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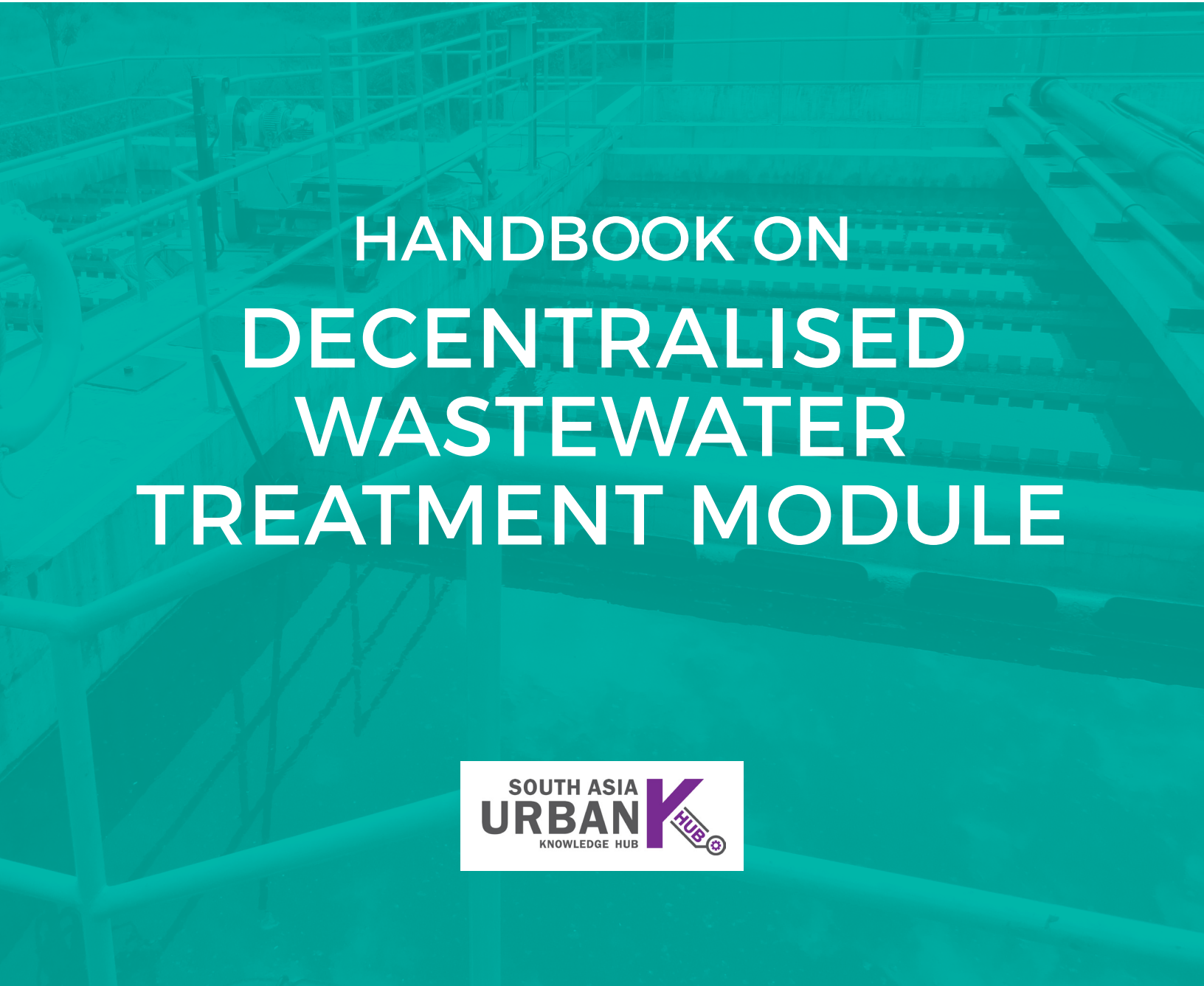

HANDBOOK ON DECENTRALISED WASTEWATER TREATMENT MODULE

SOUTH ASIA URBAN KNOWLEDGE HUB

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HANDBOOK ON

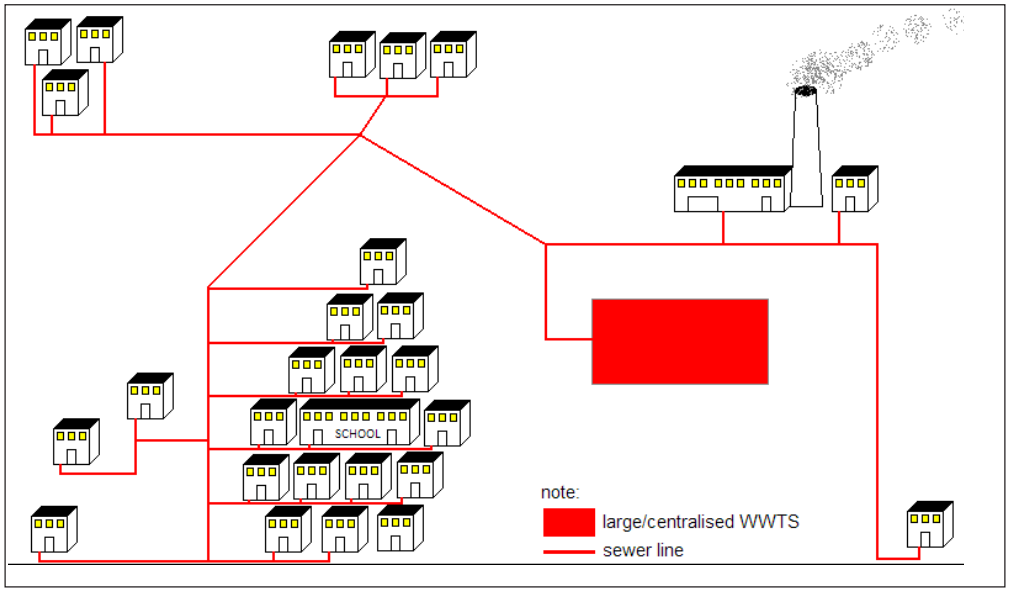
DECENTRALISED WASTEWATER TREATMENT MODULE

Foreword

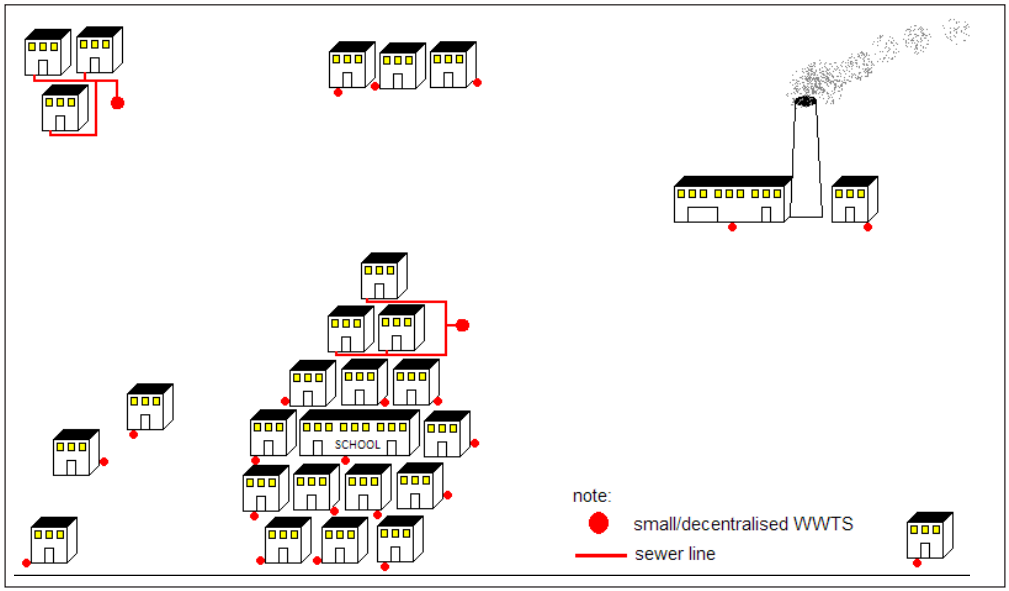
This handbook is one of the knowledge products produced as part of the South Asia Urban Knowledge Hub (K-hub). The South Asia Urban Knowledge Hub (K-hub) was established in 2014 to improve policy making in the urban sector based on credible research and knowledge from across government, academia, non-government organisations and the private sector. The K-hub strives to build a network of associated institutions in the South Asia region and become a forum for improving urban knowledge within and between countries and regions. Four national centers at National Institute of Urban Affairs (NIUA) in India, ITN-BUET in Bangladesh, University of Moratuwa in Sri Lanka and Tribhuvan University in Nepal, have been connected under the K-hub. Each national center focuses on different themes such as innovative sanitation, fecal sludge management, good governance, capacity building, housing, transportation, inclusive prosperity and regional data sharing. The K-Hub initiative is supported by the Asian Development Bank (ADB) and the respective Governments of India, Bangladesh, Nepal and Sri Lanka. For more details please see the website - khub.niua.org

The main objective of the K-Hub is to engage institutions to generate and apply knowledge to city management according to principles of sustainable development. Thus, this handbook is prepared with the motive of providing basic guidance to decision makers at the state and city level in India to assess and plan for decentralised sanitation modules where on site sanitation system is being practiced. It starts by briefly explaining where such modules can be implemented and its pros and cons in comparison to centralised systems. The contents of the handbook are derived and adapted from a number of important and reliable sources like CDD-BORDA, Eawag, UNICEF, WSP etc. that provide detailed technological, social and economic aspects of this approach. The handbook contains five sections: The first chapter contains the introduction and explains why Decentralised sanitation is a feasible solution and briefly compares it with centralised systems. The second chapter explains the technological aspects of decentralised solutions. The third chapter highlights the sources of necessary financial support, including innovative ideas needed to implement such a module. Chapters two and three are illustrated with Indian case studies where such a module is working well. Chapter four gives an overview of the capacity and skills required for implementing this module. Finally the last chapter emphasizes the need and methods to engage with stakeholders for its long term sustainability.

