible compared to estimated 200 MLD total sewage generation from the city. ii) Efficiency of primary clarifiers in terms of BOD reduction (21%) is less than expected. High effluent TSS value also indicates suboptimal performance of primary clarifier.		○
37	22 MLD STP Triambak, Nashik, Maharashtra	UASB	Unconformable (BOD,COD,TSS)	i) Plant operation and maintenance and housekeeping were very poor. ii) Plant was not meeting the prescribed norms in terms of main pollutants BOD, COD and TSS		

S. No	STP , City/Town , State	Technology of STP	Conformity to Standards for discharge	Remarks observed by CPCB Study for Sewage Treatment Plants	Problems regarding	
					Planning & Design	Operation & Maintenance
38	78 MLD STP Nashik, Nashik, Maharashtra	UASB+FP	Unconformable (BOD)	i) Plant operation and maintenance and housekeeping were very poor. ii) Plant was not meeting the prescribed norms in terms of BOD.		
39	54 MLD STP Kopri, Thane, Maharashtra	Primary	Unconformable (BOD)	i) Installed capacity of sewage treatment (56 MLD) is only about one fourth of estimated 216 MLD total sewage generation from the city. ii) High effluent TSS value indicates suboptimal performance of primary clarifier. iii) Plant was not meeting the prescribed norms in terms of main pollutant BOD.		○
40	1.75MGD (6.62 MLD) STP Naya Nangal, Punjab	ASP	Conformable	i) Plant receives low sewage of low BOD. ii) Overall efficiency of the plant is very good.		
41	1.5 MGD (5.68 MLD) STP Nangal, Punjab	ASP	Conformable	i) Plant receives low strength sewage. ii) Overall efficiency of the plant is very good. iii) Reduction of coliform is also of very high level.		
42	2.6 MLD STP Sultanpur Lodhi, Punjab	WSP	Conformable	i) At the time of power failures, whole sewage is bypassed. This defeats the purpose of having STP to an extent. Otherwise, observed overall efficiency of the plant in terms of reduction of organic matter and solids was good.	○	
43	2.56MLD STP Phillore, Punjab	WSP	Conformable	i) Plant is not looked after properly and no records are maintained. Otherwise, observed overall efficiency of the plant in terms of reduction of organic matter and solids was good.		○
44	27 MLD STP Jaipur, Rajasthan	ASP Ext. Aer.	Unconformable (BOD,COD,TSS)	i) Fifty percent wastewater was being bypassed without treatment to Jalmahal lake even though capacity of the plant remained under utilized. ii) At the time of study the plant was mainly receiving industrial effluent of textile processing units located in Grahmapuri instead of sewage and overall operation and maintenance of the plant was very poor. Screens and grit channels were not being cleaned and only 15 of the total 46 aerators were operational. iii) As a consequence of high strength wastewater coming to STP and poor operation and maintenance, the plant was not able to meet the standards. iv) High TSS in final clarifier outlet also indicates that the plant is not operating	○	○ ○

S. No	STP , City/Town , State	Technology of STP	Conformity to Standards for discharge	Remarks observed by CPCB Study for Sewage Treatment Plants	Problems regarding	
					Planning & Design	Operation & Maintenance
				properly.		
45	2.7 MLD STP Fatehgarh, Uttar Pradesh	OP	Unconformable (BOD,TSS)	i) No reduction in BOD and an increase in COD are observed within the first stage oxidation ponds. Similarly, an increase in BOD is observed in the second stage oxidation pond. This phenomenon can be attributed to algal growth, which was also observed physically. High TSS in oxidation ponds' effluents also supports this observation. ii) Plant is not able to meet the standards for discharge in streams due to high algal growth even though it is receiving very dilute sewage. iii) There is no standby arrangement of generator during power cuts for running sewage pumps. iv) Treated sewage is utilized for irrigation/farming.	○ ○	
46	5 MLD STP Jajmau, Kanpur, Uttar Pradesh	UASB	Unconformable (BOD)	i) Observed efficiency of UASB unit is terms of BOD reduction (70%) and COD reduction (56%) indicates that its performance can be improved further. ii) Treated sewage quality does not conform to the standards for discharge in streams.		○
47	36 MLD STP Jajmau, Kanpur, Uttar Pradesh	UASB	Unconformable (BOD,COD)	i) Observed efficiency of UASB unit is terms of BOD and COD reduction (60%) indicates that its performance can be improved further. ii) Treated sewage quality does not conform to the standards for discharge in streams.		○
48	130 MLD STP Jajmau, Kanpur, Uttar Pradesh	ASP	Unconformable (BOD)	i) The Sewage interception works at Kanpur are maintained and operated poorly. During heavy shortage of power (5 hr. load shedding) the sewage pumping station at Jajmau, Kanpur remains non-operational resulting in discharge of 25 to 30 MLD untreated sewage into R. Ganga every day. ii) Individual performance of primary settling unit and ASP unit can to be commented upon. However, overall performance of the plant is suboptimal. iii) Considering the minimal HRT of the aeration tank, it may not be possible to operate the plant at the recommended SRT of 9 days. However, if the plant could be operated at any SRT value higher than 5 day, it may provide sufficient safety factor. iv) High TSS in final clarifier outlet also indicates that the plant is not operating		○ ○

S. No	STP , City/Town , State	Technology of STP	Conformity to Standards for discharge	Remarks observed by CPCB Study for Sewage Treatment Plants	Problems regarding	
					Planning & Design	Operation & Maintenance
				properly. v) Treated sewage quality does not conform to the standards for discharge in streams. vi) It is observed that the performance of plant can be improved further.		
49	60 MLD STP Allahabad, Uttar Pradesh	ASP	Conformable	i) Distribution of sewage to STP & bypass is not regular, sometimes plant gets huge amount of sewage & sometimes very low. ii) Results of analysis of samples indicate that the primary settling units are performing fairly well in terms of BOD/COD reduction. Their operation needs further improvement to achieve <50 mg/L TSS in outlet. iii) The low MLSS contents and further lower content of its organic proportions, MLVSS indicate that the plant is not properly operated. This may also be due to dilute inlet characteristics iv) ASP unit is being fed with low organic load. Still, its performance in terms of percentage BOD/COD reduction is not up to the mark. Performance of biological unit can be improved. Scope for using fewer aerators can be studied. v) Treated sewage quality conforms to the standards for discharge in streams. vi) It is observed that the performance of plant can be improved further.		○ ○ ○ ○
50	14 MLD STP Mirzapur, Uttar Pradesh	UASB+PP	Conformable	i) Plant receives low strength sewage. ii) Gas formation in UASB system was found below optimum level and thus the treatment economics of the plant is being affected. iii) Flow in inlet varied highly and thus put pressure on reactor's performance and in maintenance of sludge blanket. iv) Proper screening must be ensured; otherwise it is delivering trash into the reactors. v) Overall performance of the plant is satisfactory. TSS in UASB effluent seems higher. If it can be improved, efficiency of UASB in terms of BOD/COD will also improve correspondingly. vi) Treated sewage quality conforms to the standards for discharge in streams.	○	○ ○ ○ ○
51	12 MLD STP Bhagwanpur, Varanasi, Uttar Pradesh	ASP	Conformable	i) Results of analysis of samples indicate that the primary settling units are performing fairly well in terms of BOD/COD reduction. Their operation needs further improvement to achieve <50 mg/L TSS in outlet. ii) ASP unit is being fed with low organic load. Still, its performance in terms of percentage BOD/COD reduction is not up to the mark. Performance of biological unit can be improved. Scope for using fewer aerators can be studied.		○ ○

S. No	STP , City/Town , State	Technology of STP	Conformity to Standards for discharge	Remarks observed by CPCB Study for Sewage Treatment Plants	Problems regarding	
					Planning & Design	Operation & Maintenance
				iii) Treated sewage quality conforms to the standards for discharge in streams. iv) It is observed that the performance of plant can be improved further.		
52	80 MLD STP Dinapur, Varanasi, Uttar Pradesh	ASP	Conformable	i) Results of analysis of samples indicate that the primary settling units are performing well in terms of BOD/COD reduction but not in terms of outlet TSS. Their operation needs to be improved to achieve <50 mg/L TSS in outlet. ii) ASP unit is being fed with low organic load. Still, its performance in terms of percentage BOD/COD reduction is not up to the mark because of BOD/COD associated with escaping solids. Scope for using fewer aerators can be studied. iii) Treated sewage quality conforms to the standards for discharge in streams. iv) It is observed that the performance of plant can be improved further.		○ ○
53	12 MLD STP DLW, Varanasi, Uttar Pradesh	ASP	No evaluation	i) Plant is always under loaded (3-4MLD) and has always been receiving highly diluted sewage. Intermittent sewage supply from the Main Pumping Station (MPS) is a major problem. ii) Raw sewage characteristics are appreciably diluted and this makes plant operation difficult as the plant has been designed for higher organic loading.	○	○
54	42 MLD STP Lucknow, Uttar Pradesh	FAB	Unconformable	i) Plant operation and maintenance is very poor as indicated by fluctuation in flow being fed to the plant and high TSS in final clarifier's outlet. ii) Final clarifier being an integral part of aerobic biological system for it separates settleable organic matter and results in a clarified effluent, proper operation of final clarifiers is key to achieve better overall efficiency. It is observed that overall performance of the plant could have improved if clarifiers were operated properly. SOR is too high. iii) Treated sewage quality does not conform to the standards for discharge in streams.		○ ○
55	38 MLD STP Saharanpur, Uttar Pradesh	UASB+PP	Conformable	i) Plant receives low BOD sewage but COD to BOD ratio of raw sewage (6.6) is quit high indicating possibility of industrial waste being mixed with sewage. ii) Overall performance of the plant is satisfactory. iii) Treated sewage quality conforms to the standards for discharge in streams. iv) Of the two polishing ponds, only one was in use and the other was damaged. v) During power cuts of around 10 hr per day, the sewage is bypassed untreated.	○	○
56	32.5MLD STP Muzaffarnagar , Uttar Pradesh	WSP	Unconformable (BOD)	i) Plant is not able to achieve the discharge standards in terms of BOD. ii) It was observed that the primary ponds were nearly full with sludge and their cleaning was over due. This condition must have led to reduced efficiency		○

S. No	STP , City/Town , State	Technology of STP	Conformity to Standards for discharge	Remarks observed by CPCB Study for Sewage Treatment Plants	Problems regarding	
					Planning & Design	Operation & Maintenance
				iii) TSS in final effluent is also high. Control of TSS by checking adequacy of outlet structures will also help in improving overall efficiency of the plant.	○	
57	70 MLD STP Cis Hindon, Ghaziabad, Uttar Pradesh	UASB+PP	Unconformable (BOD)	i) Overall performance of the plant is not satisfactory and plant is not able to achieve the norms for discharge in streams. ii) Efficiency of UASB reactor in terms of COD reduction is less. High TSS in UASB outlet appears to be main reason for this. iii) Efficiency of polishing pond unit in terms of BOD/COD reduction is also low because only one pond was in use the other was closed for removal of accumulated sludge. iv) Gas generated in UASB reactors is not being utilized in dual fuel generators.		○ ○
58	56 MLD STP Trans Hindon, Ghaziabad, Uttar Pradesh	UASB+PP	Unconformable (BOD)	i) Overall performance of the plant is not satisfactory and plant is not able to achieve the norms for discharge in streams. ii) Efficiency of polishing pond unit in terms of BOD/COD reduction is low because only one pond was in use the other was closed for removal of accumulated sludge. iii) Gas generated in UASB reactors is not being utilized in dual fuel generators.		○
59	27 MLD STP Sector54, NOIDA, Uttar Pradesh	UASB+PP	Conformable	i) Overall performance of the plant is such that it is just able to achieve the norms for discharge in streams. ii) Efficiency of polishing pond unit in terms of BOD/COD reduction is low. iii) Gas generated in UASB reactors is not being utilized in dual fuel generators. iv) Plant receives 36 MLD flow of which 9 MLD is diverted after Grit channel to another 9 MLD plant based on oxidation pond technology.		○
60	34 MLD STP Sector50, NOIDA, Uttar Pradesh	UASB+PP	Unconformable (BOD)	i) Plant receives low BOD sewage but COD to BOD ratio (3.6) is high. ii) Overall performance of the plant is not satisfactory and it is not able to achieve the norms for discharge in streams in spite of low BOD raw sewage. iii) Efficiency of polishing pond unit in terms of BOD/COD reduction is very low.		
61	9 MLD STP Sector54, NOIDA, Uttar Pradesh	WSP	Unconformable (BOD,TSS)	i) Plant is not maintained properly and is not able to achieve the discharge standards.		○
62	10.445MLD STP Etawah, Uttar	WSP	Unconformable (TSS)	i) Plant receives low BOD sewage but COD to BOD ratio (5) is high. ii) Plant is not able to meet the standards in terms of TSS which is 118 mg/L in final effluent. High TSS in effluent primarily consisted of algae.	○	

S. No	STP , City/Town , State	Technology of STP	Conformity to Standards for discharge	Remarks observed by CPCB Study for Sewage Treatment Plants	Problems regarding	
					Planning & Design	Operation & Maintenance
	Pradesh			iii) Improvement in outlet structure to arrest floating algal flocs will help reducing outlet TSS and increase efficiency of BOD/COD removal. iv) Plant receives 16 MLD effluents. 10.445 MLD is treated in the plant and the rest is bypassed untreated. Expansion of the plant is proposed in Phase-3	○	
63	0.5 MLD STP KaliDeh, Vrindavan, Uttar Pradesh	WSP	Unconformable (BOD)	i) About half of the sewage reaching STPs was being bypassed and only half was taken for treatment in the plant. ii) Excess sludge accumulation was observed in anaerobic and facultative ponds, which reduced retention time and efficiency. iii) Plant is not able to meet the standards in terms of BOD, which was 57 mg/L in the final effluent. iv) Plant is facing problem of availability of funds for operation and maintenance.		○
64	4 MLD STP near Pagal Baba Mandir, Vrindavan, Uttar Pradesh	WSP	Unconformable (BOD,TSS)	i) Plant was overloaded because more than twice the design flow was reaching the plant. ii) Excess sludge accumulation was observed in ponds, which reduced retention time and efficiency. iii) Plant is not able to meet the standards in terms of BOD and SS. iv) Overloading, reduced retention time are the main reasons responsible for poor performance of the plant. However, improvement in outlet structures may be required to control high TSS, and the associated BOD/COD in the effluent. v) Plant is facing problem of availability of funds for operation and maintenance.	○ ○	○
65	13.59MLD STP Masani, Mathura, Uttar Pradesh	WSP	Unconformable (BOD)	i) About 60% flow was being bypassed and only 40 % was being treated in the plant. ii) Outlet BOD/COD were observed higher than inlet values due possibly to dilution of sewage. iii) Plant operation and maintenance was very poor. Desludging of only anaerobic pond is done and desludging of facultative ponds is not done. iv) Plant is not able to meet the standards in terms of BOD.		○ ○
66	14.5MLD STP Bangali Ghat, Dairy Farm Zone, Mathura, Uttar Pradesh	WSP	Unconformable (BOD,TSS)	i) Desludging of only anaerobic pond is impractical. ii) Plant was nonoperational in the mooring hours of day of monitoring due to power cut. iii) Plant is not able to meet the standards in terms of BOD and TSS. Improvement in outlet structures may be required to control high TSS, and the associated BOD/COD in the effluent. It is expected that control of TSS within 50 mg/L may enable achieving BOD standards also.	○ ○	○ ○

S. No	STP , City/Town , State	Technology of STP	Conformity to Standards for discharge	Remarks observed by CPCB Study for Sewage Treatment Plants	Problems regarding	
					Planning & Design	Operation & Maintenance
				iv) About 20% of treated sewage is utilized for irrigation but the rest 80% is discharged into an unlined drain and this is accumulating and water logging a large area. v) High TSS and COD as compared to BOD in raw sewage indicate possibility of addition of industrial waste.	○ ○	
67	2.25MLD STP Burhi Ka Nagla, Agra, Uttar Pradesh	WSP	Unconformable (BOD)	i) About 90% flow was being bypassed and only 10 % was being treated in the plant. ii) Outfall of treated as well as untreated sewage is upstream of Old water works at Agra and affects raw water quality. iii) Plant is not able to meet the standards in terms of BOD. iv) Desludging of anaerobic ponds was in progress and removed sludge was being placed very near to Yamuna River, which will flow into the river with rain water.		○
68	10 MLD STP Peela Khar, Agra, Uttar Pradesh	WSP	unconformable (BOD)	i) About 90% flow was being bypassed and only 10 % was being treated in the plant. ii) Outfall of treated as well as untreated sewage is upstream of Old water works at Agra and affects raw water quality. iii) Plant is not able to meet the standards in terms of BOD. iv) Desludging of anaerobic ponds was in progress and removed sludge was being placed very near to Yamuna River, which will flow into the river with rain water.		○
69	78 MLD STP Dhandupura, Agra, Uttar Pradesh	UASB+PP	Unconformable (BOD)	i) Plant capacity is under utilized as less than the design flow is being treated in the plant. ii) Very less flow reaches STP during night hours 1200 midnight to 0400 a.m. iii) Excess sludge accumulation in ponds was observed as the main reasons for under performance. iv) Plant is not able to meet the standards in terms of BOD.		○
70	0.32MLD STP Swargashram, Rishikesh, Uttranchal	UASB+PP	Conformable	i) Primary settling unit is performing badly as there is almost no change in sewage characteristics within this unit. ii) UASB unit is also functioning very poorly as there is negligible improvement in characteristics of sewage within this unit. iii) Polishing pond is also effecting only marginal reduction in BOD (35%) and COD (26%).		