Centralised Treatment



Decentralised Wastewater Treatment



About this Handbook

Questions this handbook tries to answer

What is meant by decentralised wastewater treatment?
Decentralised wastewater treatment is a system where the treatment of excreta or sewage takes place at the same location where it is generated or is transported through a simplified conveyance system and is treated within a short distance of its generation.

Why does this handbook focus on decentralised sanitation?
Conventional centralised sewerage systems require an elaborate infrastructure and large amounts of water to carry the wastes or excreta away. They are resource intensive - that is, they require energy, skilled labour, expensive infrastructure, operation and maintenance. Decentralised systems can be installed wherever centralised services are unreachable, infeasible or unaffordable. Decentralised Wastewater Treatment Modules needs services that are not intended to replace but rather to complement centralised systems.

Who is this handbook meant for?
This handbook is intended to provide basic guidance to decision makers at the state and city level in India to assess and plan for decentralised sanitation systems. It is useful for regions where on site sanitation system is being practiced or where centralised systems are unable to reach due to constraints like availability of power, unfavorable physical issues such as soil or terrain conditions etc.

Does this handbook tell about cases where a Decentralised Wastewater Treatment Module is installed and working in India?
Yes, Table 3.4 highlights the basic details about where such a system is working, alongwith basic information like scale, salient features, approximate cost and contact details of the nodal person.

Does this handbook provide details on design and specifications?
The contents of the handbook are derived and adapted from a number of credible sources that provide detailed technological, social and economic aspects of this approach. For details, one has to refer to these reference provided at the end.

Acknowledgement

The Handbook on Decentralised Wastewater Treatment Module is an amalgamation of work done by credible organisations and institutes. Their contributions have been acknowledged to the extent possible through references.

At the outset I would like to thank the Asian Development Bank (ADB) whose grant support under the South Asia Urban Knowledge Hub has lead to the genesis of this document. It may be mentioned here that ADB emphasized the need to engage with the users of this document and customize it to their needs. I thank Mr. Keiichi Tamaki, Ms. Vivian Castro-Woolridge, Mr. Ashok Srivastava and Mr. Ron Slangen from ADB for their continuous engagement and guidance. I am grateful to all the officials at the State and city level for devoting time for consultations that has helped shape the report in its present form. Ms. Michelle Laurie, Knowledge Management Specialist, deserves a special mention for her suggestions and attention to details as the concept progressed.

I would like to thank Ms. Laura Kohler, Sanitation Specialist at CAWST, Calgary, Mr. Sasanka Velidandla, Director, CDD Society, Bangalore, India and Mr. Ravi Joseph, Senior Urban Specialist, Water and Sanotation Program, New Delhi, India for meticulously reviewing this handbook and providing constructive comments.

I am grateful to our Director, Prof. Jagan Shah for his continuous encouragement, direction and leadership in the project activities. I acknowledge the contributions made by the research team members from NIUA, Ms. Jyoti Dash, Research Fellow and Ms. Ankita Gupta, Research Associate who have shown collaborative team effort during the documentation. Mr. Ravi Sinha, a Masters of Planning student from the School of Planning and Architecture, Vijayawada who interned with NIUA also contributed in compiling some of the information.I would like to thank Dr. Uday Bhonde for his help whenever I sought his advice.

Finally, the report would not have been complete without the design support from Mr. Deep Pahwa and Ms. Kavita Rawat. I am also grateful to all those who helped in the completion of the project in various ways. I acknowledge the assistance of all those whose names do not appear explicitly.

Paramita Datta Dey
Senior Research Officer & Infrastructure Expert (K-Hub)

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List of Abbreviations

AMRUT	Atal Mission for Rejuvenation and Urban Transformation
CSR	Corporate Social Responsibility
DPR	Detailed Project Report
FC	Finance Commission
FFC	Fourteenth Finance Commission
FSM	Fecal Sludge Management
FSTP	Fecal Sludge Treatment Plant
FY	Financial Year
GoI	Government of India
HFI	Housing Finance Institution
HRIDAY	Heritage City Development and Augmentation Yojana
LF	Logical framework
MFI	Micro Finance Institutions
MHRD	Ministry of Human Resource Development
Mo WR, RD&GR	Ministry of Water Resources, River Development and Ganga Rejuvenation
MoEF	Ministry of Environment and Forests
MoH	Ministry of Health
MoHUPA	Ministry of Housing and Urban Poverty Alleviation
MoUD	Ministry of Urban Development
NGO	Non Governmental Organisation
NGRBA	National Ganga River Basin Authority
O & M	Operation and Maintenance
SAAP	State Annual Action Plan
SBM	Swachh Bharat Mission
SFC	State Finance Commission
SHG	Self Help Group
SLIPS	Service Level Improvement Plans
STP	Sewage Treatment Plant System
ULB	Urban Local Body
UT	Union Territory

Ill-maintained Sewage Treatment Plant at Bhagalpur, Bihar

Chapter 1

Introduction to Decentralised Sanitation Systems

Introduction

The United Nations Children's Fund (UNICEF), India estimate that there are more than 564 million people practicing open defecation in India,which is nearly half of the world's population[1]. According to the Census of India 2011, about 47 percent of India's households have a toilet at home and about 49.84 percent practice open defecation. Most Indian cities are only partially sewered. About 48 percent of urban Indian households depend on on-site facilities (largely septic tanks and pit latrines) for meeting their sanitation needs. With rapid urbanization and growth of cities, the dependence on such facilities is naturally increasing. At the national level, the perceptible need to focus on sustainable service delivery approach for sanitation is very evident. The National Urban Sanitation Policy (2008)[2] combined by the Government of India's further thrust on sanitation through the initiation of the "Swachh Bharat Mission (SBM)"[3] signifies acknowledgment of the crisis. In addition to being further expensive to provide for underground sewage systems, physical issues such as soil or terrain conditions make it tough to serve the entire city with piped systems. There is a clear need to focus on sustainable service delivery approach for sanitation that will include hybrid approach(i.e. a combination of centralised and decentralised sanitation systems). The system variables that influence treatment options are detailed in Table 1.1:

TABLE 1.1: SYSTEM VARIABLES THAT INFLUENCE TREATMENT OPTIONS

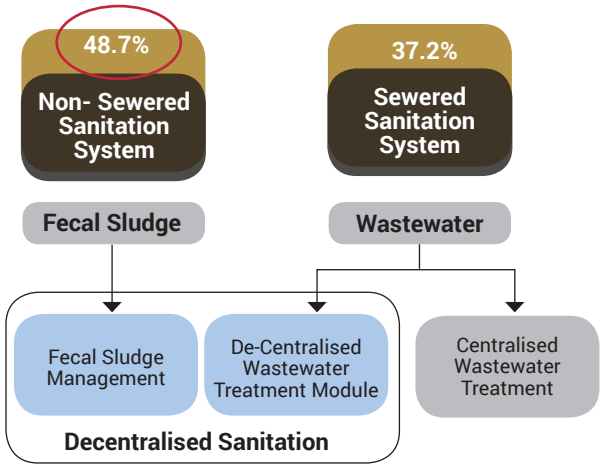
System variables	Magnitude of impact	On-site sanitation	Simplified sewarage	Centralised sewers
Growth uncertainty	High			
Population density	High			
Water scarcity	Moderate			
Soil permeability	Moderate			
Water table height	Moderate			
Rainfall	Low			

Source: Personal communication with experts

The objective of attaining open defecation free urban spaces not only requires an increase in the coverage of off-site sanitation systems, it also entails the need to design, construct, operate and maintain the present on-site sanitation systems. All these options have to be affordable and environment friendly.

Why Decentralised Wastewater Treatment Module

The disparities in sanitation in urban India is large, especially in access to toilets and treatment of waste. Access to improved sanitation facilities refers to the percentage of the population with at least adequate access



Source: Personal communication with experts, figures in percentage are from Census of India 2011

to excreta discarding facilities that can successfully prevent human, animal, and insect contact with excreta. According to the World Bank, population having access to improved sanitation facilities stands at 40 percent (JMP, 2015).[4] Where population use sanitation facilities, often these are not connected to a collection and/or treatment system. For example, only 160 out of 8,000 towns have both sewer and wastewater treatment plants, and only 13% of wastewater is actually treated.[5] This creates public health hazards and environmental degradation. Even when there are sewerage networks, much of the waste does not reach Sewage treatment plants (STPs).[5] This invites attention towards intermediate solutions which treat sewage at the source and lessens the load on piped network or transportation of sewage to STP through machines. It would be helpful for a city to manage and treat the sewage generated before disposing it off in the environment.

Conventional centralised sewerage systems require a sophisticated infrastructure and large amounts of water to transport the wastes or excreta away. Conventional processes are expensive to operate. They require energy, skilled labour, infrastructure and maintenance. In efforts to reduce the cost and complexity of waste treatment, decentralised treatment units have been developed.[6] Decentralisation means plugging the gap wherever centralised services are unviable or unaffordable.

TABLE 1.2: SUMMARY OF COMPARISON OF CENTRALISED AND DECENTRALISED MODULES

Centralised	Decentralised
1. Centralised Sewerage Systems with Underground Drains • Suitable for dense cities—but difficult to scale as city grows • Require adequate water for effective operations • Expensive to build and maintain—CapEx Rs 20,000-25,000 per capita • Estimated effectiveness only 30-50% - due to power cuts, mixing of sewage with storm water • Extensive excavation along roads and private property • More chances of failure—several cases of unsuccessful projects	**De-centralised Wastewater Treatment** • Suitable for population of 5-20,000—single home to entire neighborhood • Enables maximum local re-use of water, reducing fresh water needs • Much less expensive—CapEx Rs 4,000-6,000 per capita • Flexible and modular design for clusters • Comparatively less excavation required, easier to connect toilets • Less complex, requires basic skills to construct, operate and manage

Source: Based on consultations with CDD Society, 2016

Decentralised Wastewater Treatment Module needs services that are not intended to replace but rather to complement centralised systems.

A Decentralised Wastewater Treatment Module represents a technical approach rather than a technical package. Such applications are designed to be low on maintenance. Another important feature is that a number of parts of the system can work without any technical inputs of energy.[7]

In a Decentralised Wastewater Treatment Module application, there are four technical treatment modules. These can be combined and configured in a customized manner to suit a specific sanitation/wastewater challenge. (The modules are explained in Chapter 2). The applications are designed and dimensioned in such a way that treated effluent or wastewater meets requirements stipulated in environmental laws and regulations.

The comparison in the table1.2 between centralised and decentralised wastewater treatment highlights some of the advantages of decentralised treatment.

Decentralised Treatment Solutions: Fecal Sludge Management Vs. Decentralised Wastewater Treatment Module

There are a variety of sanitation solutions that fall on a continuum from large scale wastewater collection through sewers and treatment to decentralised sanitation solutions which include both smaller community scale or individual wastewater treatment module and the management (collection, transport, treatment and disposal) of the contents of non-sewered solutions such as latrines and septic tanks. Fecal Sludge Management (FSM) of non-sewered solutions is covered in the handbook titled “Technical Assessment and Planning Guidelines for Fecal Sludge Management”. This handbook focuses on Decentralised Wastewater Treatment Module and provides an overview of the various aspects related to its planning, design, implementation and long-term management.

Decentralied Wastewater Treatment Module at Kachhpura, Agra

Chapter 2

Technological aspects of Decentralised Sanitation

Cities in India are often faced with challenges in connecting peri-urban settlements with complete sanitation systems (i.e. provision including treatment of wastewater and sludge). In all such cases, a Decentralised Wastewater Treatment Module can be a feasible alternative.

A Typical Decentralised Wastewater Treatment Module combines the following technical treatment steps in a modular manner:

- pre-treatment – screen , grit chamber, oil and grease trap
- primary treatment – in sedimentation ponds, settlers, septic tanks.
- secondary treatment – in anaerobic baffled reactors, anaerobic filters or anaerobic and facultative pond systems
- tertiary aerobic/facultative treatment – in horizontal gravel filters
- tertiary treatment – in aerobic polishing ponds

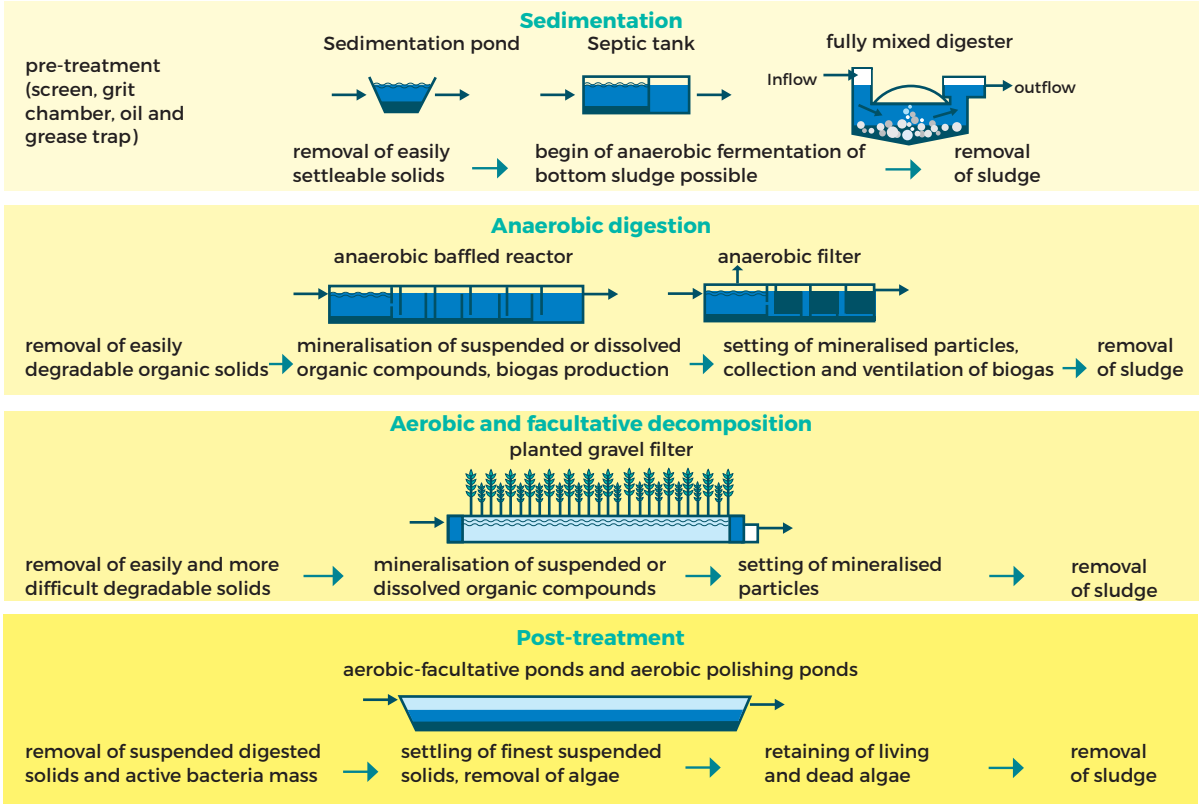
The selection of appropriate technical configuration depends on the following:

- wastewater volume
- wastewater quality
- local temperature
- underground conditions
- availability of land
- costs
- prescribed standards
- acceptance of cultural and social conditions
- final handling of the effluent (discharge and (or) reuse[8]

Selected Parameters	Decentralised as a preferred treatment Option
Wastewater volume	The capacity of the system may vary from 1KLD to 100 KLD
Wastewater quality BOD, COD, TDS, F. Coliform	Wastewater flows should be such that the COD/ BOD ratios is close for the volume of wastewater from 1m³ to 1000m³ per day and unit.
Site Conditions, Soil and Groundwater table	Ground water table more than 8m and low porosity and permeability of soil
Land availability	The total land area required to install different units of a decentralised wastewater treatment module for 1 cu.m system are following: The total land area required to install different units of a decentralised wastewater treatment module for 1 cu.m system are following: Settler 0.5 m2/m3 Anaerobic baffled reactor : 1 m2/m3 Constructed wetland: 30 m2/m3 Anaerobic ponds: 4 m2/m3 Facultative aerobic ponds:25 m2/m3 These figures are approximate. The area required increases and depends on the quality of the wastewater. Components like settler and improved septic tank or anaerobic baffled reactor are underground. So this does not lead to wastage of open area.

Source: BORDA Education Booklet on DEWATS, 2014 and CSE (http://www.cseindia.org/node/2073)

DECENTRALISED WASTEWATER TREATMENT MODULE : STEPS OF TREATMENT



The right combination and dimensions of the modules make Decentralised Wastewater Treatment Module successful.

Sources: www.sswm.info/sites/default/files/reference_attachments/DEWATS_Guidebook_small.pdf

Table 2.1 presents an overview of options available with respect to user interface, containment or storage system and treatment along-with a short description, area required, suitable conditions for installation, tentative installation costs, advantages and disadvantages. 'User interface' refers to the type of toilet used. It must ensure that human excreta is separated from human contact. This will prevent contamination due to exposure to feces. 'Containment or storage system' refers to the technologies used to collect and store the solid and liquids generated at the user interface. These also help in treatment to a certain degree depending on the time and conditions of storage. 'Treatment technologies' are mainly of two types: one, that are meant for treatment of wastewater and the other that is meant for treatment of sludge. Table 2.1 presents gives a brief overview of some of the choices under user interface, containment, storage and treatment. Detailed description on these can be referred from the *"Compendium of Sanitation Systems and Technologies"* by Eawag (www.sandec.ch) Further, Table 2.2 provides a summary of cases where these technologies have been implemented successfully in India.