S. No	STP , City/Town , State	Technology of STP	Conformity to Standards for discharge	Remarks observed by CPCB Study for Sewage Treatment Plants	Problems regarding	
					Planning & Design	Operation & Maintenance
				iv) High TSS levels in the outlets of primary clarifier, UASB reactor and Polishing pond indicates that settling in each of these units is not satisfactory. TSS level after proper settling is expected <50 mg/L and should not exceed 100 mg/L. v) There is no arrangement for handling/disposal of primary and secondary sludge, which is a must for proper functioning of primary clarifier and UASB reactors. vi) Plant is not able to comply with the discharge standards due to above reasons.	○	
71	18 MLD STP Jagjeetpur, Haridwar, Uttranchal	ASP	Conformable	i) Plant receives 30 MLD sewage. 18 MLD sewage is treated in the plant, and the rest is bypassed. ii) High TSS in outlet of primary settling unit indicates that its performing can be improved further. iii) ASP unit is being fed with low organic loading and it is performing well even though one of the three aeration tank was under maintenance at the time of study. iv) Gas generated in anaerobic sludge reactor is not being utilised v) Plant is able to comply with the discharge standards.	○	○
72	45 MLD STP Cossipore-Chitpore, Bangur, VIP Road, Kolkata, West Bengal	ASP	Conformable	i) Sewage flow reaching STP varied between 25-45 MLD. ii) Plant is able to achieve standards because very low strength sewage is being received. iii) Considering a little high SOR at full design flow on PSTs, hourly flow rate may be regulated to improve their efficiency if total flow reaching STP per day is less than full design flow. iv) A lot of energy is being consumed in ASP unit to achieve a marginal reduction of BOD in this unit. It is required that under existing conditions of low strength sewage, a minimum number of aerators may be aerators may be operated. v) Abnormally high F/M (2.84) is observed at design flow condition. Even at half the design flow F/M will be very high. vi) Gas digesters have never been used as the solids content of sewage is very less.	○ ○ ○	○ ○
73	10 MLD STP Bhatpara, Madrail, Kakinara,	WSP	Conformable	i) Plant receives very low strength sewage because most of the sewage connected is first treated in septic tanks. Even the raw sewage quality is meeting the discharge standards. ii) Accumulated sludge from the ponds has never been cleaned since the plant was		○

S. No	STP , City/Town , State	Technology of STP	Conformity to Standards for discharge	Remarks observed by CPCB Study for Sewage Treatment Plants	Problems regarding	
					Planning & Design	Operation & Maintenance
	Bhatpar, West Bengal			established in 1991.		
74	10 MLD STP Bhatpara (Old), Jagaddal, Bhatpara, West Bengal	ASP	Conformable	i) Plant is able to achieve standards because very low strength sewage is being received. ii) A lot of energy is being consumed in ASP unit to achieve a marginal reduction of BOD in this unit. It is required that under existing conditions of low strength sewage, a minimum number of aerators may be aerators may be operated. iii) Gas digesters have never been used, as the solids content of sewage is very less.		○
75	10 MLD STP Bhatpara (new), Jagaddal, Bhatpara, West Bengal	ASP	Conformable	i) Plant is not able to achieve standards. ii) Reasons for poor performance of STP need to be investigated and plant needs to be operated properly to achieve the standards. iii) Gas digesters have never been used.		○
76	4.5 MLD STP Dangapara, Rahra, West Bengal	ASP	Conformable	i) Plant is able to achieve standards because very low strength sewage is being received. ii) Considering a very high SOR at full design flow on PST, additional PST may not be added to the scheme. iii) Abnormally high F/M (1.56) is observed at full design flow condition iv) About 90% of the treated sewage is used for irrigation.	○	
77	4.54MLD STP Dangapara, Rahra, West Bengal	OP	Conformable	i) Plant is able to achieve standards because very low strength sewage is being received. ii) Separate flow measurement after distribution box of ASP plant and Oxidation pond is not possible. iii) About 90% of the treated sewage is used for irrigation	○	
78	14.1MLD STP Bandipur Gram Panchayat, Titagarh, West Bengal	WSP	Conformable	i) Plant receives very low strength sewage and treated sewage quality is meeting the discharge standards. ii) Accumulated sludge from the ponds has never been cleaned since the plant was established in 1993. iii) Anaerobic ponds were filled with accumulated sludge. iv) Bunds between the ponds have been damaged at few places and need repair.		○ ○ ○

S. No	STP , City/Town , State	Technology of STP	Conformity to Standards for discharge	Remarks observed by CPCB Study for Sewage Treatment Plants	Problems regarding	
					Planning & Design	Operation & Maintenance
79	12 MLD STP Panchayat, Panihati, West Bengal	WSP	Conformable	i) Plant receives very less flow as compared to its capacity and the treated sewage quality is meeting the discharge standards. ii) Accumulated sludge from the ponds has never been cleaned since the plant was established. iii) Bunds between the ponds have been damaged at few places and need repair.		○ ○
78	47.5MLD STP Garden Reach, Kolkata, West Bengal	ASP	Conformable	i) Plant is not able to achieve standards in spite of very low influent BOD level to activated sludge process. ii) Reasons for poor performance of STP need to be investigated and plant needs to be operated properly to achieve the standards. iii) Considering low influent BOD to aeration tank, use of aerators may be optimised to save energy. iv) Gas digesters have never been used.		○
79	30 MLD STP South Suburban (East), Kolkata, West Bengal	WSP	Conformable	i) Plant receives very low strength sewage. Treated sewage quality is meeting the discharge standards except for TSS. Reasons for high TSS need to be investigated and rectified. ii) Accumulated sludge from the ponds has never been cleaned since the plant was established. iii) Bunds between the ponds have been damaged at few places and need repair.		○ ○ ○
80	45 MLD STP Arupara, Howrah, West Bengal	TF	Conformable	i) Plant receives very low strength sewage. Treated sewage quality is meeting the discharge standards ii) Gas digesters were being used but no gas production was observed.		
81	18.16MLD STP Khalisani, Chandannagore, West Bengal	TF	Conformable	i) Plant receives very low strength sewage. Treated sewage quality is meeting the discharge standards ii) Gas digesters have never been used because of low strength of waste and low solids content.		
82	11 MLD STP Kalyani,, West Bengal	TF	Conformable	i) Plant receives very low strength sewage. Treated sewage quality is meeting the discharge standards ii) Trickling filter was found submerged due to clogging of pores and therefore trickling filter was operating under anaerobic conditions. iii) Industrial effluent mixed acidic sewage from Kalyani Silpanchal Area causes frequent corrosion of sewers.	○	○

S. No	STP , City/Town , State	Technology of STP	Conformity to Standards for discharge	Remarks observed by CPCB Study for Sewage Treatment Plants	Problems regarding	
					Planning & Design	Operation & Maintenance
83	6 MLD STP Kalyani, West Bengal	WSP	Conformable	i) Plant receives very low strength sewage. Treated sewage quality is meeting the discharge. ii) There is no flow measurement facility and flow distribution is also uneven. iii) Water hyacinth was present in abundance in anaerobic ponds. iv) Blue green algae were seen in some portion of one of the facultative ponds. Dead fish were also observed in the facultative ponds. v) Algae and fish were observed in abundance in maturation ponds.	○	○ ○
84	40 MLD STP Baranagar, West Bengal	TF	Conformable	i) Plant receives very low strength sewage. Treated sewage quality is meeting the discharge standards ii) One Trickling filter unit was found completely damaged due to break down of shaft and bearings and it was under maintenance.		○
85	18.9MLD STP Serampore, West Bengal	TF	Conformable	i) Plant receives very low strength sewage. Treated sewage quality is meeting the discharge standards. ii) The treated sewage was slightly red in colour due to probably to mixing of some cottage dying industry. iii) Owing to clogging of orifice of trickling filter, uneven distribution of wastewater and non-uniform growth of biomass over the media bed and shortcut of wastewater were observed.		○
86	10 MLD STP Nabadwip, West Bengal	WSP	Conformable	i) Treated sewage quality is meeting the discharge. ii) Water hyacinth was present in abundance in anaerobic ponds. No flow at outlet of one facultative pond was observed indicating high ground seepage from the pond. iii) Accumulated sludge has never been cleaned since establishment of the STP.		○ ○
87	3.7 MLD STP Behrampore, West Bengal	WSP	No evaluation	i) Plant does not receive sewage due to failure of civil structure near main pumping station, which occurred within a fortnight time of its commissioning in 1994. ii) There are three nearby drains that presently discharge sewage into three different Beels (Ponds). Gorabazar drain discharges sewage into Chaltia Beel, Barmuri drain that carries about 70% sewage discharges into Bishnupur Beel, and Saidabad drain discharges sewage into Chatra Beel. The three Beels meet another bigger Beel, namely, Bhanderdah Beel and thereafter the sewage is discharged into River Pagla Chandi.	○	

APPENDIX – A3-1

Questionnaires on Operation and Maintenance of STPs

Questionnaire for 8 target states and 2 Union Territories in India (below)

Face sheet

For your answer, please fill in the fields below so Study Team may want to check later.

1	Name of state	Delhi
2	Name of city/town	Delhi
3	Name of respondent	
4	Department	
5	Name of Plant	
6	Contact information	
7	-Address	
8	-Phone number	
9	-Fax number	
10	-E-mail address	

Status of Sewerage facilities and O&M

Mark the appropriate answer for the following questions related to their operation and maintenance of sewerage facilities, or indicate the quantity and content, please.

3	**Summary of sewage treatment plant**	
3.1	**Basic data related to facilities**	
3.1.1	Are there calculations for basic design and capacity of treatment plant facilities?	(Yes) Jal Board; Construction Div. (Civil) and E&M Division (Electrical and mechanical)
3.1.2	Are there completed drawings related to earthwork, machinery, and electrical equipment?	(Yes) No, Others :
3.1.3	Are there records for equipment?	(Yes) No , Others :
3.1.4	Is there the flow chart for instrumentation facility?	Yes , (No) Others :
3.1.5	Are there single-line diagrams (electrical)?	(Yes) No , Others :
3.1.6	Sewage treatment process (Example: Conventional activated sludge process)	ASP
3.1.7	Sludge treatment process (Example: Sludge drying after thickening)	Anaerobic digesters and Sludge drying beds
3.1.8	Which is the effluent discharge point?	Minor Irrigation Distribution Channels (MIDC)
3.1.9	Layout of plant (please attach the drawing, if you	No
3.2	**History**	
3.2.1	Is the history of failure, repair, or reconstruction maintained?	Yes (No) Others :
3.2.2	Are there any requests or complaints from	Yes (No)
3.3	**Design capacity and actual loading**	
3.3.1	Design wastewater flow	180 MLD
3.3.2	Average daily flow	60 MLD
3.3.3	Maximum daily flow	Around 100 MLD
3.3.4	Dry weather flow	N/A
3.3.5	Design wet weather flow	Around 180 MLD (Major trunk sewers)
3.3.6	Wet weather flow	Around 100 MLD
3.3.7	Design wastewater influent quality	BOD 250 mg/l , COD 450 mg/l , SS 400mg/l
3.3.8	Average wastewater influent quality	BOD 169.3 mg/l COD 400 mg/l , SS 359.1 mg/l
3.3.9	Design effluent quality	BOD 30.0 mg/l COD 75.0 mg/l SS 50 mg/l
3.3.10	Average effluent quality	BOD 13.5mg/l , COD 77.26mg/l SS 15.41mg/l
3.3.11	Solids capture rate	85-92%
3.3.12	Name of equipment for drawing out sludge (pump/gravity?)	N/A
3.3.13	Frequency of drawing out sludge	2 times/day; 60 times/month
3.3.14	Frequency of sludge carried outside STP	3 - 4 times/year to landfill
3.3.15	Design sludge generation volume and water content	N/A MLD, ML/year, %
3.3.16	Average sludge generation volume, and water content	0.15 metric ton/mld, ML/year, 3.5%
3.3.17	Percentage of volatile solids in generated sludge	mean: %, max: 55%, min: 45%
3.3.18	Methods of effective sludge or waste utilization	Fertilizer - Loaded on trucks and taken to farms No waste utilization
3.3.19	Annual sludge utilization or sludge disposal, and water content in sludge	Methods: Lifting by trucks; 3-4 times a year t/year, %
3.3.20	Are there operation records?	Daily report: (Yes) , Monthly report: (No) , Annual report: (Yes) No
3.3.21	Is the water quality measured regularly?	(Yes) twice a week; BOD, TSS - daily No
3.3.22	Are water quality measurement records maintained?	Daily report: (Yes) Monthly report No , Annual report: Yes No ,
3.3.23	Is record of concentration of toxic substances in sludge maintained?	Yes (No)
3.3.24	Has the water quality of the final effluent exceeded the effluent standards anytime?	(Yes) in rare cases. No
3.3.25	If Yes, what are the cause for exceeding the effluent standard?	Operational error, equipment breakdowns, etc.
3.4	**Corrosion of facilities and situation of damage**	
3.4.1	Is there corrosion of building frame part of	(Yes) Civil structures, MS structures, equipment

3.4.2	Was there any damage to the building frame part of facilities?	(Yes), No , name of part :major damage to RCC in 1957
3.4.3	Is there corrosion in equipment?	(Yes) No , name of part :
3.4.4	Is there damage to equipment?	(Yes) No , name of part :
3.4.5	Are there the records of corrosion and damage to	Yes (No)
3.4.6	Is there a bad smell ?	(Yes, sometimes but clears when BOD level maintained
3.4.7	Is scum generated?	A large amount (Small amount) No
3.5	**Management of premeditated facilities**	
3.5.1	Is there an operation plan?	(Yes) "manufacturer compilation, Others" No
3.5.2	Is there an operation manual?	(Yes) No
3.5.3	Is there a plan for wastewater examination for influent, effluent and others?	(Yes) No
3.5.4	Is there a wastewater examination method?	Yes "Name of the method": (No)
3.5.5	Are there education and training manuals for operation and inspection for the staff ?	Yes (No) ; not in-house
3.6	**Inspection of facility and equipment**	
3.6.1	Are there the check records of equipment?	Daily report: (Yes) Log sheets , Monthly report: No , Annual report: Yes (No)
3.6.2	Is there an inspection manual?	Yes (No)
3.6.3	Is there an inspection schedule?	Yes (No)
3.6.4	Inspection procedure	by watching, breakdown maintenance Others :
3.6.5	How has the result of the inspection been used?	For Plant maintenance
3.6.6	How are inspection results kept?	Electronic data, Hard copy, Others : N/A
3.7	**Repair, Rehabilitation, Reconstruction**	
3.7.1	Is there a manual of facility and equipment repair, rehabilitation and reconstruction?	Yes (No)
3.7.2	Is it being used?	Yes (No)
3.7.3	Are there the repair and rehabilitation and reconstruction plans for facility and equipment ?	Yes (No)
3.7.4	Were repair, rehabilitation and reconstruction executed?	(Yes) No
3.7.5	Are there repair, rehabilitation and reconstruction	Electronic data, (Hard copy) Others :
3.7.6	Is there any record of breakdown , repair, and reconstruction of facilities?	(Yes) : Log sheets , No , Others :
3.7.7	Is there any record of the breakdown , repair, and reconstruction of facilities?	Yes , No , Others : N/A
3.8	**Work implementing system**	
3.8.1	Staffing or manpower at plant	Manager : persons Foreman : 1person Operator : Shift-in-charge - 1 person; 3 shifts Maintenance: 8 persons Analyses of water quality: 2 persons: Total staff: 190 persons Office workers: 7 persons
3.8.2	Qualification and number of engineers	1 Executive Engineer 2 Assistant Engineers 2 Junior Engineers
3.8.3	Working time	Engineers 10-5:30, Operators - 3 shifts; 8-4/4-12/12-8
3.8.4	Work system	N/A persons: groups:
3.8.5	Work mode	In-house, Subcontract: For repairs only
3.8.6	Contents of work	N/A Operation , Maintenance, Repair
3.8.7	(Others - measures against accidents and disasters)	(Yes) No
3.9	**Procurement of utility and materials**	
3.9.1	Is the procurement of chemicals easy?	Yes (No) chemicals not nused
3.9.2	Is there a procurement plan of electric power and chemicals?	Yes (No ,) power is from govt., chemicals not used
3.9.3	Amount of electric power used each day, and of one year	6000 kWh in a day, 2190000 kWh in a year
3.9.4	Quantity of industrial chemicals consumed (chlorine, alum, etc.)	N/A : kg/d, kg/year N/A : kg/d, kg/year
3.9.5	Is there a list of vendors for electric power, chemicals, the consumable materials, and machine	Yes (No)
3.9.6	Frequency of power failure during year, total number	3 -4 times/month 40 times/year, hours/year
3.9.7	Is there the privately owned electrical	Yes No N/A
3.9.8	Driving frequency and driving time of privately owned electrical power facilities	N/A Times/year hours/year
3.10	**Relevant environmental statutes and regulatory criteria**	
3.10.1	Water quality standards for industrial wastewater, and name of law	Yes, No ,Name of law:
3.10.2	Water quality standards of effluent of sewage treatment plant	Yes, No ,Name of law:

3.10.3	Is there any emission standard value for the bad smell in a sewage treatment plant?	Yes, No ,Name of law:
3.10.4	Is there any standard value for regulation of the noise which was generated from the sewage treatment plant?	Yes, No ,Name of law:
3.10.5	Is there any standard value about regulation of the vibration which was generated from the sewage treatment plant?	Yes, No ,Name of law:
3.10.6	Is there a regulation standard value of the exhaust gas discharged from the sewage treatment plant?	Yes, No ,Name of law:
3.10.7	Is there the disposal standard value when disposing of sewage sludge as waste?	Yes, No ,Name of law:
3.10.8	Is there a standard value of toxic substance concentration, when the sewage sludge is used as	Yes, No ,Name of law:
3.10.9	Is there a law which regulates the business unit which manages a sewer enterprise?	Yes, No ,Name of law:
3.10.10	Is there any law which regulates the number of the staffs in the business unit who do maintenance	Yes, No ,Name of law:
3.11	**Efficiency improvement and remedial measures, maintenance management of**	
3.11.1	Is there a centralized control system?	Yes (No)
3.11.2	Is there a data logger system?	Yes (No)
3.11.3	Has the operation and maintenance service been consigned to a private company?	(Yes;) 1 or 2 plants for 10 years No
3.11.4	Wastewater tariff	
3.11.5	Collection rate of the wastewater charges	N/A %
3.11.6	The ratio of the wastewater tariff in comparison to maintenance expense of sewerage facilities	N/A **%** "Wastewater charge/Maintenance expense of sewerage facilities"
3.11.7	Method of collecting the wastewater tariff	Name of collection section: Outsourcing to a private corporation N/A
3.12	**Safety management**	
3.12.1	Is there a safety hygiene organization?	Yes (No) management cell in JAL Board
3.12.2	Is there a safety operation manual **?**	Yes (No)
3.12.3	Are there safety protection tools?	(Yes) No
3.12.4	Are there warning signs for dangerous parts of the	(Yes) No
3.12.5	Are there examples of disasters in the past?	(Yes) No
3.12.6	Is education and training implemented for health and safety ?	Yes (No)
3.12.7	Is there a crisis-management manual?	Yes (No)

Check list of sewerage systems, machinery and electrical systems

Please mark the appropriate answer in the following questions or indicate the quantity thereof.