Fecal Sludge Treatment Plant (FSTP), Devanhalli, near Bangalore, Karnataka

TABLE 2.1 OVERVIEW OF ON-SITE SANITATION SYSTEMS

1		2	3	
Type of system		**Important features**	**Suitable conditions for installation**	
User Interface 	Cistern Flush toilet	Usually made of porcelain, consists of a water tank that supplies water for flushing excreta and a bowl where excreta is deposited.	Should be considered when all hardware and accessories are locally available; Needs to be connected to a constant source of water for flushing.	
	Pour Flush toilet	Similar to cistern flush, but, water needs to be poured to flush the toilet.	Suitable for places where people prefer to sit or squat and use water to cleanse.	
Containment / storage system 	Twin-pit latrine / leach pit	Collects human feces in underground tanks. Two chambers (pits) are provided to hold fecal sludge. Wastewater is discharged to one chamber until it is full of fecal sludge. Discharge is then switched to the second chamber. Once the second chamber is full of fecal sludge, the contents of the first pit are dug out. During the time of storage, digestion should ensure that it is odorless and free of pathogens.	In low- to medium density areas, particularly peri-urban Areas.	
	Septic Tank	A buried chamber that collects, stores and partially treats the wastewater under anaerobic conditions.	Individual homes, Household clusters or institutional buildings.	
	Bio-digester tank (Developed by DRDO)	Anaerobic multi compartment tank with inoculums (anaerobic bacteria) which digests organic material biologically. The tank has two components, namely, anaerobic microbial inoculum (seed bacteria) and specially designed fermentation tank. The tank can be made out of Stainless steel, Mild steel, FRP or concrete. Semi-treated water from bio-digester tank is needed to be further disposed into reed bed arrangement for its treatment to acceptable levels of discharge.	Household clusters or institutional buildings where there is no sewerage network.	
Treatment 	Anaerobic Baffled Reactor (secondary treatment) and filter	Suitable for the treatment of non-settle able and dissolved solids by bringing them in close contact with a surplus of active bacterial mass; Graded gravel is used as filter media for the purpose of filtration and to enhance the bacterial action.	Bio-remediation of wastewater is an efficient process.	
	Planted Reed Bed Filter	Mud/soil balls of 20cm thick placed between the gravel layer. Each ball should contain a plant-Root zone process. Plants include Canna Indica, Reeds with (0.3x0.3)m spacing.		
	Polishing and Storage (Final Treatment)	Consists of storage tank (and) or an open polishing pond.	Appropriate for peri-urban areas where land is available. Not appropriate for dense areas.	

	4	5	6
	Tentative capital cost in ₹ (Rs)	Advantages	Disadvantages / limitations
	1200 - 12,000	Suitable for private and public toilets; No problems of odour if constructed properly.	High capital cost; requires constant source of water.
	1200 - 12,000 Depends on material used (concrete, fibreglass, plastic, stainless steal, etc.) and transport distance.	Similar to cistern flush; Requires less water than cistern flush toilets; suitable for all types of users; low capital cost; operating cost depends on price of water.	Coarse dry cleansing material may clog water seal; only appropriate where there is constant source of water.
	15000 to 20000 (for a single family of 5 members).	Twin-pit latrine rests primarily with the householder, who needs to ensure that the pits are used in the correct sequence and are emptied at the appropriate time.	Water may percolate through the soil surrounding the pit and pollute groundwater; While desludging of tanks, safe disposal of septage at a treatment plant should be ensured.
	25000 to 30000 (single family for 5 members).	A well-managed septic tank will remove about 50 to 60 % of the biological load in the wastewater.	Municipal utility or private contractors are required for desludging of septic tanks; desludgers of septic tanks should ensure safe disposal of septage at a treatment plant.
	17,000 to 22,000 (single family of 5 members).	There is no sludge formation, there is no need for desludging and treatment. It is therefore more economical in the long-term as it conserves water and has minimum O&M. Aerobic bacteria are very efficient in breaking down organic waste and the waste is decomposed into water by the bacteria within 24 hours.	Phenyl/ Harpic or any strong detergent/acid and bleaching powder should not be used to clean the pan. Only herbal / ayurvedic cleaning agents should be used. The bacteria functions best in temperatures between 4 and 55 degrees centigrade.
	The cost per KLD of a standard module plant in India works out to Rs.66,000 per KLD (standard deviation Rs.4,183) with the current price of construction materials and labour.	Nearly 90 percent of the original pollution load is removed at this stage.	If the system works in a closed environment without oxygen supply, the effluent will continue to smell, despite the fact that substantial treatment has taken place already.
		It can achieve high treatment efficiency at low-cost, if filtering material is available at site and there is no wastewater above ground.	Maintenance of planted bed filter is crucial for ensuring effective treatment.
		High reduction of solids, BOD and pathogens; Low operating cost; Enables recovery of large volumes of wastewater for useful purposes especially in urban areas.	Require large permanent space and if they are too small, mosquitoes and odour can be a problem and algae can raise the BOD of the effluent.

Sources: Based on information from the following sources: A Guide to the Development of on-Site Sanitation, © WHO, 1992, Standardisation of Design and Maintenance of DEWATS Plants in India, S.Ramesh Sakthivel, A.Seshadri, Md.Azizu Rahman, V.M.Chariar, Centre for Rural Development and Technology, Indian Institute of Technology, New Delhi, 2012; Swachh Bharat Mission Guideline, 2014 Decentralised Wastewater Treatment A Way to Manage Septage in Shimla, Centre for Science and Environmnet, New Delhi, 2010 and Compendium of Sanitation Systems and Technologies, 2nd revised edition, Elizabeth Tilley, Lukas Ulrich, Christoph Luthi, Philippe Reymond, Roland Schertenleib and Christian Zurbrugg, IWA and Eawag (Sandec), 2016

TABLE 2.2 - CASE STUDIES: DECENTRALISED SANITATION IN INDIA

S. NO	1	2	3	4
	Case Study Name	Scale and Implementing agency	Description of Treatment	Important Features
1	(Centre for Science and Environment, New Delhi) Operational since : 2005	**Institutional** Centre for Science and Environment CSE, Delhi	The treatment modules include a settler, an anaerobic baffled reactor and a planted filter bed.	The treated wastewater is stored in an underground sump. The water is retained in ABR for 24 hours for secondary treatment.
2	Aravind Eye Hospital, Pondicherry,	**Institutional** Consortium for DEWATS Dissemination (CDD) Society, Bangalore	Anaerobic treatment through baffled reactors and final treatment is done through polishing ponds.	The treatment facility receives 2.7- 3KLD from hospital building that includes only sewage. DEWATS was adopted to meet the demand of huge water requirement for horticulture and maintaining the lush green area of 15 acres within the hospital premises.
3	Decentralised Wastewater Treatment System at Kachpura village in Agra, Operational since : 2010	**Community** Centre for Urban and Regional Excellence (CURE), Agra Nagar Nigam (ANN) and USAID	The wastewater then enters into three chambered septic tank. After primary treatment, it goes to nine chambered baffled anaerobic reactor which is filled with gravels,	The aim of the programme was to improve the sanitation conditions in the slum areas. The system treats approximately 50 KLD of the total wastewater which it receives from 5 clusters of slums through a common drain.
4	Decentralised wastewater treatment system at Bankers Colony, Bhuj Operational since : 2006	**Community** Hunnarshala Foundation, Municipality of Bhuj and Kutch Navnirman Abhiyan, funded by American India Foundation and Care today group	Anaerobic Baffled Reactor which is a nine chambered system with the anaerobic filter in the last two chambers. Then, planted filter and finally to the polishing pond.	From the polishing pond the treated wastewater is reused. This treatment system is maintained in such a way so that the area can be utilised as a public space also.
5	Decentralised wastewater treatment system at Adarsh College, Distt Thane Operational since : 2008	**Institutional** Kualgaon Badlapur Municipal Council, GTZ (now GIZ), Ecosan Services Foundation	Anaerobic treatment, horizontal planted filter, polishing pond.	A toilet complex with two independent toilet blocks for male and female has been constructed in the school premises,The treatment plant receives 2-3 KLD of wastewater. Black water and grey water is collected in the collection tank from where it goes to the biogas settler.
6	Decentralised wastewater treatment system at Friends of Camphill, Bangalore Operational since : 2003	**Individual/ Residential** Consortium for DEWATS Dissemination (CDD) Society, Bangalore	Biogas produced as a result of anaerobic digestion enters into the extension chamber where it is stored for further use. From the settler, wastewater enters into 16 chambered baffled reactors, horizontal planted gravel filter, polishing pond.	Biogas production through anaerobic digestion.
7	Decentralised Wastewater Treatment System for Beedi Workers colony at neighborhood level, Operational since : 2005	**Community** Consortium for DEWATS Dissemination (CDD) Society, Bangalore	Anaerobic Baffled Reactor, planted gravel bed, treated water is finally collected in the collection tank.	Biogas produced is used by the colony residents for cooking.
8	Anoxic Bioremediation in Hauz Khaz Lake, New Delhi, Operational since: 2007-2011	**City (Water body/lake)** JM Enviro technologies Pvt. Ltd and Delhi Development Authority	Anaerobic live bacterial strains in liquid form. These bacteria decompose the accumulated sludge flocs and large organic molecules into simpler ones that can be consumed by the bacteria itself.	Consortium is effective in controlling odour, reducing TSS, BOD, oil/ grease accumulation in sewage/ polluted water and solids. Some of the strains of Persnickety® 713 also helps in increasing the DO level in wastewater.
9	Anoxic Bioremediation in Kushak Drain, New Delhi, Operational period: 2009-2010	**City (Water body/lake)** JM Enviro technologies Pvt. Ltd , New Delhi Municipal Corporation (NDMC)	In the beginning, whole of the drain was inoculated with Persnickety@713. One dosing station was established at the starting point of the drain and bacteria medium was dosed at high concentrations initially. Half of the dosing solution was introduced at the dosing station and remaining half was used to inoculate the bacterial product throughout the drain. Once the bacterial strain entered the regeneration phase dosing quantity was reduced and maintained till the end of the project.	

	5	6	7	8	9
	Tank size or Area	Tentative cost in Rs.	O & M cost	Salient features	Safe reuse or Disposal of human wastes/ water
	2m x 2m x 2m dimension for primary treatment, The ABR has a dimension of 10m x 2m x 1.5 m and consists of a series of chambers. tertiary treatment the bed size is 22m x 2m x 0.6m and filled with different sized filter materials.	Rs. 2,25,000, Designed Capacity: 8 KLD	Rs.25,000-30,000 per year (approx.)	About 8KL of wastewater is treated and reused. The entire water requirement for horticulture and gardening is met by the treated wastewater. The result showed that the efficiency of the system is 82% in terms of BOD removal.	This treated wastewater is pumped out through 1HP automatic pump to meet the horticulture requirements of the building.
	Area : 2690 sq. m	1.12 crore Designed Capacity: 320KLD	2.5-3 lakhs per year	BOD reduction: 98% COD reduction: 96% TDS reduction: 96%	Water reused in horticulture and maintaining the lush green area of 15 acres within the hospital premises.
	Not given	50KLD Rs 10-11 lakhs, Designed Capacity: 50 KLD	Rs 70,000-80,000 per year	BOD reduction: 61% COD reduction: 94% TDS reduction: 94%	The treated wastewater is reused for horticulture and irrigation.
	Area : 300 sq. m	Rs 14-15 lakhs, Designed Capacity: 30KLD	Rs 1-1.5 lakhs/year	BOD reduction: 91% COD reduction: 81% TDS reduction: 98%	The treated wastewater is reused for horticulture purpose in order to develop the green belt in the region. The excess of treated wastewater goes to the storm water drain which passes through the city and meets Hamirsar Lake.
	Area : 57 sq. m	Rs 4 lakhs, Designed Capacity: 7 KLD	Rs 60000-80000 per year	NA	Reused for horticulture purpose. The biogas collected is used to provide energy to gas stoves and lamps present in the Ecosan exhibition hall.
	Area : 110 sq. m	Rs 5.5 lakhs, Designed Capacity: 9KLD	Rs.5000-8000 per year	BOD reduction: 92% COD reduction: 91% TDS reduction: 94%	Treated wastewater is used for horticulture requirement. Biogas generated is used for cooking for 3-5 hrs daily.
	Area : 542 sq. m	Cost is not given, Designed Capacity: 36 KLD for 600 users		BOD reduction: 96% COD reduction: 96%	Achieve improved sanitation situation in the community. The treated wastewater is reused for landscaping and safe disposal of wastewater helps in reduction of Environmental pollution.
	Area: 15 acres	Capital cost: Rs. 5,72,500, Designed Capacity: 128ML	Rs. 2.8 lakhs/ acre / year	BOD reduction: 70 % pH also reduced from 9 to 8	Reused in lake. It is simple discharge.
	Length of the drain: 2.8 km in length	Rs. 60,000, Designed Capacity: 3 MLD	Rs. 1.9 lakhs / MLD / year	Increase in DO: 72% approximately BOD reduction: 77% approximately TSS reduction: 80% approximately	Reused in lake. It is simple discharge.

Source: http://www.cseindia.org/node/3769
http://www.cseindia.org/userfiles/list_technologies_jan10.pdf
http://cseindia.org/content/constructed-wetlands-%E2%80%93-wastewater-treatment-systems

Planted gravel fillter, Gurugram, Haryana

Chapter 3

Financial Support for Decentralised Sanitation

In India, States are responsible for sanitation. However, the national government plays a key role in providing direction, guidance and funding through many policies and programs. The policies and programs that enable urban sanitation are promoted by a wide range of Ministries including the Ministry of Urban Development (MoUD), Ministry of Housing and Urban Poverty Alleviation (MoHUPA), Ministry of Environment and Forests (MoEF), Ministry of Health (MoH), Ministry of Human Resource Development (MHRD) etc. This chapter gives an overview of such policies and programs and the type of financial support that can be obtained for decentralised sanitation.

3.1 Financial support from programs and schemes

Various sources of funds available from Government programs and the private sector can be grouped into a number of categories. Table 3.1 illustrates the funding sources available from the central government and private sector. This is followed by an in-depth description of each.

I. Mainstream urban programs

Atal Mission For Rejuvenation And Urban Transformation (AMRUT)

Launched in 2015, AMRUT is a flagship urban program of the GoI administered by MoUD which aims to improve the infrastructure of 500 cities under sectors such as water supply, sewerage and septage management, storm water drainage, urban transport, parks and open spaces. AMRUT is being implemented in partnership with State Government and ULB. The total outlay for AMRUT is Rupees 50,000 crore for five years from Financial Year 2015-16 to Financial Year 2019-20. Key components with respect to sewerage and septage management that can be funded through this program are:

TABLE 3.1 - FINANCIAL SUPPORT FROM GOVERNMENT PROGRAMS AND PRIVATE SECTOR

Main Urban Programs	Dedicated Sanitation Programs	Programs of other Ministries	Finance Commission	Private Finance
AMRUT	Swachh Bharat Mission	Namami Gange	14th Finance Commission	CSR funds
HRIDAY				Loans from commercial banks
Smart City Mission				MFI
Housing For All				Crowd sourcing

TABLE 3.2 - OPPORTUNITIES FOR FUNDING IN DECENTRALISED SANITATION IN GOVERNMENT PROGRAM

Program	Opportunity for funding in decentralised sanitation embedded in different program guidelines
AMRUT	Funds can be sought for creating "decentralised sewerage systems, ...recycling and reuse of wastewater"
HRIDAY	One of the key components that the program can fund includes " Provision of basic services....and its linkage with city infrastructure/trunks for water and wastewater management and treatment"
Smart Cities Mission	Sanitation (particularly wastewater recycling and storm water reuse) is one of the core infrastructure elements included in the program
PMAY – Housing for All	Program guideline mentions that ".....if these houses are located in the peri-urban/newly developed/ compact areas where trunk sewer is not available, then these toilets can be connected to on-site / decentralised sanitation systems"
Swachh Bharat Mission (SBM)	Program guidelines mention that "...In the event that a sewerage system is not available within 30 meters from the proposed household toilet, in addition to the construction of the toilet superstructure, an on-site treatment system ....should also be constructed for the collection, treatment and/or disposal off sewage at, or near the point of generation."
Namami Gange	Program guidelines refer to "...in situ sewage treatment in open drains"
Fourteenth Finance Commission (FFC)	The FFC recommends basic grants to ULBs "....with the purpose of providing unconditional support for the delivery of basic services that includes water supply, sanitation including septage management, sewage and solid waste management..... among other services assigned to them under relevant legislature".

Sewerage

i. Decentralised and networked underground sewerage systems, including expansion of existing sewerage systems and sewage treatment plants (STPs).
ii. Rehabilitation of old sewerage system and treatment plants.
iii. Recycling of water for beneficial purposes and reuse of wastewater.

Septage

i. Fecal Sludge Management (FSM) - cleaning, transportation and treatment in a cost-effective manner.
ii. Mechanical and biological cleaning of sewers and septic tanks and complete recovery of operational cost[9]

This program emphasizes on improving the complete sanitation chain. In order to be eligible for funding, cities are mandated to submit yearly Service Level Improvement Plans (SLIPS) as per guidelines. SLIPs of eligible cities are further aggregated into State Annual Action Plan (SAAP) for the entire mission period.

In the AMRUT program, central assistance will be 50 percent of project cost for cities and towns with a population of up to a million. For cities with a population of above one million, central assistance will be one-third of the project cost. The central assistance will be released in three installments in the ratio of 20:40:40 based on accomplishment. AMRUT seeks to lay a groundwork to enable cities and towns to, in due course, grow into smart cities.