1	**Machinery system**		
1.1	**Grit chamber**		
1.1.1	**Type of screens**		
1.1.2	Is there a coarse screen?	(Yes)	No
1.1.3	Is screen type mechanical?	(Yes)	No
1.1.4	Is there a fine screen?	Yes	(No)
1.1.5	Is screen type mechanical?	Yes	(No)
1.1.6	Is there a crushing device?	Yes	(No)
1.1.7	Is there a conveyor?	(Yes)	No
1.1.8	How is the grid chamber cleaned?	Yes	No
	Mechanically?	(Yes)	No
	Bucket elevator?	(Yes)	No
	Jet pump?	Yes	(No)
	Screw?	Yes	(No)
	Air lift?	Yes	(No)
	Manually?	Yes	(No)
	Aeration?	Yes	(No)
1.2	**Pumps**		
1.2.1	What is the rated voltage of main pump?	415 V	
1.2.2	Is there any speed controlled pump?	Yes	(No)
1.2.3	And if there is, what is the type of pump?	Yes	(No)
1.2.4	And if there Yes, what is the method of speed	No	
1.3	**What type of aeration facilities are used?**	Surface aerators	
1.3.1	What type of air diffuser is used?	No	
1.4	**Disinfection equipment**		
1.4.1	What type of disinfection of effluent is adopted?	No	
	Chlorination?	Yes	(No)
	Ultra violet ray?	Yes	(No)
	Ozonizer?	Yes	(No)
1.5	**Sludge thickening equipment**		
1.5.1	**What type of sludge thickening is adopted ?**		
	Gravity thickening?	No	
	Air flotation?	No	
	Centrifugal thickening?	No	
	Belt type?	No	

1.6	**Sludge dehydration equipment**				
1.6.1	**What type of sludge dehydration method is**				
	Mechanical?	No			
	Filter press?	Yes	(No)		
	Centrifugal dehydration	Yes	(No)		
	Vacuum filtration?	Yes	(No)		
	Others?				
1.6.2	Where does the dewatered sludge go to?	Landfill			
1.7	**Sludge digestion facility**				
1.7.1	**What type of sludge digestion is adopted?**				
	Anaerobic?	Yes			
	Aerobic?	No			
1.7.2	Is digester gas used?	Yes(for)	(No)	Incinerated	
2	**Electrical system**				
2.1	**Substation facility**				
2.1.1	What is the substation voltage?		11 kV		
2.2	**Domestic power system**				
2.2.1	Is there a domestic power system?	N/A			
2.3	**Uninterrupted power supply**				
2.3.1	Is there uninterrupted power supply?	Yes	(No)		
2.3.2	If there Yes, is it DC supply or AC supply?	AC	DC	No	
2.3.3	What are the applications of this power supply?	For		No	
2.5	**Measuring instruments**				
2.5.1	**What type of flow meter is adopted and where?**				
	Electro-magnetic?	Yes ( )	(No)		
	Ultrasonic?	(Yes)	( ) No		
	Orifice plate?	Yes ( )	(No)		
	Venturi?	(Yes)	( ) No		
	Weir?	Yes ( )	(No)		
	Partial flume?	Yes ( )	(No)		
2.5.2	**What type of level gauge is adopted and where?**				
	Float-type?	(Yes)	( ) No		
	Pressure-type?	Yes ( )	(No)		
	Ultrasonic?	Yes ( )	(No)		
	Radio wave ?	Yes ( )	(No)		
2.5.3	**Is a water quality meter used?**				
	PH?	(Yes)	No		
	DO?	(Yes)	All in laboratory; Do meter online	No	
	MLSS?	(Yes)	No		
	ORP?	Yes	(No)		
	Turbidity?	Yes	(No)		
	RCL?	Yes	(No)		
	Nitrogen?	Yes	(No)		
	Phosphorus?	Yes	(No)		
2.5.4	**Is sludge measurement performed?**				
	Sludge concentration?	Yes	No		
2.5.5	**Is any meteorological instrument used?**				
	Temperature?	Yes	(No)		
	Atmospheric pressure?	Yes	(No)		
	Rain?	Yes	(No)		
	Wind velocity (Anemometer)?	Yes	(No)		
2.5	**Monitoring control system**				
2.5.1	Where is the lookout post?	Individual			
	Grit chamber	No			
	Dry well	No			
	Sewage treatment facility	Yes			
	Sludge thickening equipment	No			
	Sludge dehydration equipment	No			
	Anaerobic digestion tank	No			
	Pumping station	Yes			
2.5.2	**Where is the control room?**	No			
	Grit chamber	No			
	Dry well	No			
	Sewage treatment facility	at Aeration unit			
	Sludge thickening equipment	No			
	Sludge dehydration equipment	No			
	Anaerobic digestion tank	No			
	Pumping station	No			
2.5.3	Is SCADA（Supervisory Control And Data Acquisition）system adopted?	Yes	(No)		

Questionnaire for 8 target states and 2 Union Territories in India (below)

Face sheet

For your answer, please fill in the fields below so Study Team may want to check later.

1	Name of state	Delhi
2	Name of city/town	Delhi
3	Name of respondent	
4	Plant Capacity	
5	Name of Plant	
6	Contact information	
7	-Address	
8	-Phone number	
9	-Fax number	
10	-E-mail address	

Status of Sewerage facilities and O&M

Mark the appropriate answer for the following questions related to their operation and maintenance of sewerage facilities, or indicate the quantity and content, please.

3	**Summary of sewage treatment plant**	
3.1	**Basic data related to facilities**	
3.1.1	Are there calculations for basic design and capacity of treatment plant facilities?	Yes
3.1.2	Are there completed drawings related to earthwork, machinery, and electrical equipment?	Yes
3.1.4	Is there the flow chart for instrumentation facility?	No
3.1.5	Are there single-line diagrams (electrical)?	Yes
3.1.6	Sewage treatment process（Example: Conventional activated sludge process）	ASP, BIOFOR
3.1.7	Sludge treatment process （Example: Sludge drying after thickening）	Anaerobic Digester, Sludge drying beds
3.1.8	Which is the effluent discharge point?	Drain outfall, Sultanpuri Nangloi Drain to Yamuna Rive
3.1.9	Layout of plant (please attach the drawing, if you	Yes
3.2	**History**	
3.2.1	Is the history of failure, repair, or reconstruction maintained?	Yes, record for 5 years available
3.2.2	Are there any requests or complaints from surrounding residents?	No
3.3	**Design capacity and actual loading**	
3.3.1	Design wastewater flow	180 MLD
3.3.2	Average daily flow	70-90 MLD
3.3.3	Maximum daily flow	90 MLD
3.3.4	Dry weather flow	70-90 MLD
3.3.5	Design wet weather flow	70-90 MLD
3.3.6	Wet weather flow	70-90 MLD
3.3.7	Design wastewater influent quality	BOD 250 mg/l , COD 450 mg/l , SS 400.0 mg/l
3.3.8	Average wastewater influent quality	BOD 187.2 mg/l , COD 425.7 mg/l , SS 281.2 mg/l
3.3.9	Design effluent quality	BOD 30.0 mg/l , COD 75.0 mg/l , SS 50.0 mg/l
3.3.10	Average effluent quality	BOD 19.2 mg/l , COD 63.5 mg/l , SS 26.0 mg/l
3.3.11	Solids capture rate	N/A
3.3.12	Name of equipment for drawing out sludge (pump/gravity?)	Convey by trucks
3.3.13	Frequency of drawing out sludge	N/A
3.3.14	Frequency of sludge carried outside STP	N/A
3.3.15	Design sludge generation volume and water content	N/A
3.3.16	Average sludge generation volume, and water content	N/A
3.3.17	Percentage of volatile solids in generated sludge	N/A
3.3.18	Methods of effective sludge or waste utilization	N/A
3.3.19	Annual sludge utilization or sludge disposal, and water content in sludge	N/A
3.3.20	Are there operation records?	Log sheets
3.3.21	Is the water quality measured regularly?	Yes
3.3.22	Are water quality measurement records	Yes
3.3.23	Is record of concentration of toxic substances in sludge maintained?	N/A
3.3.24	Has the water quality of the final effluent exceeded the effluent standards anytime?	Rare cases
3.3.25	If Yes, what are the cause for exceeding the effluent standard?	Shutdown, flooding, water logging

3.4	**Corrosion of facilities and situation of damage**	
3.4.1	Is there corrosion of building frame part of	Yes, MS, structural equipment, motors
3.4.2	Was there any damage to the building frame part of facilities?	N/A
3.4.3	Is there corrosion in equipment?	N/A
3.4.4	Is there damage to equipment?	N/A
3.4.5	Are there the records of corrosion and damage to facilities?	No
3.4.6	Is there a bad smell ?	Rare cases
3.4.7	Is scum generated?	Normal amount
3.5	**Management of premeditated facilities**	
3.5.1	Is there an operation schedule for pumps and	Log sheets
3.5.2	Is there an operation manual?	Yes
3.5.3	Is there a plan for wastewater examination for influent, effluent and others?	Yes
3.5.4	Is there a wastewater examination method?	N/A
3.5.5	Are there education and training manuals for operation and inspection for the staff ?	No
3.6	**Inspection of facility and equipment**	
3.6.1	Are there the check records of equipment?	Yes, log sheets
3.6.2	Is there an inspection manual?	No
3.6.3	Is there an inspection schedule?	Yes
3.6.4	Inspection procedure	N/A
3.6.5	How has the result of the inspection been used?	N/A
3.6.6	How are inspection results kept?	Hard copy
3.7	**Repair, Rehabilitation, Reconstruction**	
3.7.1	Is there a manual of facility and equipment repair, rehabilitation and reconstruction?	No
3.7.2	Is it being used?	No
3.7.3	Are there the repair and rehabilitation and reconstruction plans for facility and equipment ?	No
3.7.4	Were repair, rehabilitation and reconstruction executed?	No
3.7.5	Are there repair, rehabilitation and reconstruction	No
3.7.6	Is there any record of breakdown , repair, and reconstruction of facilities?	No
3.7.7	Is there any record of the breakdown , repair, and reconstruction of facilities?	No
3.8	**Work implementing system**	
3.8.1	Staffing or manpower at plant	40 persons total + outside agencies 3 shifts, 13-14 persons
3.8.2	Qualification and number of engineers	3 Engineers
3.8.3	Working time	3 shifts
3.8.4	Work system	N/A
3.8.5	Work mode	N/A
3.8.6	Contents of work	N/A
3.8.7	(Others - measures against accidents and disasters)	Safety Equipment
3.9	**Procurement of utility and materials**	
3.9.1	Is the procurement of chemicals easy?	None used
3.9.2	Is there a procurement plan of electric power and chemicals?	N/A
3.9.3	Amount of electric power used each day, and of one year	2.5 to 3.0 lakh kWh per month
3.9.4	Quantity of industrial chemicals consumed (chlorine, alum, etc.)	None used
3.9.5	Is there a list of vendors for electric power, chemicals, the consumable materials, and machine	N/A
3.9.6	Frequency of power failure during year, total number	Rarely
3.9.7	Is there the privately owned electrical power	N/A
3.9.8	Driving frequency and driving time of privately owned electrical power facilities	N/A
3.10	**Relevant environmental statutes and regulatory criteria**	
3.10.1	Water quality standards for industrial wastewater, and name of law	
3.10.2	Water quality standards of effluent of sewage treatment plant	
3.10.3	Is there any emission standard value for the bad smell in a sewage treatment plant?	
3.10.4	Is there any standard value for regulation of the noise which was generated from the sewage treatment plant?	
3.10.5	Is there any standard value about regulation of the vibration which was generated from the sewage treatment plant?	

3.10.6	Is there a regulation standard value of the exhaust gas discharged from the sewage treatment plant?	
3.10.7	Is there the disposal standard value when disposing of sewage sludge as waste?	
3.10.8	Is there a standard value of toxic substance concentration, when the sewage sludge is used as	
3.10.9	Is there a law which regulates the business unit which manages a sewer enterprise?	
3.10.10	Is there any law which regulates the number of the staffs in the business unit who do maintenance	
3.11	**Efficiency improvement and remedial measures, maintenance management of**	
3.11.1	Is there a centralized control system?	No
3.11.2	Is there a data logger system?	No
3.11.3	Has the operation and maintenance service been consigned to a private company?	Only repair subcontracts
3.11.4	Wastewater tariff	
3.11.5	Collection rate of the wastewater charges	
3.11.6	The ratio of the wastewater tariff in comparison to maintenance expense of sewerage facilities	
3.11.7	Method of collecting the wastewater tariff	
3.12	**Safety management**	
3.12.1	Is there a safety & hygiene organization?	N/A
3.12.2	Is there a safety operation manual **?**	Yes
3.12.3	Are there safety protection tools?	Yes
3.12.4	Are there warning signs for dangerous parts of the	Yes
3.12.5	Are there examples of disasters in the past?	Yes
3.12.6	Is education and training implemented for health and safety ?	From time to time
3.12.7	Is there a crisis-management manual?	No

Check list of sewerage systems, machinery and electrical systems

Please mark the appropriate answer in the following questions or indicate the quantity thereof.

1	**Machinery system**	
1.1	**Grit chamber**	
1.1.1	**Type of screens**	
1.1.2	Is there a coarse screen?	Yes
1.1.3	Is screen type mechanical?	Yes
1.1.4	Is there a fine screen?	No
1.1.5	Is screen type mechanical?	Yes
1.1.6	Is there a crushing device?	No
1.1.7	Is there a conveyor?	No
1.1.8	**How is the grid chamber cleaned?**	
	Mechanically?	Yes
	Bucket elevator?	No
	Jet pump?	No
	Screw?	No
	Air lift?	No
	Manually?	Yes
	Aeration?	No
1.2	**Pumps**	
1.2.1	What is the rated voltage of main pump?	N/A
1.2.2	Is there any speed controlled pump?	No
1.2.3	And if there is, what is the type of pump?	No
1.2.4	And if there is, what is the method of speed	No
1.3	**What type of aeration facilities are used?**	Surface aerators
1.3.1	What type of air diffuser is used?	No
1.4	**Disinfection equipment**	
1.4.1	What type of disinfection of effluent is adopted?	
	Chlorination?	No
	Ultra violet ray?	No
	Ozonizer?	No
1.5	**Sludge thickening equipment**	
1.5.1	**What type of sludge thickening is adopted ?**	
	Gravity thickening?	No
	Air flotation?	No
	Centrifugal thickening?	No
	Belt type?	No
1.6	**Sludge dehydration equipment**	
1.6.1	**What type of sludge dehydration method is adopted ?**	
	Mechanical?	No
	Filter press?	No
	Centrifugal dehydration	No
	Vacuum filtration?	No
	Others?	

1.6.2	Where does the dewatered sludge go to?	N/A
1.7	**Sludge digestion facility**	
1.7.1	**What type of sludge digestion is adopted?**	
	Anaerobic?	Yes
	Aerobic?	No
1.7.2	Is digester gas used?	Yes (for power)
2	**Electrical system**	
2.1	**Substation facility**	
2.1.1	What is the substation voltage?	415V This is probably line voltage
2.2	Domestic power system	No
2.2.1	Is there a domestic power system?	No
2.3	**Uninterrupted power supply**	
2.3.1	Is there uninterrupted power supply?	N/A
2.3.2	If Yes, is it DC supply or AC supply?	N/A
2.3.3	What are the applications of this power supply?	N/A
2.5	**Measuring instruments**	
2.5.1	**What type of flow meter is adopted and where?**	
	Electro-magnetic?	Yes At Inlet
	Ultrasonic?	Yes
	Orifice plate?	No
	Venturi?	No
	Weir?	No
	Partial flume?	No
2.5.2	**What type of level gauge is adopted and where?**	
	Float-type?	No
	Pressure-type?	No
	Ultrasonic?	No
	Radio wave ?	No
2.5.3	**Is a water quality meter used?**	
	PH?	Yes
	DO?	Yes,All in laboratory
	MLSS?	No
	ORP?	No
	Turbidity?	Yes
	RCL?	No
	Nitrogen?	No
	Phosphorus?	No
2.5.4	**Is sludge measurement performed?**	
	Sludge concentration?	No
2.5.5	**Is any meteorological instrument used?**	
	Temperature?	No
	Atmospheric pressure?	No
	Rain?	No
	Wind velocity (Anemometer)?	No
2.5	**Monitoring control system**	
2.5.1	**Where is the lookout post?**	
	Grit chamber	No
	Dry well	No
	Sewage treatment facility	No
	Sludge thickening equipment	No
	Sludge dehydration equipment	No
	Anaerobic digestion tank	No
	Pumping station	Control rooms where only electric panels exist
2.5.2	**Where is the control room?**	
	Grit chamber	No
	Dry well	No
	Sewage treatment facility	No
	Sludge thickening equipment	No
	Sludge dehydration equipment	No
	Anaerobic digestion tank	No
	Pumping station	Control rooms where only electric panels exist
2.5.3	Is SCADA（Supervisory Control And Data Acquisition）system adopted?	No

Part B Individual Treatment Plant

Questionnaire for 8 target states and 2 Union Territories in India

Face sheet

Please fill in the fields below. Attach additional sheets if necessary.