Heritage City Development and Augmentation Yojana (HRIDAY)

Launched in January, 2015, this program focuses on

holistic development of heritage cities. The scheme aims to preserve and regenerate twelve heritage cities to reflect the city's unique character. The program encourages advancing aesthetically appealing, accessible, informative and secure environment. Administered by MoUD, it supports development of core heritage infrastructure projects including revitalization of urban infrastructure for areas around heritage assets identified / approved by the Ministry of Culture, Government of India and State Governments. In addition to improving water supply, drainage and waste management, it also includes development of approach roads, footpaths, street lights, tourist conveniences, electricity wiring, landscaping and citizen services. The total outlay for the scheme is INR 500 Crore up to the financial year 2018.

Key components of the program under sanitation are[10]:

I. Provision of basic services such as for improved sanitation as toilets, drinking water facilities, parking, solid waste management etc.
II. Linkage with city infrastructure/trunks for water and wastewater management and treatment

Smart Cities Mission

Launched in June 2015, the Smart Cities Mission is a new initiative by the Government of India to drive economic growth and improve the quality of life of people. It strives to enable this through local development and harnessing technology for citizens.[11] The objective is to promote and develop 100 smart cities that provide core infrastructure, clean and sustainable environment and a decent quality of life to its citizens, through application of 'Smart' Solutions. The focus is on sustainable and inclusive development and the program aspires to consider compact areas, create a replicable model which will act like a good example to other cities. Sanitation (particularly wastewater recycling and storm water reuse) is one of the core infrastructure elements included in the program.

Cities are competing with each other for selection under the Smart Cities Mission. In order to score 10 points in the challenge, a city should have percentage of increase in figures related to sanitation over Census 2011 or Swachh Bharat baseline on number of household sanitary latrines, whichever is less (Form 2, Part -1).[12] Rs 48,000 crore has been allocated to this mission. The duration of the mission is five years (FY2015-16 to FY2019- 20). Each city would get Rs 100 crore every year from the Centre for five years. The residual money has to come from the states, urban bodies and the consortium that are formed with corporate entities. In addition, 10 percent of budget allocation will be given to States/Union Territories as incentive based on accomplishment of reforms during the mission period.

Pradhan Mantri Awas Yojana – Housing for All

The PMAY - Housing for All (Urban) program will provide central assistance to implementing agencies through States and UTs for providing houses to all eligible families/ beneficiaries by 2022. It covers all statutory towns. All houses built or expanded under the Mission should essentially have toilet facility.[13]

Credit linked subsidy would be available for housing loans sought for new construction and addition of rooms, kitchen, toilet etc. to existing dwelling unit as incremental housing. The other condition mentions that the carpet area of houses constructed as part of this mission, should be up to 30 square meters for EWS and 60 square meters for LIG. According to the guidelines, the beneficiary, at his or her discretion, can build a house of larger area but interest subvention would be limited to first Rupees 6 lakh only.[14]

The program focuses on provision of toilet at every household level which can be connected to trunk sewer line if present in the city. However, if these houses are located in the peri-urban or newly developed areas where trunk sewer is not available, such toilets can be connected to on-site or decentralised sanitation systems.

II. Dedicated sanitation Programs

Swachh Bharat Mission (SBM)

SBM is a national level program of the GoI administered by MoUD. SBM (urban) is a dedicated program for sanitation for all statutory towns (4,041). This program emphasizes on provision of toilet to each individual in the form of individual/household toilet including conversion of insanitary latrines into pour-flush latrines; community toilet and public toilet.

SBM (Urban) aims to ensure that [15]

a) No households engage in the practice of open defecation
b) No new insanitary toilets are constructed during the mission period
c) Unlined pit latrines are converted to sanitary latrines.

Toilets constructed under SBM (Urban) will have two main components; toilet superstructure and substructure (either an on-site treatment system, or a connection to existing underground sewerage system).

According to the program guidelines, in situations where a sewerage network is available within 30 meters from the proposed household toilet, the toilet should be connected to the existing sewerage system. In such cases, only the toilet superstructure may be constructed. ULBs must facilitate toilet connections, wherever applicable. In cases where sewerage system is not available within 30 meters from the proposed household toilet, an on-site treatment system (such as twin pits, septic tanks, bio-digesters, or bio-tanks) should be constructed. Such a system should be able to support collection, treatment and disposal of wastewater at or near its point of generation.

The program guidelines further mentions that ULBs should ensure that all household toilets being constructed under SBM are built in conjunction with water supply arrangements. It specifies that the Central government incentive for the construction of household toilets will be Rupees 4,000 per household toilet. This is applicable for each identified beneficiary household. It will be disbursed in two instalments of Rupees 2000 each per household. The remaining cost must be borne by the beneficiary.

Toilet constructed under SBM at Gudur, Andhra Pradesh

III. Programs of other Ministries

Namami Gange

Namami Gange is a national level program towards the approach for Rejuvenation of the Ganga river by consolidating the existing ongoing efforts and planning for a concrete action plan for future. Recognizing the multi-sectoral, multi-dimensional and multi-stakeholder nature of the Ganga Rejuvenation challenge, the key Ministries comprising (a) Ministry of Water Resources, River Development and Ganga Rejuvenation (WR, RD&GR) (b) Environment, Forests & Climate Change, (c) Shipping (d) Tourism (e) Urban Development, (f) Drinking Water and Sanitation and Rural Development have been working together since June, 2014 to arrive at an action plan.

On a medium term basis, certain interventions, both infrastructure and non-infrastructure need to be introduced to set the tone for implementation of long term vision. Following are proposed to be taken up under Namami Gange for ensuring sanitation at municipal level among others :[16]

Nirmal Dhara- ensuring sustainable municipal sewage management :

i. Project prioritization in coordination with Ministry of Urban Development.
ii. Incentive for states to take up projects on Ganga Main-stem by providing an additional share of central grants for sewerage infrastructure.
iii. Uniform standards for both MoUD scheme and Namami Gange program; 10 years mandatory O&M by the same service provider at par with National Ganga River Basin Authority (NGRBA)program and mandatory reuse of treated water
iv. Expanding coverage of sewerage infrastructure in 118 urban habitations on banks of Ganga, for which the estimated cost by MoUD is Rupees.51,000 Crores

In addition to the activities mentioned above, short term interventions had also been identified by Group of Secretaries under guidance of Hon'ble Ministers. Activities applicable in cities under Namami Gange are as follows:

i. Scheme for rehabilitation and up-gradation of existing STPs along Ganga
ii. Ensuring 100 percent sewerage infrastructure in identified town alongside Ganga
iii. In situ sewage treatment in open drains
iv. Support for preparation of DPRs
v. Capacity building of urban local bodies

IV. The Fourteenth Finance Commission (FFC)[17]

The 14th Finance Commission assures transfer of funds to Urban Local Bodies (ULBs) for planning and delivery of basic services smoothly and effectively within the functions assigned to them under relevant legislations. It further advises that all expenditure incurred by ULBs on basic services within the functions devolved to them under the State laws may be incurred after proper plans are prepared by the ULBs. The total size of the grant for ULBs is Rupees 87,143.80 Crore for the award period of 2015-20. It recommends a grant-in-aid in two parts (i) Basic Grant and (ii) Performance Grant. In case of ULBs, the division between Basic and Performance Grant is on 80:20 basis.

The FFC recommends basic grants to ULBs with the purpose of providing unconditional support for the delivery of basic services that includes water supply, sanitation including septage management, sewage and solid waste management, storm water drainage among other services assigned to them under relevant legislature. The FFC has not distinguished between capital cost and operation and maintenance expenditure within the components of basic services. However, it is advised that the cost of technical and administrative support towards capital cost and operation and maintenance expenditure should not exceed 10 percent of the allocation to the ULBs under any circumstances. The FFC has recommended a Basic Grant of Rupees 69,715.03 Crore for Municipalities for 2015 - 2020. State-wise and year-wise distribution of Basic grant can be accessed at http://finmin.nic.in/TFC/guideline-

localbodygrant.pdf. The Basic Grant for ULBs is divided into tier-wise shares and distributed across each tier - the Municipal Corporation (tier I), Municipalities (tier II), and Nagar Panchayats (tier III), using a formula prescribed by the SFC. In case the SFC formula is not available for ULBs, the share of each of the tiers will be determined on the basis of population of 2011. This will include a weight of 90 percent for population and a weight of 10 percent for area. Further, it will be distributed among the ULBs for each tier in proportion to the population of 2011 and area in the ratio 90:10.

The Performance Grant for ULBs amounts to Rupees 17,428.76 Crore for the period 2015-2020. The FFC has recommended that the detailed procedure and operational criteria, including the quantum of incentives to be given for disbursal of performance grant will be decided by the State Governments subject to the following eligibility conditions for ULBs:

(i) the ULB will have to submit audited accounts that relate to year not earlier than two years preceding the year in which the ULB seeks to claim the performance grant
(ii) The ULB will have to show an increase in its own revenues over the preceding year as reflected in the audited accounts. The improvement in revenues will be determined on the basis of such audited accounts. For computing the increase in own revenues in a particular year, the proceeds from octroi and entry tax must be excluded.
(iii) The ULB must measure and publish the service level benchmarks relating to urban basic services each year for the period of the award and make it publicly available.

TABLE 3.3 - POTENTIAL SOURCES OF PRIVATE FINANCE FOR URBAN SANITATION

Source/Financing Mechanisms	Reach to target urban household without on premise toilets	Current/potential interest in urban sanitation	Favourability of loan/ collateral terms
Microfinance (MFIs/SHGs)	Both MFIs and SHGs cater to this clientele and will have high reach.	Interest in sanitation has emerged in recent years. However, efforts will be needed to focus on urban areas.	Favourable collateral terms but high interest on loans.
Housing Finance Institutions (HFIs)	Only a few HFIs have focused on the low-market segments that do not have toilets.	Specific sanitation products are not currently offered. These can be introduced as a part of housing improvement products. Good potential in meeting urban sanitation finance demand.	Lower cost of loans but stringent requirements for collateral and formal sector employment of loan applicant.
Commercial Banks	Potential reach of banks is high especially with the new financial inclusion policies.	No focus on sanitation so far. Can be enhanced, if sanitation is explicitly included in priority sector lending.	Collateral requirement can be stringent.
Corporate sector and local benefactors	Potential reach to low-market segments is high but limited experience in urban areas.	Interest in sanitation exists as sanitation is included in CSR requirements. However, efforts will be needed to focus on urban areas.	Available as grants.
Social impact investors (through instruments such as social impact bonds/mutual funds)	Potential reach is high but there is a dearth of agencies engaged in these activities. A new compact with urban local governments will be needed.	Potential interest in sanitation may be high given evidence of health and environment impact as well as for dignity and security of women.	Potentially favourable terms for debt, but stringent requirements for capability of agencies receiving funding and outcome verification.
Crowd funding	Low reach at present, but high potential reach.	A few Indian portals exist (example, Milaap BitGiving). However efforts needed to focus on urban sanitation and building capacity to access global platforms.	Most funds are likely to be grants/ donations or loans. For any equity, Securities and Exchange Board of India (SEBI) rules are under discussion and will apply.

Source: http://www.ideasforindia.in/article.aspx?article_id=370, Financing sanitation by Dinesh and Meera Mehta, 2014.

V. Some ideas for private financing[18]

Transforming urban India open defecation-free by 2019 entails reaching out to a projected 22 million households that will not have toilets in their homes. This could potentially require an investment of over Rupees 65,000 crore (US$ 11 bn approx.) – an average of about Rupees 30,000 (US$ 500 approx.) per toilet. One of the main reasons why households do not have toilets are inability to meet the cost of a new toilet and lack of space for it. It must be noted that nearly two-thirds (10 million) of these households do not reside in slums (based on data from the Census of India 2011). Provision of toilets for such households can be financed through a demand-led program. A small incentive grant may be provided by the government and all decisions about toilet design, construction and financing can be left to the household. Considering that SBM (U) has an incentive subsidy of about Rupees 5,000 per toilet (about 20 percent of toilet cost) in urban areas, this can be availed to raise additional market-based resources by facilitating innovative finance.[18]

Corporate social responsibility (CSR): According to the new Companies Act 2013* of India, it is mandatory for large corporate to devote at least 2 percent of their profits for CSR. This may seem like a small estimated annual share of around INR or Rupees 12,000 to 15,000 crore (US$ 1.6 billion to 2.8 billion). However, it can provide a significant amount of funds for financing household sanitation. E.g. "*Namma toilets*" installed in Delhi are designed by NBCC as part of their CSR initiative.

Crowd-funding: This is a relatively new financing mechanism. It mobilises funds from a large number of people through internet platforms for targeted initiatives. It is estimated that in 2013, about US$ 5.1 billion will be mobilised through crowd-funding globally (OECD 2014).[18] Some examples include Global platforms such as Indiegogo,

Decentralised wastewater system constructed on a drain at Kachhpura, Agra, Uttar Pradesh., through funding support from a bilateral agency

*With effect from April 1, 2014, every company, private limited or public limited, which either has a net worth of Rs 500 crore or a turnover of Rs 1,000 crore or net profit of Rs 5 crore, needs to spend at least 2% of its average net profit for the immediately preceding three financial years on corporate social responsibility activities.

Spacehive, Akvo, Kiva. There are some Indian platforms as well - for example, Milaap and BitGiving have been mobilising loans and donations for local projects and activities such as education, water and sanitation. These funds can not only bring in greater transparency and effectiveness, in addition they can be linked effectively to local initiatives for sanitation.

Microfinance for sanitation: The micro finance industry has grown significantly in India with an estimated total portfolio of nearly Rupees 40,000 crore (US$ 6.5 bn approx.)[19]. A number of micro-finance institutions (MFIs) with significant portfolios have focused on sanitation. Whenever there is a possibility of creating a sustainable and predictable line of credit, it is possible to create increased access to credit for sanitation through micro-finance. Many MFIs have created dedicated loans for water and sanitation. Such organisations often work closely with local government and nongovernmental organisation (NGO) programs to improve awareness and encourage demand for water and sanitation.

Housing Finance Institutions (HFIs): Since the last few years, many HFIs have developed special schemes that target lower income groups. HFIs have a significant reach, (more than 70 registered)[20] with the National Housing Bank (NHB). Hence, there could be considerable scope for introducing sanitation loans. However, HFIs have overwhelming mortgage requirements. They will also require special lending terms for small toilet loans.

Commercial Banks: One of the largest source of funding for sanitation can come from commercial banks. They can provide loans to households and SHGs. Sanitation loans should be included explicitly under priority sector lending, if they have to expand their spread. As per the Government of India's new financial inclusion scheme, Pradhan Mantri Jan Dhan Yojana, every family is entitled to have a bank account. This can make it easier to reach the right groups for sanitation loans.

As mentioned in the above sections, all the programs - Atal Mission For Rejuvenation And Urban Transformation (AMRUT), Smart Cities Mission, Swacch Bharat Mission (SBM), Housing for All, contain elements that advocate enhanced basic services in urban areas. Hence it is very important for States and cities to look at convergence of funds and activities. The FFC grants are unconditional – so it is the responsibility of the State governments and ULBs to make best use of it. Very importantly, even towns / cities that are not part of program can enhance basic services through FFC grants.

Table 3.4 provides a brief overview of the cost of Decentralised Wastewater Treatment Module projects implemented in different parts of the country. It also adds the sources of funding of the each of the initiatives, along-with contact details of persons who implemented them.

TABLE 3.4 - OVERVIEW OF COST OF DECENTRALISED WASTEWATER TREATMENT MODULES IN INDIA

S. No	Location	Technology	Capacity of Treatment Plant	Cost of Installation	O& M Cost	Contact Details
Community based						
1	Bankers Colony, Bhuj, Gujarat	Two chamber settler, nine chambered Anaerobic Baffled Reactor (anaerobic filter in the last two chambers), planted gravel filter, polishing pond	30 KLD	Rs. 14-15 lakhs	Rs. 1-1.5 lakhs/ year	Tejas Kotak Unit Head , Earth & Wastewater Solutions Hunnarshala Foundation Bhuj, Gujarat tejas.hunnarshala@gmail. com http://cseindia.org/node/3771
2	Kachpura slum near Mehtab Bagh, Agra	Screen Chamber, three chambered septic tank, nine chambered Anaerobic Baffled Reactor, planted gravel filter	50 KLD	Rs. 10-11 lakhs	Rs. 0.7-0.8 lakhs/year	Dr. Renu Khosla Director, Social Development Centre for Urban and Regional Excellence A-10, Green Park (Main Aurobindo Marg), New Delhi renukhosla@cureindia.org http://cseindia.org/node/3770
3	Bhil Basti, Delwara, Udaipur	Three-chambered septic tank, eight-chambered anaerobic baffled reactor, planted filter bed	21 KLD	Rs. 22.5 lakh	Not Available	Jagdish Bodiwal Assistant Secretary Seva Mandir, Old Fatehpura, Udaipur Rajasthan info@sevamandir.org, jagdish.bodiwal@sevamandir.org http://1.23.211.114/DBNSN/CDDProjectList.aspx
Institutional						
4	Aravind Eye Hospital, Pondicherry	Two chambered settler, anaerobic baffled reactors, planted gravel filter, polishing pond	320 KLD	Rs. 1.12 Cr	Rs. 2.5-3 lakhs/ year	Consortium of DEWATS Dissemination (CDD) Society, 621, 5th Main Road, OMBR Layout Banaswadi Post, Bangalore bangalore@cddindia.org dbns.tech@cddindia.org http://cseindia.org/node/3769
5	Kualgaon-Badlapur, District Thane, Maharashtra	Biogas settler, 6 chambered anaerobic baffled reactor, four chambers anaerobic up flow filters, horizontal planted filter, polishing pond	7 KLD	Rs. 4 lakhs	Rs. 0.6-0.8 lakhs/ year	MMR-Environment Improvement Society 7th Floor, MMRDA Building, Bandra Kurla Complex, Bandra (East), Mumbai http://cseindia.org/node/3772
6	Indian Agricultural Research Institute (IARI), Pusa, New Delhi	2-sewage wells and 1-grit chamber,3-treatment cells, treated water-collection tank	2.2 MLD	Rs. 1.2 Cr	Rs. 1335/ year	Dr. Ravinder Kaur, Project Director Water Technology Centre IARI, Pusa, New Delhi pd_wtc@iari.res.in, rk132.iari@gmail.com http://cseindia.org/content/constructed-wetland-wastewater-treatment-indian-agriculture-research-institute-pusa-new-delh
7	Constructed wetland to treat Wastewater at Indian Institute of Technology, Powai, Mumbai	Primary settling tank, planted filter bed with horizontal sub-surface flow (HSSF) system	25 KLD	Rs. 10 lakhs	Rs. 1.2 lakhs/ year	Dr. Shyam R. Asolekar, Professor Centre for Environmental Science and Engineering (CESE), Indian Institute of Technology Powai, Mumbai asolekar@iitb.ac.in http://cseindia.org/node//6209
Individual						
8	Friends of Camphill, Banerghatta Road, Bangalore	Biogas settler , 16 chambered baffled reactors, planted gravel filter, polishing pond	9 KLD	Rs. 5.5 lakhs	Rs. 5000-8000/ year	Consortium of DEWATS Dissemination (CDD) Society, 621, 5th Main Road, OMBR Layout Banaswadi Post, Bangalore bangalore@cddindia.org dbns.tech@cddindia.org http://cseindia.org/node/3773
9	Centre for Science and Environment New Delhi	Two chambered settler, anaerobic baffled reactor, horizontal planted filter, treated water-collection tank	8 KLD	Rs. 2.25 lakhs	Rs. 0.25-0.30 lakhs/ year	Dr. Suresh Kumar Rohilla Programme Director srohilla@cseindia.org http://cseindia.org/node/4603
10	Convention Center at Pondicherry	Settler, Anaerobic Baffled Reactor, Planted Gravel Filter, Collection Tank	82 KLD	Rs. 30 lakhs	Rs. 0.02 lakhs/ year	Consortium of DEWATS Dissemination (CDD)Society 621, 5th Main Road, OMBR Layout Banaswadi Post, Bangalore 560 043. bangalore@cddindia.org dbns.tech@cddindia.org http://1.23.211.114/DBNSN/CDDProjectList.aspx
11	Kuttiyandiyur Colony at Nagapattinam Tamil Nadu	Settler, Anaerobic Baffled Reactor, Anaerobic Filter , Planted Gravel Filter, Collection Tank	50 KLD	Rs. 91 lakhs	Rs. 0.08 lakhs/ year	Consortium of DEWATS Dissemination (CDD) Society, 621, 5th Main Road, OMBR Layout Banaswadi Post, Bangalore bangalore@cddindia.org dbns.tech@cddindia.org http://1.23.211.114/DBNSN/CDDProjectList.aspx