1	Name of state	Delhi
2	Name of city/town	Okhla
3	Name of respondent	
4	STP Name	
5	Contact information	
6	Address	
7	Phone number	
8	E-mail address	

I Summary of sewage treatment plant

1	**Basic data related to facilities**	
1.1	Are there calculations for basic design and capacity of treatment plant facilities?	No
1.2	Is there a layout plan showing earthwork, machinery, and electrical equipment?	No
1.3	Are there detailed specifications of all facilities and equipment fitted in the plant? Are there as-fitted drawings of all sewers? Are there structural drawings of tanks, digesters, reactors, buildings,	N/A
1.4	Is there a flow chart for instrumentation?	No
1.5	Are there single-line diagrams (electrical)?	No
1.6	Sewage treatment process used (Example: Conventional activated sludge process)	ASP
1.7	Sludge treatment process used (Example: Sludge drying after thickening)	Anaerobic digester. Slude drying beds.
1.8	Which is the effluent discharge point?	40 MGD discharged to CPWD and used as water for gardening. 100 MGD discharged into the Agra Canal and drained into the Yamuna river.
1.9	Layout of plant (please attach the drawing, if you	Received, but practically unreadable. Even their staff could not understand
2	**History**	
2.1	Is the history of failure, repair, or reconstruction recorded?	Yes
2.2	Are there any requests or complaints from surrounding residents?	No
3	**Design capacity and actual loading**	
3.1	Design wastewater flow	45 MGD (These figures were given orally without referring to records)
3.2	Average daily flow	40-45 MGD
3.3	Maximum daily flow	45 MGD
3.4	Dry weather flow	N/A
3.5	Design wet weather flow	40-45 MGD
3.6	Wet weather flow	N/A
3.7	Design wastewater influent quality	BOD 250mg/l , COD 450 mg/l , SS 400.0 mg/l
3.8	Average wastewater influent quality	BOD 211 mg/l , COD 593 mg/l , SS 336.0 mg/l
3.9	Design effluent quality	BOD 30.0 mg/l , COD 250 mg/l , SS 50 mg/l
3.10	Average effluent quality	BOD 31.8 mg/l , COD 114.8 mg/l , SS 49.9 mg/l
3.11	Solids capture rate	85%
3.12	What equipment is used for drawing out sludge from primary/secondary sedimentation tank or digester (pump/gravity, etc.)?	Pumps used.
3.13	Frequency of drawing out sludge	Drawn out for 2 hours continuously per day
3.14	Frequency of sludge carried outside STP	Many times a month only during January to March only.
3.15	Design sludge generation volume and water content	Not available
3.16	Average sludge generation volume, and water content	0.2 MLD & 73 Million liters / Year & water content 50%
3.17	Percentage of volatile solids in generated sludge	40%
3.18	Methods of effective sludge or waste utilization	Sludge collected by farmers manually.
3.19	Is sludge used for agricultural purpose or some other purpose? What is the amount of sludge disposed and water content in sludge?	for agricultural purpose Amount: 5475t/year, (Approx.) Water Content: 50 % Currently sludge is being sold at the rate of 3 tons/ 10 rupees that gives revenue of 18250 rupees annually.
3.2	Are there operation records for pumps, equipment, blowers, etc.?	Yes
3.2.1	Is the water quality measured regularly?	Yes, measured daily. Reported every 15 days.
3.2.2	Are water quality measurement records maintained?	Daily report: Yes reported every 15 days.

3.2.3	Is record of concentration of toxic substances in sludge maintained?	No
3.2.4	Has the water quality of the final effluent exceeded the effluent standards anytime?	No
3.2.5	If Yes, what are the cause for exceeding the effluent standard?	N/A
4	**Corrosion of facilities and damage status**	
4.1	Is there corrosion of buildings or structures?	Yes, in gas chamber, FST, PST, Pump house
4.2	Was there any damage to the building frame part of facilities?	Yes
4.3	Is there corrosion in equipment?	Yes
4.4	Is there damage to equipment?	Yes
4.5	Are there records of corrosion and damage to facilities?	No
4.6	Is there foul smell most of the time?	Yes
4.7	Is scum generated?	Small amount
5	**Management of planned facilities**	
5.1	Is there an operation schedule for machinery and equipment	No, 24-hour operation.
5.2	Is there an operation manual?	No
5.3	Is there a schedule for wastewater examination for influent, effluent and others?	Yes. Measured 4-5 times a day.
	Is there a wastewater examination method?	Yes. Refer to Laboratory.
5.4	Are there the education and training manuals for the staff?	No. Training conducted from time to time as necessary.
6	**Inspection of facility and equipment**	
6.1	Are there check records for equipment?	Private company appointed by DJB performs checks periodically.
6.2	Is there an inspection manual?	N/A
6.3	Is there an inspection schedule?	N/A
6.4	Details of inspection procedure	Visual
6.5	How has the result of the investigation been used?	N/A
6.6	How are inspection results maintained?	Hard copy
7	**Repair, Rehabilitation, Reconstruction**	
7.1	Is there a manual for repair, rehabilitation and reconstruction of facility and equipment?	No
7.2	If Yes, is it being used?	No
7.3	Are there repair, rehabilitation and reconstruction plans for facility and equipment ?	No
7.4	Have repairs, rehabilitation and reconstruction been implemented?	Yes. This is ongoing.
7.5	Are there repair, rehabilitation and reconstruction	Data not available.
8	**Work implementation**	
8.1	Staffing or Manpower at Plant	Executive Engineer: 1 person (for entire 140 MGD)
		Engineers: 7 persons Foreman: 1 person
		Maintenance: 3-4 persons per shift; 3 shifts Shift-in-charge: 3 pers
		Analyses of water quality: 3-4 persons in laboratory
		Office workers: 20 persons Total staff:
8.2	Qualification of engineers	1 Executive Engineer
		3 Assistant Engineers
		4 Junior Engineers
8.3	Working time	3 Shifts : 8-16,16-24,24-8
8.4	Work mode	Permanent workers; if repairs cannot be handled, then subcontractors are c
8.5	Contents of work	Operation , Maintenance
8.6	Others（Are there the special measures taken at the time of accidents or disasters?）	Instructions have been given on what equipment to switch off when flood
9	**Procurement of utility and materials**	
9.1	Is the procurement of the chemicals easy?	N/A
9.2	Is there a procurement plan of chemicals?	No
9.3	Amount of electric power used each day/month, and of one year	855,660 kWh in month
9.4	Quantity of industrial chemicals used "Chlorine, Coagulant, etc.."	No
9.5	Is there a list of vendors for chemicals, consumable materials, and machine parts?	No
9.6	Frequency of power failure during year, total number	Power failure is rare. Two-grid power system used. When one fails, other automatically takes over.
9.7	Are there standby power generators?	No
9.8	How many times a year and how many hours a year is the standby power generator used?	No

10	**Efficiency improvement and remedial measures and maintenance management of**	
10.1	Is there a centralized control system?	No - only electrical control room available with control panels.
.	Is there a data logger system?	No
10.2	Has the operation and maintenance service been subcontracted to a private company?	Yes, only for renovation and replacement of parts or equipment.
11	**Safety management**	
11.1	Is there a safety and hygiene organization?	No
11.2	Is there a safety operation manual ?	No
11.3	Are there safety protection tools?	Yes
11.4	Are there warning signs for dangerous parts of the facilities?	Yes, shown as warning symbols.
11.5	Have there been instances of accidents/disasters in the past?	No
11.6	Is education and training implemented for health and safety ?	No
11.7	Is there a rsik management manual (for floods, cyclones, earthquakes, and other natural disasters)?	No

Ⅱ Check list of sewerage systems, machinery and electrical systems

Please reply as indicated on the right side.

1	**Machinery system**	
1.1	**Type of screens**	
1.1.1	Is there a coarse screen?	Yes
1.1.2	Is screen type mechanical?	No
1.1.3	Is there a fine screen?	Yes
1.1.4	Is screen type mechanical?	Yes
1.1.5	**Grit chamber**	
1.1.6	Is there a crushing device?	No
1.1.7	Is there a conveyor?	No. Scraper arm, rack classifier used.
1.1.8	**How is the grid chamber cleaned?**	
	Mechanically?	Yes
	Bucket elevator?	No
	Jet pump?	No
	Screw?	No
	Air lift?	No
	Manually?	No
	Aeration?	No
1.2	**Pumps**	
1.2.1	What is the rated voltage of main pump?	440V
1.2.2	Is there any speed controlled pump?	No
1.2.3	If YES, what is the type of pump?	No
1.2.4	If YES, what is the method of speed control?	No
1.3	**What type of aeration facilities used?**	Surface aerators
1.3.1	What type of air diffuser is used?	Not used
1.4	**Disinfection equipment**	
1.4.1	What type of disinfection method for effluent is	Not used
	Chlorination?	No
	Ultra violet ray?	No
	Ozonizer?	No
1.5	**Sludge thickening equipment**	
1.5.1	**What type of sludge thickening equipment is**	Not used
	Gravity thickening?	No
	Air flotation?	No
	Centrifugal thickening?	No
	Belt type?	No
1.6	**Sludge dehydration equipment**	
1.6.1	**What type of sludge dehydration method is**	Not used
	Mechanical?	No
	Filter press?	No
	Centrifugal dehydration	No
	Vacuum filtration?	No
	Others?	No
1.6.2	Where does the dewatered sludge go to?	Picked up by farmers and used for making fertilizer
1.7.1	Sludge digestion facility (Anaerobic)?	Yes
1.7.2	Is digester gas used?	Yes (for cooking)
2	**Electrical system**	
2.1	**Substation facility**	
2.1.1	What is the substation voltage?	11kV
2.3	**Uninterrupted power supply (UPS)**	
2.3.1	Is there uninterrupted power supply?	No
2.3.2	If YES, is it DC supply or AC supply?	No
2.3.3	What are the applications of this power supply?	No

2.5	**Measuring instruments**	
2.5.1	**What type of flow meter is used and where?**	Flow measured only at SPS
	Electro-magnetic?	No
	Ultrasonic?	No
	Orifice plate?	No
	Venturi?	No
	Weir?	No
	Partial flume?	No
2.5.2	**What type of level gauge is adopted and where?**	
	Float-type?	No
	Pressure-type?	No
	Ultrasonic?	No
	Radio wave ?	No
2.5.3	**Is a water quality meter used?**	
	PH?	Yes
	DO?	Yes
	MLSS?	No
	ORP?	No
	Turbidity?	Yes
	RCL?	No
	Nitrogen?	No
	Phosphorus?	No
2.5.4	Is sludge measurement performed?	
	Sludge concentration?	Once got done from Sriram laboratories (At Delhi). Data not available
2.5.5	Is any meteorological instrument used for the	
	Temperature?	No
	Atmospheric pressure?	No
	Rain?	No
	Wind velocity (Anemometer)?	No
2.5	**Monitoring control system**	
2.5.1	**Does a lookout post exist at the following**	
	Grit chamber	Yes
	Dry well	Yes (pump pit)
	Sewage treatment facility	No
	Sludge thickening equipment	No
	Sludge dehydration equipment	No
	Anaerobic digestion tank	Yes
	Pumping station	No
2.5.3	Is SCADA（Supervisory Control And Data Acquisition）system used?	No

Part B Individual Treatment Plant

Questionnaire for 8 target states and 2 Union Territories in India

Face sheet

Please fill in the fields below. Attach additional sheets if necessary.

1	Name of state	Delhi
2	Name of city/town	Delhi
3	Name of respondent	
4	STP Name	
5	Contact information	
6	Address	
7	Phone number	
8	E-mail address	

I Summary of sewage treatment plant

1	**Basic data related to facilities**	
1.1	Are there calculations for basic design and capacity of treatment plant facilities?	(Yes), No, Others :
1.2	Is there a layout plan showing earthwork, machinery, and electrical equipment?	(Yes), No, Others :
1.3	Are there detailed specifications of all facilities and equipment fitted in the plant? Are there as-fitted drawings of all sewers? Are there structural drawings of tanks, digesters, reactors, buildings,	(Yes) No, Others :
1.4	Is there a flow chart for instrumentation?	(Yes) No, Others :
1.5	Are there single-line diagrams (electrical)?	(Yes) No, Others :
1.6	Sewage treatment process used (Example: Conventional activated sludge process)	Recycled nitrification denitrification process For Reuse : UF-MF-RO membrane
1.7	Sludge treatment process used (Example: Sludge drying after thickening)	Centrifugal dehydration
1.8	Which is the effluent discharge point?	River (7MLD), Planting(3MLD)
1.9	Layout of plant (please attach the drawing, if you have one)	Yes
2	**History**	
2.1	Is the history of failure, repair, or reconstruction recorded?	Yes (No) Others :
2.2	Are there any requests or complaints from surrounding residents?	Yes (No)
3	**Design capacity and actual loading**	
3.1	Design wastewater flow	N/A
3.2	Average daily flow	10 MLD
3.3	Maximum daily flow	N/A
3.4	Dry weather flow	N/A
3.5	Design wet weather flow	N/A
3.6	Wet weather flow	N/A
3.7	Design wastewater influent quality	N/A
3.8	Average wastewater influent quality	BOD 52mg/l , COD 151.04 mg/l , SS 196 mg/l
3.9	Design effluent quality	N/A
3.10	Average effluent quality	BOD 22mg/l , COD 62.7 mg/l , SS 50 mg/l at SST
3.11	Solids capture rate	N/A
3.12	What equipment is used for drawing out sludge from primary/secondary sedimentation tank or digester (pump/gravity, etc.)?	Air flotation, Pressurization surfacing separation
3.13	Frequency of drawing out sludge	N/A
3.14	Frequency of sludge carried outside STP	Not carried out
3.15	Design sludge generation volume and water content	N/A
3.16	Average sludge generation volume, and water content	Not using the centrifugal dehydrator.
3.17	Percentage of volatile solids in generated sludge	Not carried out
3.18	Methods of effective sludge or waste utilization	Fertilizer, Waste Other methods : N/A
3.19	Is sludge used for agricultural purpose or some other purpose? What is the amount of sludge disposed and water content in sludge?	Not carried out
3.2	Are there operation records for pumps, equipment, blowers, etc.?	Daily report: (Yes) No, Monthly report: (Yes) No, Annual report: (Yes) No

3.2.1	Is the water quality measured regularly?	(Yes) No
3.2.2	Are water quality measurement records maintained?	Daily report: (Yes) No, Annual report: (Yes) No,
3.2.3	Is record of concentration of toxic substances in sludge maintained?	Yes (No)
3.2.4	Has the water quality of the final effluent exceeded the effluent standards anytime?	Yes (No)
3.2.5	If Yes, what are the cause for exceeding the effluent standard?	N/A
4	**Corrosion of facilities and dam age status**	
4.1	Is there corrosion of buildings or structures?	Yes (No,) name of part :
4.2	Was there any damage to the building frame part of facilities?	Yes (No,) name of part :
4.3	Is there corrosion in equipment?	Yes (No,) name of part :
4.4	Is there damage to equipment?	Yes (No,) name of part :
4.5	Are there records of corrosion and damage to facilities?	Yes (No)
4.6	Is there foul smell most of the time?	(Yes) sometimes
4.7	Is scum generated?	A large amount (Small amount) No
5	**Management of planned facilities**	
5.1	Is there an operation schedule for machinery and equipment	(Yes) "manufacturer compilation, Others" No
5.2	Is there an operation manual?	N/A
5.3	Is there a schedule for wastewater examination for influent, effluent and others?	(Yes) No
	Is there a wastewater examination method?	N/A
5.4	Are there the education and training manuals for the staff?	Yes (No)
6	**Inspection of facility and equipment**	
6.1	Are there check records for equipment?	Daily report: (Yes) No, Monthly report: (Yes) No, Annual report: (Yes) No
6.2	Is there an inspection manual?	N/A
6.3	Is there an inspection schedule?	N/A
6.4	Details of inspection procedure	(Visual/audible/TV camera, others :
6.5	How has the result of the investigation been used?	N/A
6.6	How are inspection results maintained?	Electronic data, (Hard copy,) Others :
7	**Repair, Rehabilitation, Reconstruction**	
7.1	Is there a manual for repair, rehabilitation and reconstruction of facility and equipment?	Yes (No)
7.2	If Yes, is it being used?	Yes (No)
7.3	Are there repair, rehabilitation and reconstruction plans for facility and equipment ?	Yes (No)
7.4	Have repairs, rehabilitation and reconstruction been implemented?	Yes (No)
7.5	Are there repair, rehabilitation and reconstruction records?	No records
8	**Work implementation**	
8.1	Staffing or Manpower at Plant	N/A
8.2	Engineers	N/A
8.3	Working time	Regular working time From 9 :00 to 17:30
8.4	Work mode	Permanent worker (Subcontractor)
8.5	Contents of work	(Operation , Maintenance) Repair
8.6	Others（Are there the special measures taken at the time of accidents or disasters)	Yes (No)
9	**Procurement of utility and materials**	
9.1	Is the procurement of the chemicals easy?	(Yes) No
9.2	Is there a procurement plan of chemicals?	(Yes) No
9.3	Amount of electric power used each day/month, and of one year	N/A
9.4	Quantity of industrial chemicals used "Chlorine, Coagulant, etc. "	N/A

9.5	Is there a list of vendors for chemicals, consumable materials, and machine parts?	(Yes)	No	
9.6	Frequency of power failure during year, total number of hours of power failure	N/A		
9.7	Are there standby power generators?	Yes		
9.8	How many times a year and how many hours a year is the standby power generator used?	N/A		
10	**Efficiency improvement and remedial measures and maintenance management of**			
10.1	Is there a centralized control system?	(Yes)	No	
.	Is there a data logger system?	(Yes)	No	
10.2	Has the operation and maintenance service been subcontracted to a private company?	(Yes)	No	
11	**Safety management**			
11.1	Is there a safety and hygiene organization?	Yes	(No)	
11.2	Is there a safety operation manual ?	Yes	(No)	
11.3	Are there safety protection tools?	(Yes)	No	
11.4	Are there warning signs for dangerous parts of the facilities?	(Yes)	No	
11.5	Have there been instances of accidents/disasters in the past?	Yes	(No)	
11.6	Is education and training implemented for health and safety ?	(Yes)	No	
11.7	Is there a rsik management manual (for floods, cyclones, earthquakes, and other natural disasters)?	Yes	(No)	

Ⅱ Check list of sewerage systems, machinery and electrical systems

Please reply as indicated on the right side.

1	**Machinery system**			
1.1	**Type of screens**			
1.1.1	Is there a coarse screen?	(Yes)	No	
1.1.2	Is screen type mechanical?	(Yes)	No	Under failure
1.1.3	Is there a fine screen?	(Yes)	No	
1.1.4	Is screen type mechanical?	(Yes)	No	
1.1.5	**Grit chamber**			
1.1.6	Is there a crushing device?	Yes	(No)	
1.1.7	Is there a conveyor?	Yes	(No)	
1.1.8	How is the grid chamber cleaned?	(Yes)	No	
	Mechanically?	(Yes)	No	
	Bucket elevator?	Yes	(No)	
	Jet pump?	Yes	(No)	
	Screw?	Yes	(No)	
	Air lift?	Yes	(No)	
	Manually?	Yes	(No)	
	Aeration?	Yes	(No)	
1.2	**Pumps**			
1.2.1	What is the rated voltage of main pump?	N/A		
1.2.2	Is there any speed controlled pump?	Yes	(No)	
1.2.3	If YES, what is the type of pump?	Yes	(No)	
1.2.4	If YES, what is the method of speed control?	No		
1.3	**What type of aeration facilities used?**	Only the hose which sends air		
1.3.1	What type of air diffuser is used?	No		
1.4	**Disinfection equipment**			
1.4.1	What type of disinfection method for effluent is			
	Chlorination?	Yes	(No)	
	Ultra violet ray?	Yes	(No)	
	Ozonizer?	Yes	(No)	
1.5	**Sludge thickening equipment**			
1.5.1	**What type of sludge thickening equipment is**			
	Gravity thickening?	Yes (But not using)		
	Air flotation?	N/A		
	Centrifugal thickening?	No		
	Belt type?	No		
1.6	**Sludge dehydration equipment**			
1.6.1	**What type of sludge dehydration method is**			
	Mechanical?			
	Filter press?	Yes	(No)	
	Centrifugal dehydration	(Yes)	No	
	Vacuum filtration?	Yes	(No)	
	Others?	No		
1.6.2	Where does the dewatered sludge go to?	Fertilizer, Planting		
1.7.1	**Sludge digestion facility (Anaerobic)?**	Yes	(No)	
1.7.2	Is digester gas used?	Yes (for	(No)	
2	**Electrical system**			
2.1	Substation facility			
2.1.1	What is the substation voltage?	GT625 kVA		

2.3	**Uninterrupted power supply (UPS)**		
2.3.1	Is there uninterrupted power supply?	(Yes)	No
2.3.2	If YES, is it DC supply or AC supply?	AC	(DC)
2.3.3	What are the applications of this power supply?	for control system	
2.5	**Measuring instruments**		
2.5.1	What type of flow meter is used and where?		
	Electro-magnetic?	(Yes)	( ) No
	Ultrasonic?	no data	
	Orifice plate?	Yes (	(No)
	Venturi?	Yes (	(No)
	Weir?	Yes (	(No)
	Partial flume?	Yes (	(No)
2.5.2	**What type of level gauge is adopted and where?**		
	Float-type?	no data	
	Pressure-type?	no data	
	Ultrasonic?	no data	
	Radio wave ?	no data	
2.5.3	**Is a water quality meter used?**		
	PH?	(Yes)	No
	DO?	Yes	(No)
	MLSS?	Yes	(No)
	ORP?	Yes	(No)
	Turbidity?	Yes	(No)
	~~RCL?~~	Yes	No
	Nitrogen?	Yes	(No)
	Phosphorus?	Yes	(No)
2.5.4	**Is sludge measurement performed?**		
	Sludge concentration?	Yes	(No)
2.5.5	**Is any meteorological instrument used for the following?**		
	Temperature?	(Yes)	No
	Atmospheric pressure?	Yes	(No)
	Rain?	Yes	(No)
	Wind velocity (Anemometer)?	Yes	(No)
2.5	**Monitoring control system**		
2.5.1	**Does a lookout post exist at the following**		
	Grit chamber	Yes	
	Dry well	No	
	Sewage treatment facility	Yes	
	Sludge thickening equipment	Yes	
	Sludge dehydration equipment	Yes	
	Anaerobic digestion tank	No	
	Pumping station	Yes (main pump system)	
2.5.3	Is SCADA（Supervisory Control And Data Acquisition）system used?	(Yes)	No

Part B Individual Sewage Treatment Plant

Questionnaire for 8 target states and 2 Union Territories in India

Face sheet

Please fill in the fields below. Attach additional sheets if necessary.

1	Name of state	Haryana
2	Name of city/town	Karnal
3	Name of respondent	
4	STP Name	
5	Contact information	
6	Address	
7	Phone number	
8	E-mail address	

I Summary of sewage treatment plant

1	**Basic data related to facilities**	
1.1	Are there calculations for basic design and capacity of treatment plant facilities?	(Yes), No, Others :
1.2	Is there a layout plan showing earthwork, machinery, and electrical equipment?	Yes , (No,) Others :
1.3	Are there detailed specifications of all facilities and equipment fitted in the plant? Are there as-fitted drawings of all sewers? Are there structural drawings of tanks, digesters, reactors, buildings,	(Yes), No, Others :
1.4	Is there a flow chart for instrumentation?	Yes , (No,) Others :
1.5	Are there single-line diagrams (electrical)?	Yes , (No,) Others :
1.6	Sewage treatment process used (Example: Conventional activated sludge process)	UASB+FPU
1.7	Sludge treatment process used (Example: Sludge drying after thickening)	Sludge drying beds
1.8	Which is the effluent discharge point?	Irrigation +darin to Yamuna
1.9	Layout of plant (please attach the drawing, if you have one)	Yes
2	**History**	
2.1	Is the history of failure, repair, or reconstruction recorded?	(Yes) No Others :
2.2	Are there any requests or complaints from surrounding residents?	Yes (No)
3	**Design capacity and actual loading**	
3.1	Design wastewater flow	40 MLD
3.2	Average daily flow	39 MLD
3.3	Maximum daily flow	44 MLD
3.4	Dry weather flow	39 MLD
3.5	Design wet weather flow	80 MLD
3.6	Wet weather flow	64 MLD
3.7	Design wastewater influent quality	BOD 300 mg/l , COD 700 mg/l , SS 350 mg/l
3.8	Average wastewater influent quality	BOD 150 mg/l , COD 450 mg/l , SS 230 mg/l
3.9	Design effluent quality	BOD 30 mg/l , COD 250 mg/l , SS 100 mg/l
3.10	Average effluent quality	BOD 30 mg/l , COD 150 mg/l , SS 80 mg/l
3.11	Solids capture rate	56 %
3.12	What equipment is used for drawing out sludge from primary/secondary sedimentation tank or digester (pump/gravity, etc.)?	N/A
3.13	Frequency of drawing out sludge	times/day 10 times/month
3.14	Frequency of sludge carried outside STP	15 times/month(Jan-Mar, June-July), times/year
3.15	Design sludge generation volume and water content	N/A MLD, ML/year, %
3.16	Average sludge generation volume, and water content	N/A MLD, ML/year, %
3.17	Percentage of volatile solids in generated sludge	N/A mean: %, max: %, min: %
3.18	Methods of effective sludge or waste utilization	(Fertilizer) Waste Other methods :
3.19	Is sludge used for agricultural purpose or some other purpose? What is the amount of sludge disposed and water content in sludge?	150 t/year, %

3.20	Are there operation records for pumps, equipment, blowers, etc.?	Daily report: Yes No, Monthly report: Yes No Annual report: Yes No
3.21	Is the water quality measured regularly?	Yes No
3.22	Are water quality measurement records maintained?	Daily report: Yes No Annual report: Yes No
3.23	Is record of concentration of toxic substances in sludge maintained?	Yes No
3.24	Has the water quality of the final effluent exceeded the effluent standards anytime?	Yes No
3.25	If Yes, what are the cause for exceeding the effluent standard?	N/A
4	**Corrosion of facilities and dam age status**	
4.1	Is there corrosion of buildings or structures?	Yes No, name of part :
4.2	Was there any damage to the building frame part of facilities?	Yes No, name of part :
4.3	Is there corrosion in equipment?	Yes No, name of part : Motor
4.4	Is there damage to equipment?	Yes No, name of part :
4.5	Are there records of corrosion and damage to facilities?	Yes No
4.6	Is there foul smell most of the time?	Yes, sometime No
4.7	Is scum generated?	A large amount, Small amount, No
5	**Management of planned facilities**	
5.1	Is there an operation schedule for machinery and equipment	Yes "manufacturer compilation, Others" No
5.2	Is there an operation manual?	Yes No
5.3	Is there a schedule for wastewater examination for influent, effluent and others?	Yes No
	Is there a wastewater examination method?	Yes, Name of the method: APHA No
5.4	Are there the education and training manuals for the staff?	Yes No
6	**Inspection of facility and equipment**	
6.1	Are there check records for equipment?	Daily report: Yes No, Monthly report: Yes No, Annual report: Yes No
6.2	Is there an inspection manual?	Yes No
6.3	Is there an inspection schedule?	Yes No
6.4	Details of inspection procedure	Visual/audible / TV camera, others :
6.5	How has the result of the inspection been used?	Used (orally) to decide priority of work
6.6	How are inspection results maintained?	Electronic data, Hard copy, Others :
7	**Repair, Rehabilitation, Reconstruction**	
7.1	Is there a manual for repair, rehabilitation and reconstruction of facility and equipment?	Yes No N/A
7.2	If Yes, is it being used?	Yes No N/A
7.3	Are there repair, rehabilitation and reconstruction plans for facility and equipment ?	Yes No N/A
7.4	Have repairs, rehabilitation and reconstruction been implemented?	Yes No N/A
7.5	Are there repair, rehabilitation and reconstruction records?	Electronic data, Hard copy, Others : N/A
8	**Work implementation**	
8.1	Staffing or Manpower at Plant	Engineers: persons Foreman: persons SEE Staffing Sheet Maintenance: persons Shift-in-charge: persons Analyses of water quality: persons Office workers: persons Total staff:
8.2	Engineers	S.E : 1 persons, Exec : 1 persons, S.D.E : 1 persons, J.E : 1 persons,
8.3	Working time	Regular working time From 9.00 : to 5.00 : to : Shifts 3 : to : Permanent worker subcontractor for O& M
8.4	Work mode	Permanent worker Subcontractor N/A
8.5	Contents of work	Operation , Maintenance, Repair- Subcontracted N/A
8.6	Others（Are there the special measures taken at the time of accidents or disasters?）	Yes No
9	**Procurement of utility and materials**	
9.1	Is the procurement of the chemicals easy?	Yes No
9.2	Is there a procurement plan of chemicals?	Yes No
9.3	Amount of electric power used each day/month, and of one year	2600 kWh in a day/month, kWh in a year
9.4	Quantity of industrial chemicals used "Chlorine, Coagulant, etc."	N/A ; kg/d, kg/year N/A ; kg/d, kg/year

9.5	Is there a list of vendors for chemicals, consumable materials, and machine parts?	Yes	(No)
9.6	Frequency of power failure during year, total number of hours of power failure	2-3 times/day (for1hour) 1000 hours/year	
9.7	Are there standby power generators?	Yes	
9.8	How many times a year and how many hours a year is the standby power generator used?	times/year	500 hours/year
10	**Efficiency improvement and remedial measures and maintenance management of**		
10.1	Is there a centralized control system?	Yes	(No)
.	Is there a data logger system?	Yes	(No)
10.2	Has the operation and maintenance service been subcontracted to a private company?	(Yes)	No
11	**Safety management**		
11.1	Is there a safety and hygiene organization?	Yes	(No)
11.2	Is there a safety operation manual ?	Yes	(No)
11.3	Are there safety protection tools?	(Yes)	No
11.4	Are there warning signs for dangerous parts of the facilities?	(Yes)	No
11.5	Have there been instances of accidents/disasters in the past?	(Yes)	No
11.6	Is education and training implemented for health and safety ?	Yes	(No)
11.7	Is there a risk management manual (for floods, cyclones, earthquakes, and other natural disasters)?	Yes	(No)

Ⅱ Check list of sewerage systems, machinery and electrical systems

Please reply as indicated on the right side.

1	**Machinery system**			
1.1	**Type of screens**			
1.1.1	Is there a coarse screen?	(Yes)	No	
1.1.2	Is screen type mechanical?	(Yes)	No	
1.1.3	Is there a fine screen?	(Yes)	No	
1.1.4	Is screen type mechanical?	(Yes)	No	Not Working
1.1.5	**Grit chamber**			
1.1.6	Is there a crushing device?	Yes	(No)	
1.1.7	Is there a conveyor?	Yes	(No)	
1.1.8	**How is the grit chamber cleaned?**			
	Mechanically?	Yes	(No)	
	Bucket elevator?	Yes	(No)	
	Jet pump?	Yes	(No)	
	Screw?	Yes	(No)	
	Air lift?	Yes	(No)	
	Manually?	(Yes)	No	
	Aeration?	Yes	(No)	
1.2	**Pumps**			
1.2.1	What is the rated voltage of main pump?	420 V		
1.2.2	Is there any speed controlled pump?	Yes	(No)	
1.2.3	If Yes, what is the type of pump?	Yes	(No)	Submersible
1.2.4	If Yes, what is the method of speed control?	No		
1.3	**What type of aeration facilities used?**	No		
1.3.1	What type of air diffuser is used?	No		
1.4	**Disinfection equipment**			
1.4.1	**What type of disinfection method for effluent is**			
	Chlorination?	Yes	(No)	
	Ultra violet ray?	Yes	(No)	
	Ozonizer?	Yes	(No)	
1.5	**Sludge thickening equipment**			
1.5.1	**What type of sludge thickening equipment is**			
	Gravity thickening?	No		
	Air flotation?	No		
	Centrifugal thickening?	No		
	Belt type?	No		
1.6	**Sludge dehydration equipment**			
1.6.1	**What type of sludge dehydration method is**			
	Mechanical?			
	Filter press?	Yes	(No)	
	Centrifugal dehydration	Yes	(No)	
	Vacuum filtration?	Yes	(No)	
	Others?	Sludge drying beds		
1.6.2	**Where does the dewatered sludge go to?**	N/A		
1.7.1	Sludge digestion facility (Anaerobic)?	Yes	(No)	
1.7.2	Is digester gas used?	Yes (for)	(No)	
2	**Electrical system**			
2.1	**Substation facility**			
2.1.1	What is the substation voltage?	11 kV		

2.3	**Uninterrupted power supply (UPS)**		
2.3.1	Is there uninterrupted power supply?	Yes	(No)
2.3.2	If Yes, is it DC supply or AC supply?	AC	DC No
2.3.3	What are the applications of this power supply?	No	
2.5	**Measuring instruments**		
2.5.1	**What type of flow meter is used and where?**		
	Electro-magnetic?	Yes (	(No)
	Ultrasonic?	Yes (	(No)
	Orifice plate?	Yes (	(No)
	Venturi?	Yes (	(No)
	Weir?	(Yes) (	) No
	Partial flume?	Yes (	(No)
2.5.2	**What type of level gauge is adopted and where?**		
	Float-type?	Yes (	(No)
	Pressure-type?	Yes (	(No)
	Ultrasonic?	Yes (	(No)
	Radio wave ?	Yes (	(No)
2.5.3	**Is a water quality meter used?**		
	PH?	(Yes)	No
	DO?	(Yes)	No
	MLSS?	Yes	(No)
	ORP?	(Yes)	No
	Turbidity?	(Yes)	No
	RCL?	Yes	(No)
	Nitrogen?	(Yes)	No
	Phosphorus?	Yes	(No)
2.5.4	**Is sludge measurement performed?**		
	Sludge concentration?	Yes	(No)
2.5.5	**Is any meteorological instrument used for the following?**		
	Temperature?	Yes	(No)
	Atmospheric pressure?	Yes	(No)
	Rain?	Yes	(No)
	Wind velocity (Anemometer)?	Yes	(No)
2.5	**Monitoring control system**		
2.5.1	**Does a lookout post exist at the following**		
	Grit chamber	No	
	Dry well	No	
	Sewage treatment facility	No	
	Sludge thickening equipment	No	
	Sludge dehydration equipment	No	
	Anaerobic digestion tank	No	
	Pumping station	No	
2.5.3	Is SCADA（Supervisory Control And Data Acquisition）system used?	Yes	(No)

Part B Individual Treatment Plant

Questionnaire for 8 target states and 2 Union Territories in India

Face sheet

Please fill in the fields below. Attach additional sheets if necessary.

1	Name of state	Haryana
2	Name of city/town	Gurgaon
3	Name of respondent	
4	STP Name	
5	Contact information	
6	Address	
7	Phone number	
8	E-mail address	

I Summary of sewage treatment plant

1	**Basic data related to facilities**	
1.1	Are there calculations for basic design and capacity of treatment plant facilities?	(Yes), No, Others :
1.2	Is there a layout plan showing earthwork, machinery, and electrical equipment?	(Yes), No, Others :
1.3	Are there detailed specifications of all facilities and equipment fitted in the plant? Are there as-fitted drawings of all sewers? Are there structural drawings of tanks, digesters, reactors, buildings,	(Yes), No, Others :
1.4	Is there a flow chart for instrumentation?	Yes , (No), Others :
1.5	Are there single-line diagrams (electrical)?	Yes , No, Others : N/A
1.6	Sewage treatment process used (Example: Conventional activated sludge process)	ASP
1.7	Sludge treatment process used (Example: Sludge drying after thickening)	Sludge drying beds
1.8	Which is the effluent discharge point?	STP Channels → Agricultural (25mld) Rainy Season yamuna
1.9	Layout of plant (please attach the drawing, if you have one)	Yes
2	**History**	
2.1	Is the history of failure, repair, or reconstruction recorded?	Yes (No) Others :
2.2	Are there any requests or complaints from surrounding residents?	(Yes) No Sometime bad smell
3	**Design capacity and actual loading**	
3.1	Design wastewater flow	15MGD
3.2	Average daily flow	N/A MLD
3.3	Maximum daily flow	N/A MLD
3.4	Dry weather flow	N/A MLD
3.5	Design wet weather flow	N/A MLD
3.6	Wet weather flow	N/A MLD
3.7	Design wastewater influent quality	N/A BOD mg/l , COD mg/l , SS mg/l
3.8	Average wastewater influent quality	BOD 167 mg/l , COD 612 mg/l , SS 629 mg/l
3.9	Design effluent quality	N/A BOD mg/l , COD mg/l , SS mg/l
3.10	Average effluent quality	BOD 28 mg/l , COD 96 mg/l , SS 26 mg/l
3.11	Solids capture rate	N/A %
3.12	What equipment is used for drawing out sludge from primary/secondary sedimentation tank or digester (pump/gravity, etc.)?	N/A
3.13	Frequency of drawing out sludge	Once a week times/month
3.14	Frequency of sludge carried outside STP	3-4 times/month, times/year
3.15	Design sludge generation volume and water content	N/A kLD, ML/year, %
3.16	Average sludge generation volume, and water content	N/A kLD, ML/year, %
3.17	Percentage of volatile solids in generated sludge	N/A mean: %, max: %, min: %
3.18	Methods of effective sludge or waste utilization	(Fertilizer), land application
3.19	Is sludge used for agricultural purpose or some other purpose? What is the amount of sludge disposed and water content in sludge?	t/year, % N/A
3.2	Are there operation records for pumps, equipment, blowers, etc.?	Daily report: (Yes) No, Monthly report: Yes No, Annual report: Yes No
3.2.1	Is the water quality measured regularly?	(Yes) No
3.2.2	Are water quality measurement records maintained?	Daily report: (Yes) No Annual report: Yes No
3.2.3	Is record of concentration of toxic substances in sludge maintained?	Yes (No)
3.2.4	Has the water quality of the final effluent exceeded the effluent standards anytime?	Yes (No) (<30 BOD)
3.2.5	If Yes, what are the cause for exceeding the effluent standard?	N/A

4	**Corrosion of facilities and dam age status**	
4.1	Is there corrosion of buildings or structures?	Yes (No), name of part :
4.2	Was there any damage to the building frame part of facilities?	Yes (No) name of part :
4.3	Is there corrosion in equipment?	(Yes) No, name of part : pumps etc.
4.4	Is there damage to equipment?	(Yes) No, name of part :
4.5	Are there records of corrosion and damage to facilities?	Yes (No)
4.6	Is there foul smell most of the time?	(Yes) No Rarely
4.7	Is scum generated?	A large amount, (Small amount,) No
5	**Management of planned facilities**	
5.1	Is there an operation schedule for machinery and	(Yes, "manufacturer compilation, Others" No
5.2	Is there an operation manual?	(Yes) No pumps in aeration unit
5.3	Is there a schedule for wastewater examination for influent, effluent and others?	Yes (No)
	Is there a wastewater examination method?	(Yes:) Name of the method: N/A No
5.4	Are there the education and training manuals for	Yes (No)
6	**Inspection of facility and equipment**	
6.1	Are there check records for equipment?	Daily report: Yes No, Monthly report: (Yes) No Annual report: Yes No
6.2	Is there an inspection manual?	Yes (No)
6.3	Is there an inspection schedule?	Yes (No)
6.4	Details of inspection procedure	Visual/audible/TV camera, others : N/A
6.5	How has the result of the inspection been used?	Yes (No)
6.6	How are inspection results maintained?	Electronic data, Hard copy, Others : N/A
7	**Repair, Rehabilitation, Reconstruction**	
7.1	Is there a manual for repair, rehabilitation and reconstruction of facility and equipment?	Yes (No)
7.2	If Yes, is it being used?	Yes (No)
7.3	Are there repair, rehabilitation and reconstruction plans for facility and equipment ?	Yes (No)
7.4	Have repairs, rehabilitation and reconstruction been implemented?	Yes (No)
7.5	Are there repair, rehabilitation and reconstruction	Electronic data, Hard copy, Others : N/A
8	**Work implementation**	
8.1	Staffing or Manpower at Plant	Engineers: persons Foreman: persons Maintenance: persons Shift-in-charge: persons Analyses of water quality: persons Office workers: persons Total staff:
8.2	Engineers	N/A : persons, : persons, : persons, : persons,
8.3	Working time	N/A Regular working time From : to : to : Shifts : to
8.4	Work mode	N/A Permanent worker Subcontractor
8.5	Contents of work	N/A Operation , Maintenance, Repair
8.6	Others（Are there the special measures taken at the time of accidents or disasters?）	Yes No N/A
9	**Procurement of utility and materials**	
9.1	Is the procurement of the chemicals easy?	Yes No Not using
9.2	Is there a procurement plan of chemicals?	Yes (No)
9.3	Amount of electric power used each day/month, and of one year	5000kWh in a day/month, kWh in a year
9.4	Quantity of industrial chemicals used "Chlorine, Coagulant, etc."	No ; kg/d, kg/year No ; kg/d, kg/year
9.5	Is there a list of vendors for chemicals, consumable materials, and machine parts?	Yes (No)
9.6	Frequency of power failure during year, total number of hours of power failure	1/2hr/day 30 times a year hours/year
9.7	Are there standby power generators?	Yes
9.8	How many times a year and how many hours a year is the standby power generator used?	times/year hours/year N/A
10	**Efficiency improvement and remedial measures and maintenance management of**	
10.1	Is there a centralized control system?	Yes (No)
.	Is there a data logger system?	Yes (No)
10.2	Has the operation and maintenance service been subcontracted to a private company?	Yes No N/A
11	**Safety management**	
11.1	Is there a safety and hygiene organization?	Yes (No)
11.2	Is there a safety operation manual ?	Yes (No)
11.3	Are there safety protection tools?	(Yes) No

11.4	Are there warning signs for dangerous parts of the facilities?	Yes	(No)
11.5	Have there been instances of accidents/disasters in the past?	Yes	(No)
11.6	Is education and training implemented for health and safety?	Yes	(No)
11.7	Is there a risk management manual (for floods, cyclones, earthquakes, and other natural disasters)?	Yes	(No)

Ⅱ Check list of sewerage systems, machinery and electrical systems

Please reply as indicated on the right side.

1	**Machinery system**			
1.1	**Type of screens**			
1.1.1	Is there a coarse screen?	Yes	(No)	
1.1.2	Is screen type mechanical?	Yes	(No)	
1.1.3	Is there a fine screen?	(Yes)	No	
1.1.4	Is screen type mechanical?	(Yes)	No	Breakdown
1.1.5	**Grit chamber**			
1.1.6	Is there a crushing device?	Yes	(No)	
1.1.7	Is there a conveyor?	Yes	(No)	
1.1.8	**How is the grid chamber cleaned?**			
	Mechanically?	(Yes)	No	
	Bucket elevator?	Yes	(No)	
	Jet pump?	Yes	(No)	
	Screw?	Yes	(No)	
	Air lift?	Yes	(No)	
	Manually?	Yes	(No)	
	Aeration?	Yes	(No)	
1.2	**Pumps**			
1.2.1	What is the rated voltage of main pump?	N/A	V	
1.2.2	Is there any speed controlled pump?	Yes	(No)	
1.2.3	If Yes, what is the type of pump?	Yes	(No)	
1.2.4	If Yes, what is the method of speed control?	No		
1.3	**What type of aeration facilities used?**	Surface aeration		
1.3.1	What type of air diffuser is used?	No		
1.4	**Disinfection equipment**			
1.4.1	**What type of disinfection method for effluent is**			
	Chlorination?	Yes	(No)	
	Ultra violet ray?	Yes	(No)	
	Ozonizer?	Yes	(No)	
1.5	**Sludge thickening equipment**			
1.5.1	**What type of sludge thickening equipment is**			
	Gravity thickening?	No		
	Air flotation?	No		
	Centrifugal thickening?	No		
	Belt type?	No		
1.6	**Sludge dehydration equipment**			
1.6.1	**What type of sludge dehydration method is**			
	Mechanical?			
	Filter press?	Yes	(No)	
	Centrifugal dehydration	Yes	(No)	
	Vacuum filtration?	Yes	(No)	
	Others?	Sludge drying beds		
1.6.2	Where does the dewatered sludge go to?	N/A		
1.7.1	Sludge digestion facility (Anaerobic)?	(Yes)	No	
1.7.2	Is digester gas used?	Yes (for	) No	N/A
2	**Electrical system**			
2.1	**Substation facility**			
2.1.1	What is the substation voltage?		11kV	
2.3	Uninterrupted power supply (UPS)			
2.3.1	Is there uninterrupted power supply?	Yes	No	N/A
2.3.2	If Yes, is it DC supply or AC supply?	AC	DC	N/A
2.3.3	What are the applications of this power supply?			
2.5	**Measuring instruments**			
2.5.1	**What type of flow meter is used and where?**			
	Electro-magnetic?	Yes (	) (No)	
	Ultrasonic?	Yes (	) (No)	
	Orifice plate?	Yes (	) (No)	
	Venturi?	Yes (	) (No)	
	Weir?	Yes (	) (No)	
	Partial flume?	(Yes (	) No	
2.5.2	**What type of level gauge is adopted and where?**			
	Float-type?	Yes (	) (No)	
	Pressure-type?	Yes (	) (No)	
	Ultrasonic?	Yes (	) (No)	
	Radio wave ?	Yes (	) (No)	

2.5.3	**Is a water quality meter used?**		
	PH?	Yes	No
	DO?	Yes	No
	MLSS?	Yes	No
	ORP?	Yes	No
	Turbidity?	Yes	No
	Nitrogen?	Yes	No
	Phosphorus?	Yes	No
2.5.4	**Is sludge measurement performed?**		
	Sludge concentration?	Yes	No
2.5.5	**Is any meteorological instrument used for the following?**		
	Temperature?	Yes	No
	Atmospheric pressure?	Yes	No
	Rain?	Yes	No
	Wind velocity (Anemometer)?	Yes	No
2.5	**Monitoring control system**		
2.5.1	**Does a lookout post exist at the following**		
	Grit chamber	Yes	No
	Dry well	Yes	No
	Sewage treatment facility	Yes	No
	Sludge thickening equipment	Yes	No
	Sludge dehydration equipment	Yes	No
	Anaerobic digestion tank	Yes	No
	Pumping station	Yes	No
2.5.3	Is SCADA（Supervisory Control And Data Acquisition）system used?	Yes	No

Part B Individual Sewage Treatment Plant

Questionnaire for 8 target states and 2 Union Territories in India

Face sheet

Please fill in the fields below. Attach additional sheets if necessary.

1	Name of state	Uttar Pradesh
2	Name of city/town	Ghaziabad
3	Name of respondent	
4	STP Name	
5	Contact information	
6	Address	
7	Phone number	
8	E-mail address	

Ⅰ Summary of sewage treatment plant

1	**Basic data related to facilities**	
1.1	Are there calculations for basic design and capacity of treatment plant facilities?	Yes , (No,) Others :
1.2	Is there a layout plan showing earthwork, machinery, and electrical equipment?	Yes , (No,) Others :
1.3	Are there detailed specifications of all facilities and equipment fitted in the plant? Are there as-fitted drawings of all sewers? Are there structural drawings of tanks, digesters, reactors, buildings, and so on?	Yes , (No,) Others :
1.4	Is there a flow chart for instrumentation?	Yes , (No) Others :
1.5	Are there single-line diagrams (electrical)?	Yes , (No) Others :
1.6	Sewage treatment process used (Example: Conventional activated sludge process)	UASB+PP
1.7	Sludge treatment process used (Example: Sludge drying after thickening)	Sludge drying beds
1.8	Which is the effluent discharge point?	River , Lakes and marshes , Sea area , Underground seepage (Agricultural use)
1.9	Layout of plant (please attach the drawing, if you have one)	Yes
2	**History**	
2.1	Is the history of failure, repair, or reconstruction recorded?	Yes (No) Others :
2.2	Are there any requests or complaints from surrounding residents?	Yes (No)
3	**Design capacity and actual loading**	
3.1	Design wastewater flow	Every hour MLD
3.2	Average daily flow	68 MLD
3.3	Maximum daily flow	70 MLD
3.4	Dry weather flow	N/A MLD
3.5	Design wet weather flow	N/A MLD
3.6	Wet weather flow	73-74 MLD
3.7	Design wastewater influent quality	N/A BOD mg/l , COD mg/l , SS m
3.8	Average wastewater influent quality	BOD 240 mg/l , COD mg/l , SS 420 mg/l
3.9	Design effluent quality	N/A BOD mg/l , COD mg/l , SS m
3.10	Average effluent quality	BOD 30 mg/l , COD 120 mg/l , SS 50 mg/l
3.11	Solids capture rate	N/A %
3.12	What equipment is used for drawing out sludge from primary/secondary sedimentation tank or digester (pump/gravity, etc.)?	N/A
3.13	Frequency of drawing out sludge	Once in 3 days times/month
3.14	Frequency of sludge carried outside STP	N/A times/month, times/year
3.15	Design sludge generation volume and water content	N/A MLD, ML/year, %
3.16	Average sludge generation volume, and water content	N/A MLD, ML/year, %
3.17	Percentage of volatile solids in generated sludge	N/A mean: %, max: %, min: %
3.18	Methods of effective sludge or waste utilization	Manure /Fertilizer
3.19	Is sludge used for agricultural purpose or some other purpose? What is the amount of sludge disposed and water content in sludge?	100 t/year
3.20	Are there operation records for pumps, equipment, blowers, etc.?	Daily report: (Yes) No, Monthly report: Yes No, Annual report: Yes No

3.21	Is the water quality measured regularly?	(Yes) No
3.22	Are water quality measurement records maintained?	Daily report: Yes (No) Annual report: Yes No
3.23	Is record of concentration of toxic substances in sludge maintained?	Yes (No)
3.24	Has the water quality of the final effluent exceeded the effluent standards anytime?	N/A Yes No
3.25	If Yes, what are the cause for exceeding the effluent standard?	N/A
4	**Corrosion of facilities and dam age status**	
4.1	Is there corrosion of buildings or structures?	Yes (No) name of part :
4.2	Was there any damage to the building frame part of facilities?	Yes (No,) name of part :
4.3	Is there corrosion in equipment?	Yes (No,) name of part :
4.4	Is there damage to equipment?	Yes (No,) name of part :
4.5	Are there records of corrosion and damage to facilities?	Yes (No)
4.6	Is there foul smell most of the time?	Yes (No)
4.7	Is scum generated?	A large amount, Small amount (No)
5	**Management of planned facilities**	
5.1	Is there an operation schedule for machinery and equipment	Yes "manufacturer compilation, Others" (No)
5.2	Is there an operation manual?	Yes (No)
5.3	Is there a schedule for wastewater examination for influent, effluent and others?	Yes (No)
	Is there a wastewater examination method?	N/A Yes: Name of the method: No
5.4	Are there the education and training manuals for the staff?	Yes (No)
6	**Inspection of facility and equipment**	
6.1	Are there check records for equipment?	Daily report: Yes No, Monthly report: (Yes) No Annual report: Yes No
6.2	Is there an inspection manual?	Yes (No)
6.3	Is there an inspection schedule?	Yes (No)
6.4	Details of inspection procedure	Visual/audible/TV camera, others : N/A
6.5	How has the result of the inspection been used?	N/A
6.6	How are inspection results maintained?	Electronic data, Hard copy, Others : N/A
7	**Repair, Rehabilitation, Reconstruction**	
7.1	Is there a manual for repair, rehabilitation and reconstruction of facility and equipment?	Yes (No)
7.2	If Yes, is it being used?	Yes (No)
7.3	Are there repair, rehabilitation and reconstruction plans for facility and equipment ?	Yes (No)
7.4	Have repairs, rehabilitation and reconstruction been implemented?	Yes (No)
7.5	Are there repair, rehabilitation and reconstruction records?	Electronic data, Hard copy, Others : N/A
8	**Work implementation**	
8.1	Staffing or Manpower at Plant	G.M 1 person Ass. Engineer 1 person, Junior Engineer 1 person Supervisor 5 person , Labor 5 person
8.2	Engineers	: persons, : persons, : persons, : persons,
8.3	Working time	Regular working time From 9 to 16
8.4	Work mode	Permanent worker Subcontractor N/A
8.5	Contents of work	(Operation ,) Maintenance, Repair
8.6	Others（Are there the special measures taken at the time of accidents or disasters?）	Yes No N/A
9	**Procurement of utility and materials**	
9.1	Is the procurement of the chemicals easy?	Yes No Not using
9.2	Is there a procurement plan of chemicals?	Yes No Not using
9.3	Amount of electric power used each day/month, and of one year	57768 KWH/Month, this amounts Rs: 295259. On daily/ annually basis data is not available
9.4	Quantity of industrial chemicals used "Chlorine, Coagulant, etc."	Not using ; kg/d, kg/year Not using ; kg/d, kg/year

9.5	Is there a list of vendors for chemicals, consumable materials, and machine parts?	Yes	(No)
9.6	Frequency of power failure during year, total number of hours of power failure	6 hours/ day	
9.7	Are there standby power generators?	Yes	
9.8	How many times a year and how many hours a year is the standby power generator used?	4 hours/ day	
10	**Efficiency improvement and remedial measures and maintenance management of**		
10.1	Is there a centralized control system?	Yes	(No)
.	Is there a data logger system?	Yes	(No)
10.2	Has the operation and maintenance service been subcontracted to a private company?	Yes	(No)
11	**Safety management**		
11.1	Is there a safety and hygiene organization?	Yes	(No)
11.2	Is there a safety operation manual ?	Yes	(No)
11.3	Are there safety protection tools?	(Yes)	No
11.4	Are there warning signs for dangerous parts of the facilities?	(Yes)	No
11.5	Have there been instances of accidents/disasters in the past?	Yes	(No)
11.6	Is education and training implemented for health and safety ?	Yes	(No)
11.7	Is there a risk management manual (for floods, cyclones, earthquakes, and other natural disasters)?	Yes	(No)

Ⅱ Check list of sewerage systems, machinery and electrical systems

Please reply as indicated on the right side.

1	**Machinery system**		
1.1	**Type of screens**		
1.1.1	Is there a coarse screen?	(Yes)	No
1.1.2	Is screen type mechanical?	(Yes)	No
1.1.3	Is there a fine screen?	(Yes)	No
1.1.4	Is screen type mechanical?	(Yes)	No
1.1.5	**Grit chamber**		
1.1.6	Is there a crushing device?	Yes	(No)
1.1.7	Is there a conveyor?	Yes	(No)
1.1.8	**How is the grit chamber cleaned?**		
	Mechanically?	Yes	(No)
	Bucket elevator?	Yes	(No)
	Jet pump?	Yes	(No)
	Screw?	Yes	(No)
	Air lift?	Yes	(No)
	Manually?	(Yes)	No
	Aeration?	Yes	(No)
1.2	**Pumps**		
1.2.1	What is the rated voltage of main pump?	440 V	
1.2.2	Is there any speed controlled pump?	Yes	(No)
1.2.3	If Yes, what is the type of pump?	Yes	(No)
1.2.4	If Yes, what is the method of speed control?	No	
1.3	**What type of aeration facilities used?**	No	
1.3.1	What type of air diffuser is used?	No	
1.4	**Disinfection equipment**		
1.4.1	What type of disinfection method for effluent is		
	Chlorination?	Yes	(No)
	Ultra violet ray?	Yes	(No)
	Ozonizer?	Yes	(No)
1.5	**Sludge thickening equipment**		
1.5.1	What type of sludge thickening equipment is used	Yes	(No)
	Gravity thickening?	Yes	(No)
	Air flotation?	Yes	(No)
	Centrifugal thickening?	Yes	(No)
	Belt type?	Yes	(No)
1.6	**Sludge dehydration equipment**		
1.6.1	**What type of sludge dehydration method is**		
	Mechanical?		
	Filter press?	Yes	(No)
	Centrifugal dehydration	Yes	(No)
	Vacuum filtration?	Yes	(No)
	Others?	Sludge drying bed	
1.6.2	Where does the dewatered sludge go to?	Fertilizer	
1.7.1	Sludge digestion facility (Anaerobic)?	Yes	(No)
1.7.2	Is digester gas used?	Yes (for	(No)
2	**Electrical system**		
2.1	**Substation facility**		
2.1.1	What is the substation voltage?	850 V	
2.3	Uninterrupted power supply (UPS)		

2.3.1	Is there uninterrupted power supply?	Yes	No
2.3.2	If Yes, is it DC supply or AC supply?	AC	DC
2.3.3	What are the applications of this power supply?	N/A	
2.5	**Measuring instruments**		
2.5.1	**What type of flow meter is used and where?**		
	Electro-magnetic?	Yes	breakdown) No
	Ultrasonic?	Yes (	) No
	Orifice plate?	Yes (	) No
	Venturi?	Yes (	) No
	Weir?	Yes	) No
	Partial flume?	Yes (	) No
2.5.2	**What type of level gauge is adopted and where?**		
	Float-type?	Yes (	) No
	Pressure-type?	Yes (	) No
	Ultrasonic?	Yes (	) No
	Radio wave ?	Yes (	) No
2.5.3	**Is a water quality meter used?**		
	PH?	Yes	No
	DO?	Yes	No
	MLSS?	Yes	No
	ORP?	Yes	No
	Turbidity?	Yes	No
	RCL?	Yes	No
	Nitrogen?	Yes	No
	Phosphorus?	Yes	No
2.5.4	**Is sludge measurement performed?**		
	Sludge concentration?	Yes	No
2.5.5	**Is any meteorological instrument used for the following?**		
	Temperature?	Yes	No
	Atmospheric pressure?	Yes	No
	Rain?	Yes	No
	Wind velocity (Anemometer)?	Yes	No
2.5	**Monitoring control system**		
2.5.1	**Does a lookout post exist at the following**		
	Grit chamber	No	
	Dry well	No	
	Sewage treatment facility	No	
	Sludge thickening equipment	No	
	Sludge dehydration equipment	No	
	Anaerobic digestion tank	No	
	Pumping station	No	
2.5.3	Is SCADA（Supervisory Control And Data Acquisition）system used?	Yes	No

Part B Individual Sewage Treatment Plant

Questionnaire for 8 target states and 2 Union Territories in India

Face sheet

Please fill in the fields below. Attach additional sheets if necessary.

1	Name of state	Uttar Pradesh
2	Name of city/town	Noida
3	Name of respondent	
4	STP Name	
5	Contact information	
6	Address	
7	Phone number	
8	E-mail address	

I Summary of sewage treatment plant

1	**Basic data related to facilities**	
1.1	Are there calculations for basic design and capacity of treatment plant facilities?	Yes , No, Others : N/A
1.2	Is there a layout plan showing earthwork, machinery, and electrical equipment?	(Yes ,) No, Others :
1.3	Are there detailed specifications of all facilities and equipment fitted in the plant? Are there as-fitted drawings of all sewers? Are there structural drawings of tanks, digesters, reactors, buildings, and so on?	(Yes ,) No, Others :(avilable seprately)
1.4	Is there a flow chart for instrumentation?	Yes , No, Others : N/A
1.5	Are there single-line diagrams (electrical)?	Yes , (No,) Others : could be given later
1.6	Sewage treatment process used (Example: Conventional activated sludge process)	UASB +PP
1.7	Sludge treatment process used (Example: Sludge drying after thickening)	Sludge drying beds
1.8	Which is the effluent discharge point?	Through irrigation drain to river
1.9	Layout of plant (please attach the drawing, if you have one)	Yes
2	**History**	
2.1	Is the history of failure, repair, or reconstruction recorded?	Yes No Others : N/A
2.2	Are there any requests or complaints from surrounding residents?	Yes No N/A
3	**Design capacity and actual loading**	
3.1	Design wastewater flow	34MLD
3.2	Average daily flow	34MLD
3.3	Maximum daily flow	37MLD
3.4	Dry weather flow	30MLD
3.5	Design wet weather flow	N/A MLD
3.6	Wet weather flow	N/A MLD
3.7	Design wastewater influent quality	N/A
3.8	Average wastewater influent quality	BOD 176 mg/l, COD 369 mg/l , SS 249 mg/l ,
3.9	Design effluent quality	N/A
3.10	Average effluent quality	BOD 29 mg/l , COD 116 mg/l , SS 41 mg/l
3.11	Solids capture rate	N/A %
3.12	What equipment is used for drawing out sludge from primary/secondary sedimentation tank or digester (pump/gravity, etc.)?	Pumps
3.13	Frequency of drawing out sludge	25 times/ year
3.14	Frequency of sludge carried outside STP	1times/month, 12times/year
3.15	Design sludge generation volume and water content	N/A MLD, ML/year, %
3.16	Average sludge generation volume, and water content	600m^3/ month
3.17	Percentage of volatile solids in generated sludge	mean: %, max: %, min: % N/A
3.18	Methods of effective sludge or waste utilization	Horticulture (land application)
3.19	Is sludge used for agricultural purpose or some other purpose? What is the amount of sludge disposed and water content in sludge?	Yes

3.20	Are there operation records for pumps, equipment, blowers, etc.?	Daily report: Yes No, Monthly report: Yes No, Annual report: Yes No
3.21	Is the water quality measured regularly?	Yes No
3.22	Are water quality measurement records maintained?	Daily report: Yes No, Annual report: Yes No,
3.23	Is record of concentration of toxic substances in sludge maintained?	Yes No
3.24	Has the water quality of the final effluent exceeded the effluent standards anytime?	Yes No
3.25	If Yes, what are the cause for exceeding the effluent standard?	N/A
4	**Corrosion of facilities and dam age status**	
4.1	Is there corrosion of buildings or structures?	Yes No, name of part :
4.2	Was there any damage to the building frame part of facilities?	Yes No, name of part :
4.3	Is there corrosion in equipment?	Yes No, name of part : screen
4.4	Is there damage to equipment?	Yes No, name of part :
4.5	Are there records of corrosion and damage to facilities?	Yes No
4.6	Is there foul smell most of the time?	Yes No Sometaimes
4.7	Is scum generated?	A large amount Small amount No
5	**Management of planned facilities**	
5.1	Is there an operation schedule for machinery and equipment	Yes "manufacturer compilation, Others" No
5.2	Is there an operation manual?	Yes No
5.3	Is there a schedule for wastewater examination for influent, effluent and others?	Yes No
	Is there a wastewater examination method?	Yes: Name of the method: APHA No
5.4	Are there the education and training manuals for the staff?	Yes No
6	**Inspection of facility and equipment**	
6.1	Are there check records for equipment?	Daily report: Yes No, Monthly report: Yes No, Annual report: Yes No
6.2	Is there an inspection manual?	Yes No
6.3	Is there an inspection schedule?	Yes No
6.4	Details of inspection procedure	Visual/audible/TV camera, others : N/A
6.5	How has the result of the inspection been used?	N/A
6.6	How are inspection results maintained?	Electronic data, Hard copy, Others : N/A
7	**Repair, Rehabilitation, Reconstruction**	
7.1	Is there a manual for repair, rehabilitation and reconstruction of facility and equipment?	Yes No
7.2	If Yes, is it being used?	Yes No N/A
7.3	Are there repair, rehabilitation and reconstruction plans for facility and equipment ?	Yes No
7.4	Have repairs, rehabilitation and reconstruction been implemented?	Yes No
7.5	Are there repair, rehabilitation and reconstruction records?	Electronic data, Hard copy, Others : N/A
8	**Work implementation**	
8.1	Staffing or Manpower at Plant	1)CME , 2)Project Engineer, 3)Ass. Project Engineer 4)Junior Engineer, 5)Chemist 6)Foreman, 7) Pump Operators 3 person 8)Gunmen 3 person, 9)Other staff 14 person
8.2	Qualification of engineers	: persons, : persons, : persons,
8.3	Working time	Regular working time From 9.00 to 6.00 3Shifts (6-14,14-22,22-6)
8.4	Work mode	Permanent worker Subcontractor N/A
8.5	Contents of work	Operation , Maintenance, Repair N/A
8.6	Others（Are there the special measures taken at the time of	Yes No N/A
9	**Procurement of utility and materials**	
9.1	Is the procurement of the chemicals easy?	Not using
9.2	Is there a procurement plan of chemicals?	Not using
9.3	Amount of electric power used each day/month, and of one year	Rs 133536 KWH From December 2009 to August 2010, i.e. 09 months. Records on daily/annually basis are not maintained.
9.4	Quantity of industrial chemicals used "Chlorine, Coagulant, etc."	Not using : kg/d, kg/year Not using ; kg/d, kg/year

9.5	Is there a list of vendors for chemicals, consumable materials, and machine parts?	Yes	(No)
9.6	Frequency of power failure during year, total number of hours of power failure	2-3 hours/day	
9.7	Are there standby power generators?	Yes	
9.8	How many times a year and how many hours a year is the standby power generator used?	2-3 hours/day	
10	**Efficiency improvement and remedial measures and maintenance management of**		
10.1	Is there a centralized control system?	Yes	(No)
.	Is there a data logger system?	Yes	(No)
10.2	Has the operation and maintenance service been subcontracted to a private company?	Yes	(No)
11	**Safety management**		
11.1	Is there a safety and hygiene organization?	Yes	(No)
11.2	Is there a safety operation manual ?	Yes	(No)
11.3	Are there safety protection tools?	(Yes)	No
11.4	Are there warning signs for dangerous parts of the facilities?	Yes	(No)
11.5	Have there been instances of accidents/disasters in the past?	Yes	(No)
11.6	Is education and training implemented for health and safety ?	Yes	(No)
11.7	Is there a risk management manual (for floods, cyclones, earthquakes, and other natural disasters)?	Yes	(No)

Ⅱ Check list of sewerage systems, machinery and electrical systems

Please reply as indicated on the right side.

1	**Machinery system**			
1.1	**Type of screens**			
1.1.1	Is there a coarse screen?	(Yes)	No	
1.1.2	Is screen type mechanical?	(Yes)	No	Not Working
1.1.3	Is there a fine screen?	(Yes)	No	
1.1.4	Is screen type mechanical?	(Yes)	No	
1.1.5	**Grit chamber**			
1.1.6	Is there a crushing device?	Yes	(No)	
1.1.7	Is there a conveyor?	Yes	(No)	
1.1.8	**How is the grit chamber cleaned?**			
	Mechanically?	Yes	(No)	
	Bucket elevator?	Yes	(No)	
	Jet pump?	Yes	(No)	
	Screw?	Yes	(No)	
	Air lift?	Yes	(No)	
	Manually?	(Yes)	No	
	Aeration?	Yes	(No)	
1.2	**Pumps**			
1.2.1	What is the rated voltage of main pump?	440V		
1.2.2	Is there any speed controlled pump?	Yes	(No)	
1.2.3	If Yes, what is the type of pump?	Yes	(No)	
1.2.4	If Yes, what is the method of speed control?	Yes	(No)	
1.3	What type of aeration facilities used?	No		
1.3.1	What type of air diffuser is used?	No		
1.4	**Disinfection equipment**			
1.4.1	**What type of disinfection method for effluent is**			
	Chlorination?	Yes	(No)	
	Ultra violet ray?	Yes	(No)	
	Ozonizer?	Yes	(No)	
1.5	**Sludge thickening equipment**			
1.5.1	**What type of sludge thickening equipment is**			
	Gravity thickening?	No		
	Air flotation?	No		
	Centrifugal thickening?	No		
	Belt type?	No		
1.6	**Sludge dehydration equipment**			
1.6.1	**What type of sludge dehydration method is**			
	Mechanical			
	Filter press?	Yes	(No)	
	Centrifugal dehydration?	Yes	(No)	
	Vacuum filtration?	Yes	(No)	
	Others?	Sludge drying beds		
1.6.2	Where does the dewatered sludge go to?	Horticulture (land application)		
1.7.1	Sludge digestion facility (Anaerobic)?	Yes	(No)	
1.7.2	Is digester gas used?	Yes (for)	(No)	
2	**Electrical system**			
2.1	**Substation facility**			
2.1.1	What is the substation voltage?	11 kV		

2.3	**Uninterrupted power supply (UPS)**			
2.3.1	Is there uninterrupted power supply?	Yes	(No)	
2.3.2	If Yes, is it DC supply or AC supply?	AC	DC	No
2.3.3	What are the applications of this power supply?	pumps and lighting		
2.5	**Measuring instruments**			
2.5.1	**What type of flow meter is used and where?**			
	Electro-magnetic?	Yes ( )	(No)	
	Ultrasonic?	Yes ( )	(No)	
	Orifice plate?	Yes ( )	(No)	
	Venturi?	Yes ( )	(No)	
	Weir?	(Yes) ( )	(No)	
	Partial flume?	Yes ( )	(No)	
2.5.2	**What type of level gauge is adopted and where?**			
	Float-type?	Yes ( )	(No)	
	Pressure-type?	Yes ( )	(No)	
	Ultrasonic?	Yes ( )	(No)	
	Radio wave ?	Yes ( )	(No)	
2.5.3	**Is a water quality meter used?**			
	PH?	(Yes)	(No)	
	DO?	Yes	(No)	
	MLSS?	Yes	(No)	
	ORP?	Yes	(No)	
	Turbidity?	Yes	(No)	
	RCL?	Yes	(No)	
	Nitrogen?	Yes	(No)	
	Phosphorus?	Yes	(No)	
2.5.4	**Is sludge measurement performed?**			
	Sludge concentration?	Yes	(No)	
2.5.5	**Is any meteorological instrument used for the following?**			
	Temperature?	(Yes)	No	
	Atmospheric pressure?	Yes	(No)	
	Rain?	Yes	(No)	
	Wind velocity (Anemometer)?	Yes	(No)	
2.5	**Monitoring control system**			
2.5.1	**Does a lookout post exist at the following**	Yes	(No)	
	Grit chamber	Yes	(No)	
	Dry well	Yes	(No)	
	Sewage treatment facility	Yes	(No)	
	Sludge thickening equipment	Yes	(No)	
	Sludge dehydration equipment	Yes	(No)	
	Anaerobic digestion tank	Yes	(No)	
	Pumping station	Yes	(No)	
2.5.3	Is SCADA（Supervisory Control And Data Acquisition）system used?	Yes	(No)	

Part B Individual Sewage Treatment Plant

Questionnaire for 8 target states and 2 Union Territories in India

Face sheet

Please fill in the fields below. Attach additional sheets if necessary.

1	Name of state	Uttar Pradesh
2	Name of city/town	Agra
3	Name of respondent	
4	STP Name	
5	Contact information	
6	Address	
7	Phone number	
8	E-mail address	

I Summary of sewage treatment plant

1	**Basic data related to facilities**	
1.1	Are there calculations for basic design and capacity of treatment plant facilities?	Yes ,
1.2	Is there a layout plan showing earthwork, machinery, and electrical equipment?	Yes ,
1.3	Are there detailed specifications of all facilities and equipment fitted in the plant? Are there as-fitted drawings of all sewers? Are there structural drawings of tanks, digesters, reactors, buildings	Yes ,
1.4	Is there a flow chart for instrumentation?	Yes ,
1.5	Are there single-line diagrams (electrical)?	Yes ,
1.6	Sewage treatment process used (Example: Conventional activated sludge process)	WSP
1.7	Sludge treatment process used (Example: Sludge drying after thickening)	N/A
1.8	Which is the effluent discharge point?	River, Through drains
1.9	Layout of plant (please attach the drawing, if you	Yes
2	**History**	
2.1	Is the history of failure, repair, or reconstruction recorded?	Yes ,
2.2	Are there any requests or complaints from surrounding residents?	No
3	**Design capacity and actual loading**	
3.1	Design wastewater flow	10.00 MLD
3.2	Average daily flow	09.50 MLD
3.3	Maximum daily flow	10.00 MLD
3.4	Dry weather flow	09.00 MLD
3.5	Design wet weather flow	10.00 MLD
3.6	Wet weather flow	10.00 MLD
3.7	Design wastewater influent quality	BOD 148 mg/l COD 478 mg/l SS 225 mg/l
3.8	Average wastewater influent quality	BOD 148 mg/l COD 478 mg/l SS 225 mg/l
3.9	Design effluent quality	BOD 30 mg/l COD 250 mg/l SS 100 mg/l
3.10	Average effluent quality	BOD 30 mg/l COD 250 mg/l SS 100 mg/l
3.11	Solids capture rate	N/A
3.12	What equipment is used for drawing out sludge from primary/secondary sedimentation tank or digester (pump/gravity, etc.)?	Manually
3.13	Frequency of drawing out sludge	Once in two year
3.14	Frequency of sludge carried outside STP	Once in two year
3.15	Design sludge generation volume and water content	MLD, ML/year, % N/A
3.16	Average sludge generation volume, and water content	MLD, ML/year, % N/A
3.17	Percentage of volatile solids in generated sludge	mean: % max: %, min: % N/A
3.18	Methods of effective sludge or waste utilization	Sludge is being disposed off
3.19	Is sludge used for agricultural purpose or some other purpose? What is the amount of sludge disposed and water content in sludge?	Not used.
3.20	Are there operation records for pumps, equipment, blowers, etc.?	Daily report: Yes, Monthly report: Yes Annual report: Yes
3.21	Is the water quality measured regularly?	Yes ,
3.22	Are water quality measurement records maintained?	Weekly report Yes Annual report: Yes
3.23	Is record of concentration of toxic substances in sludge maintained?	No
3.24	Has the water quality of the final effluent exceeded the effluent standards anytime?	No
3.25	If Yes, what are the cause for exceeding the effluent standard?	N/A

4	**Corrosion of facilities and dam age status**	
4.1	Is there corrosion of buildings or structures?	No
4.2	Was there any damage to the building frame part of facilities?	No
4.3	Is there corrosion in equipment?	Yes
4.4	Is there damage to equipment?	Yes
4.5	Are there records of corrosion and damage to facilities?	Yes
4.6	Is there foul smell most of the time?	No
4.7	Is scum generated?	No
5	**Management of planned facilities**	
5.1	Is there an operation schedule for machinery and equipment	Yes "manufacturer compilation, others"
5.2	Is there an operation manual?	Yes
5.3	Is there a schedule for wastewater examination for influent, effluent and others?	Yes
	Is there a wastewater examination method?	Yes : Name of method: - Laboratory test
5.4	Are there the education and training manuals for the staff?	Yes
6	**Inspection of facility and equipment**	
6.1	Are there check records for equipment?	Daily report : Yes Monthly report : Yes Annual report : Yes
6.2	Is there an inspection manual?	Yes
6.3	Is there an inspection schedule?	Yes
6.4	Details of inspection procedure	Visual
6.5	How has the result of the inspection been used?	For improvement of system
6.6	How are inspection results maintained?	Hard copy,
7	**Repair, Rehabilitation, Reconstruction**	
7.1	Is there a manual for repair, rehabilitation and reconstruction of facility and equipment?	Yes, manufacturer's guidelines
7.2	If Yes, is it being used?	Yes
7.3	Are there repair, rehabilitation and reconstruction plans for facility and equipment ?	Yes
7.4	Have repairs, rehabilitation and reconstruction been implemented?	Yes
7.5	Are there repair, rehabilitation and reconstruction records?	Hard copy
8	**Work implementation**	
8.1	Staffing or Manpower at Plant Ass.project Engineer and others	Manager : 3 Persons (Partly) Engineers : 4 Persons (Partly) Foreman : 2 Persons Maintenance : 12 persons shift-in-charge: 3 persons Analyses of water quality: 1 persons Office workers : 15 persons (Partly) Total staff: - 40
8.2	Engineers	B-Tech - 3 : Persons, Diploma - 4 : Persons, : persons,
8.3	Working time	Regular working time from 10 to 5pm to 8 hrs. shifts 3
8.4	Work mode	Subcontractor
8.5	Contents of work	Operation, & Maintenance,
8.6	Others（Are there the special measures taken at the time of accidents or disasters?）	N/A
9	**Procurement of utility and materials**	
9.1	Is the procurement of the chemicals easy?	No Chemical required
9.2	Is there a procurement plan of chemicals?	No
9.3	Amount of electric power used each day/month, and of one year	2880/86400 kWh in a day/month, 1036800 kWh in a year
9.4	Quantity of industrial chemicals used "Chlorine, Coagulant, etc."	Nil
9.5	Is there a list of vendors for chemicals, consumable materials, and machine parts?	Yes
9.6	Frequency of power failure during year, total number of hours of power failure	365 times/year 730 hour/year
9.7	Are there standby power generators?	Yes
9.8	How many times a year and how many hours a year is the standby power generator used?	365 times/year 730 hours/year
10	**Efficiency improvement and remedial measures and maintenance management of**	

10.1	Is there a centralized control system?	No
.	Is there a data logger system?	No
10.2	Has the operation and maintenance service been subcontracted to a private company?	No
11	**Safety management**	
11.1	Is there a safety and hygiene organization?	No
11.2	Is there a safety operation manual ?	Yes
11.3	Are there safety protection tools?	Yes
11.4	Are there warning signs for dangerous parts of the facilities?	Yes
11.5	Have there been instances of accidents/disasters in the past?	No
11.6	Is education and training implemented for health and safety ?	Yes
11.7	Is there a risk management manual (for floods, cyclones, earthquakes, and other natural disasters)?	No

Ⅱ Check list of sewerage systems, machinery and electrical systems

Please reply as indicated on the right side.

1	**Machinery system**	
1.1	**Type of screens**	
1.1.1	Is there a coarse screen?	Yes
1.1.2	Is screen type mechanical?	No
1.1.3	Is there a fine screen?	No
1.1.4	Is screen type mechanical?	No
1.1.5	**Grit chamber**	
1.1.6	Is there a crushing device?	No
1.1.7	Is there a conveyor?	No
1.1.8	**How is the grit chamber cleaned?**	
	Mechanically?	No
	Bucket elevator?	No
	Jet pump?	No
	Screw?	No
	Air lift?	No
	Manually?	Yes
	Aeration?	No
1.2	**Pumps**	5 Nos (Main Pumps) each pumping station
1.2.1	What is the rated voltage of main pump?	440 V
1.2.2	Is there any speed controlled pump?	Yes
1.2.3	If Yes, what is the type of pump?	Non clog submersible
1.2.4	If Yes, what is the method of speed control?	N/A
1.3	**What type of aeration facilities used?**	Natural
1.3.1	What type of air diffuser is used?	No
1.4	**Disinfection equipment**	
1.4.1	**What type of disinfection method for effluent is**	
	Chlorination?	No
	Ultra violet ray?	No
	Ozonizer?	No
1.5	**Sludge thickening equipment**	
1.5.1	**What type of sludge thickening equipment is**	
	Gravity thickening?	Yes
	Air flotation?	No
	Centrifugal thickening?	No
	Belt type?	No
1.6	**Sludge dehydration equipment**	
1.6.1	**What type of sludge dehydration method is**	
	Mechanical?	
	Filter press?	No
	Centrifugal dehydration	No
	Vacuum filtration?	No
	Others?	No
1.6.2	Where does the dewatered sludge go to?	Municipal Corporation dumping place
1.7.1	Sludge digestion facility (Anaerobic)?	No
1.7.2	Is digester gas used?	No
2	**Electrical system**	
2.1	**Substation facility**	
2.1.1	What is the substation voltage?	11kV
2.3	**Uninterrupted power supply (UPS)**	
2.3.1	Is there uninterrupted power supply?	No
2.3.2	If YES, is it DC supply or AC supply?	No
2.3.3	What are the applications of this power supply?	No

2.5	**Measuring instruments**	
2.5.1	**What type of flow meter is used and where?**	
	Electro-magnetic?	No
	Ultrasonic?	No
	Orifice plate?	No
	Venturi?	No
	Weir?	Yes
	Partial flume?	No
2.5.2	**What type of level gauge is adopted and where?**	
	Float-type?	No
	Pressure-type?	No
	Ultrasonic?	No
	Radio wave ?	No
2.5.3	**Is a water quality meter used?**	
	PH?	No
	DO?	No
	MLSS?	No
	ORP?	No
	Turbidity?	No
	RCL?	No
	Nitrogen?	No
	Phosphorus?	No
2.5.4	**Is sludge measurement performed?**	
	Sludge concentration?	No
2.5.5	**Is any meteorological instrument used for the following?**	
	Temperature?	
	Atmospheric pressure?	No
	Rain?	No
	Wind velocity (Anemometer)?	No
2.5	**Monitoring control system**	
2.5.1	**Does a lookout post exist at the following**	
	Grit chamber	Yes
	Dry well	N/A
	Sewage treatment facility	Yes
	Sludge thickening equipment	N/A
	Sludge dehydration equipment	N/A
	Anaerobic digestion tank	No
	Pumping station	Yes
2.5.3	Is SCADA（Supervisory Control And Data Acquisition）system used?	No

Part B Individual Treatment Plant

Questionnaire for 8 target states and 2 Union Territories in India

Face sheet

Please fill in the fields below. Attach additional sheets if necessary.

1	Name of state	Maharashtra
2	Name of city/town	Mumbai
3	Name of respondent	
4	STP Name	
5	Contact information	
6	Address	
7	Phone number	
8	E-mail address	

I Summary of sewage treatment plant

Only pumping station

1	**Basic data related to facilities**	
1.1	Are there calculations for basic design and capacity of treatment plant facilities?	(Yes), No, Others :
1.2	Is there a layout plan showing earthwork, machinery, and electrical equipment?	Yes , (No), Others :
1.3	Are there detailed specifications of all facilities and equipment fitted in the plant? Are there as-fitted drawings of all sewers? Are there structural drawings of tanks, digesters, reactors, buildings,	Yes , (No), Others :
1.4	Is there a flow chart for instrumentation?	Yes , (No), Others :
1.5	Are there single-line diagrams (electrical)?	Yes , (No), Others :
1.6	Sewage treatment process used (Example: Conventional activated sludge process)	None
1.7	Sludge treatment process used (Example: Sludge drying after thickening)	None
1.8	Which is the effluent discharge point?	Sea area , Underground seepage
1.9	Layout of plant (please attach the drawing, if you	N/A
2	**History**	
2.1	Is the history of failure, repair, or reconstruction recorded?	Yes (No) Others :
2.2	Are there any requests or complaints from surrounding residents?	Yes (No)
3	**Design capacity and actual loading**	
3.1	Design wastewater flow	797 MLD
3.2	Average daily flow	380～400 MLD
3.3	Maximum daily flow	400 MLD
3.4	Dry weather flow	380 MLD
3.5	Design wet weather flow	MLD
3.6	Wet weather flow	800～1000 MLD
3.7	Design wastewater influent quality	N/A
3.8	Average wastewater influent quality	N/A
3.9	Design effluent quality	N/A
3.10	Average effluent quality	BOD 1.6 mg/l , COD mg/l , SS mg/l
3.11	Solids capture rate	N/A %
3.12	What equipment is used for drawing out sludge from primary/secondary sedimentation tank or digester (pump/gravity, etc.)?	None
3.13	Frequency of drawing out sludge	N/A times/day times/month
3.14	Frequency of sludge carried outside STP	N/A times/month, times/year
3.15	Design sludge generation volume and water content	N/A MLD, ML/year, %
3.16	Average sludge generation volume, and water content	6㎥/day(Grit) 130㎥/month(Grit)
3.17	Percentage of volatile solids in generated sludge	mean: %, max: %, min: % N/A
3.18	Methods of effective sludge or waste utilization	Fertilizer, Waste Other methods : N/A
3.19	Is sludge used for agricultural purpose or some other purpose? What is the amount of sludge disposed and water content in sludge?	t/year, % N/A
3.2	Are there operation records for pumps, equipment, blowers, etc.?	Daily report: (Yes) No, Monthly report: Yes No, Annual report: Yes NO
3.2.1	Is the water quality measured regularly?	(Yes) No
3.2.2	Are water quality measurement records maintained?	Daily report: (Yes) No, Annual report: Yes No,
3.2.3	Is record of concentration of toxic substances in sludge maintained?	Yes (No)

3.2.4	Has the water quality of the final effluent exceeded the effluent standards anytime?	Yes No N/A
3.2.5	If Yes, what are the cause for exceeding the effluent standard?	N/A
4	**Corrosion of facilities and damage status**	
4.1	Is there corrosion of buildings or structures?	Yes (No,) name of part :
4.2	Was there any damage to the building frame part of facilities?	Yes (No,) name of part :
4.3	Is there corrosion in equipment?	Yes (No,) name of part :
4.4	Is there damage to equipment?	(Yes) No, name of part :
4.5	Are there records of corrosion and damage to facilities?	Yes (No)
4.6	Is there foul smell most of the time?	Yes (No)
4.7	Is scum generated?	A large amount, (Small amount,) No
5	**Management of planned facilities**	
5.1	Is there an operation schedule for machinery and equipment	Yes "manufacturer compilation, Others (No)
5.2	Is there an operation manual?	Yes (No)
5.3	Is there a schedule for wastewater examination for influent, effluent and others?	(Yes) No
	Is there a wastewater examination method?	Yes: Name of the method: N/A No
5.4	Are there the education and training manuals for the staff?	Yes (No)
6	**Inspection of facility and equipment**	
6.1	Are there check records for equipment?	Daily report: (Yes) No, Monthly report: Yes No, Annual report: Yes No
6.2	Is there an inspection manual?	Yes (No)
6.3	Is there an inspection schedule?	Yes (No)
6.4	Details of inspection procedure	Visual/audible/TV camera, others : N/A
6.5	How has the result of the inspection been used?	N/A
6.6	How are inspection results maintained?	Electronic data, Hard copy, Others : N/A
7	**Repair, Rehabilitation, Reconstruction**	
7.1	Is there a manual for repair, rehabilitation and reconstruction of facility and equipment?	Yes (No)
7.2	If Yes, is it being used?	Yes (No)
7.3	Are there repair, rehabilitation and reconstruction plans for facility and equipment ?	Yes (No)
7.4	Have repairs, rehabilitation and reconstruction been implemented?	Yes (No)
7.5	Are there repair, rehabilitation and reconstruction records?	Electronic data, Hard copy, Others : N/A
8	**Work implementation**	
8.1	Staffing or Manpower at Plant	Asst.Engineer : 1 person Engineers : 5person (4operation 1maintenance) Foremen : 4person Operators : 3person + 1reliever
8.2	Engineers	Laborers : 6person (2per shift 3shift) : persons,
8.3	Working time	N/A Regular working time From : to : to : Shifts : to :
8.4	Work mode	N/A Permanent worker Subcontractor
8.5	Contents of work	N/A Operation , Maintenance, Repair
8.6	Others（Are there the special measures taken at the time of accidents or disasters)	Yes No N/A
9	**Procurement of utility and materials**	
9.1	Is the procurement of the chemicals easy?	Yes No Not using
9.2	Is there a procurement plan of chemicals?	Yes No N/A
9.3	Amount of electric power used each day/month, and of one year	53196kWH/day, 1618061kWH/month, 19416732kWH/year
9.4	Quantity of industrial chemicals used "Chlorine, Coagulant, etc."	Not using : kg/d, kg/year Not using : kg/d, kg/year
9.5	Is there a list of vendors for chemicals, consumable materials, and machine parts?	Yes (No)
9.6	Frequency of power failure during year, total number of hours of power failure	N/A times/year hours/year
9.7	Are there standby power generators?	Yes
9.8	How many times a year and how many hours a year is the standby power generator used?	times/year hours/year N/A
10	**Efficiency improvement and remedial measures and maintenance management of**	

10.1	Is there a centralized control system?	Yes	(No)	
.	Is there a data logger system?	Yes	(No)	
10.2	Has the operation and maintenance service been subcontracted to a private company?	Yes	(No)	
11	**Safety management**			
11.1	Is there a safety and hygiene organization?	Yes	(No)	
11.2	Is there a safety operation manual ?	Yes	(No)	
11.3	Are there safety protection tools?	Yes	(No)	
11.4	Are there warning signs for dangerous parts of the facilities?	Yes	(No)	
11.5	Have there been instances of accidents/disasters in the past?	Yes	(No)	
11.6	Is education and training implemented for health and safety ?	Yes	(No)	
11.7	Is there a risk management manual (for floods, cyclones, earthquakes, and other natural disasters)?	Yes	No	

Ⅱ Check list of sewerage systems, machinery and electrical systems

Please reply as indicated on the right side.

1	**Machinery system**			
1.1	**Type of screens**			
1.1.1	Is there a coarse screen?	(Yes)	No	
1.1.2	Is screen type mechanical?	Yes	(No)	
1.1.3	Is there a fine screen?	(Yes)	No	
1.1.4	Is screen type mechanical?	(Yes)	No	
1.1.5	Grit chamber			
1.1.6	Is there a crushing device?	Yes	(No)	
1.1.7	Is there a conveyor?	Yes	(No)	
1.1.8	**How is the grid chamber cleaned?**			
	Mechanically?	(Yes)	No	
	Bucket elevator?	Yes	(No)	
	Jet pump?	Yes	(No)	
	Screw?	Yes	(No)	
	Air lift?	Yes	(No)	
	Manually?	Yes	(No)	
	Aeration?	(Yes)	(No)	
1.2	**Pumps**			
1.2.1	What is the rated voltage of main pump?	6600 v		
1.2.2	Is there any speed controlled pump?	Yes	(No)	
1.2.3	If Yes, what is the type of pump?	Yes	(No)	
1.2.4	If Yes, what is the method of speed control?	No		
1.3	**What type of aeration facilities used?**	No		
1.3.1	What type of air diffuser is used?	No		
1.4	**Disinfection equipment**			
1.4.1	What type of disinfection method for effluent is			
	Chlorination?	Yes	(No)	
	Ultra violet ray?	Yes	(No)	
	Ozonizer?	Yes	(No)	
1.5	**Sludge thickening equipment**			
1.5.1	**What type of sludge thickening equipment is**			
	Gravity thickening?	No		
	Air flotation?	No		
	Centrifugal thickening?	No		
	Belt type?	No		
1.6	**Sludge dehydration equipment**			
1.6.1	What type of sludge dehydration method is adopted			
	Mechanical?	No		
	Filter press?	No		
	Centrifugal dehydration	No		
	Vacuum filtration?	No		
	Others?	No		
1.6.2	Where does the dewatered sludge go to?	N/A		
1.7.1	Sludge digestion facility (Anaerobic)?	No		
1.7.2	Is digester gas used?	No		
2	**Electrical system**			
2.1	**Substation facility**			
2.1.1	What is the substation voltage?	N/A	V	
2.3	**Uninterrupted power supply (UPS)**			
2.3.1	Is there uninterrupted power supply?	Yes	No	N/A
2.3.2	If Yes, is it DC supply or AC supply?	AC	DC	N/A
2.3.3	What are the applications of this power supply?	N/A		
2.5	**Measuring instruments**			
2.5.1	**What type of flow meter is used and where?**			
	Electro-magnetic?	Yes ( )	No	N/A
	Ultrasonic?	Yes ( )	No	N/A
	Orifice plate?	Yes ( )	No	N/A
	Venturi?	Yes ( )	No	N/A
	Weir?	Yes ( )	No	N/A
	Partial flume?	Yes ( )	No	N/A

2.5.2	**What type of level gauge is adopted and where?**			
	Float-type?	Yes（ ）	No	N/A
	Pressure-type?	Yes（ ）	No	N/A
	Ultrasonic?	Yes（ ）	No	N/A
	Radio wave ?	Yes（ ）	No	N/A
2.5.3	**Is a water quality meter used?**			
	PH?	Yes	No	N/A
	DO?	Yes	No	N/A
	MLSS?	Yes	No	N/A
	ORP?	Yes	No	N/A
	Turbidity?	Yes	No	N/A
	Nitrogen?	Yes	No	N/A
	Phosphorus?	Yes	No	N/A
2.5.4	**Is sludge measurement performed?**			
	Sludge concentration?	Yes	No	N/A
2.5.5	**Is any meteorological instrument used for the following?**			
	Temperature?	Yes	No	N/A
	Atmospheric pressure?	Yes	No	N/A
	Rain?	Yes	No	N/A
	Wind velocity (Anemometer)?	Yes	No	N/A
2.5	**Monitoring control system**			
2.5.1	**Does a lookout post exist at the following**			
	Grit chamber	N/A		
	Dry well	N/A		
	Sewage treatment facility	N/A		
	Sludge thickening equipment	N/A		
	Sludge dehydration equipment	N/A		
	Anaerobic digestion tank	N/A		
	Pumping station	N/A		
2.5.3	Is SCADA（Supervisory Control And Data Acquisition）system used?	Yes	No	N/A