Toilet with pit latrine constructed very close to a handpump, Hajipur, Bihar

Chapter 4

Capacity and Skills required for Implementation of a Decentralised Wastewater Treatment Module

The planning and design of a decentralised wastewater modules require basic technical capacities. When operated and maintained efficiently, they have the potential to be sustainable economically, environmentally and socially for 20 years and more. The day to day operational tasks are simple and require basic training. However, they are critical in ensuring that the system continues to perform well. The important steps to check in day to day operations are, for example, checks for free-flow wastewater, grease formation, water seal level in the biogas settler, gas leakages, release of condensed water in the biogas supply pipe, cleaning the biogas stove burner, swivel pipe level in the planted gravel filter, weeding, removal of dead leaf, litter etc.[20] However, when this system has be implemented at the city level, it requires a package of skills that has been detailed out in Table 4.1

Mason shows a newly constructed septic tank, Proddatur, Andhra Pradesh

TABLE 4.1 - SKILLS FOR IMPLEMENTATION OF DECENTRALISED WASTEWATER TREATMENT MODULES

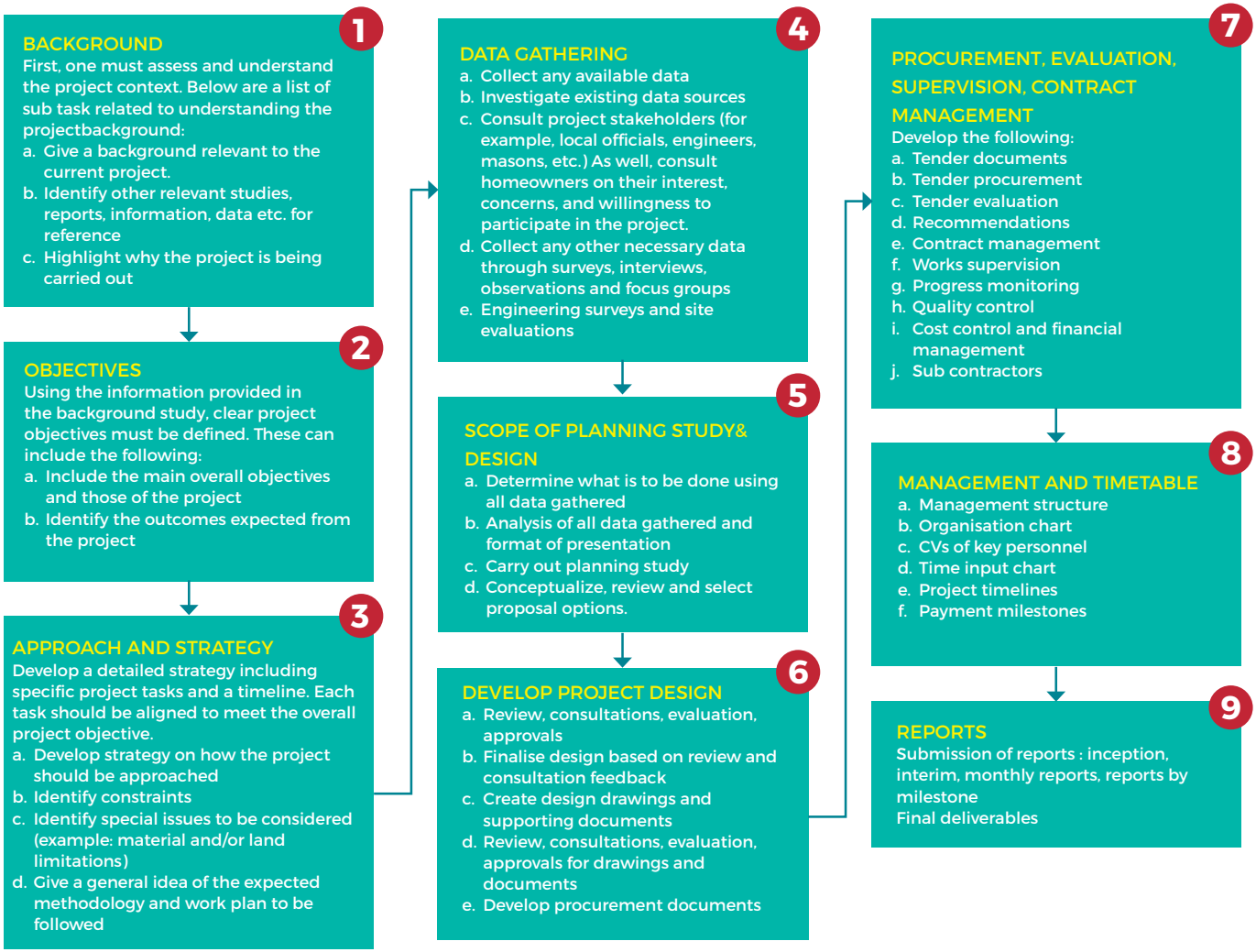
Category	Tasks	Required position	Knowledge/ Qualification	Job Description
Management and Development	Policy Development	Legal expert	Understanding decentralised sanitation, Familiar with Water and Sanitation Laws, Knowledge of Local/ Country Laws and regulations	Review existing water related laws and regulation, Expert advice on developing or Amending Laws and regulation with respect to Decentralised Wastewater Treatment Module
	Financial Management	Financial specialist	Preparation of financial plan, Understanding of relevant municipal legislation, policy and procedures, Understanding of local culture and political environment, Computerized accounting programs, Analytical and problem solving skills, Strong IT skills	Manage or develop fund allocation mechanism, Implement financial policies and procedures, Assist in Planning and management of funding for Decentralised Wastewater Treatment Module, Establish and maintain cash controls, Monitor cash reserves and investments, Monitor cash reserves and investments
	Technical, (manual or guideline) development and Technical Support	Technical Support (Engineer) (Civil/ wastewater)	Strong technical knowledge in wastewater/ Septage treatment, Knowledge of Local needs, Communication and management, Excellent writing and analytical skills, Language Proficiency and Computer skills	Reviewing the technical requirements of Decentralised Wastewater Treatment Module, Developing technical guidelines and manuals related to services, or processes , Advising or Training the local implementers or field engineers, Translating the technical documents if required
Planning	Planning		Knowledge of Decentralised Wastewater Treatment Module, Demonstrated writing/drafting skills, Project Planning, Familiar with local conditions, and government procedure, Familiar with Laws and regulations (regarding to DEWAT) local context, Field experience	Assess and organise logistics in terms of National project requirement, Working closely with the experts in different aspects of the project to plan the follow-up actions, Establish a detailed program plan, Liaises and keep close contact with Donors (if other source), and implementation partners, Report regularly on updated project conditions, Coordinate field-level activities of Decentralsed Wastewater Treatment Module program
Procurement, communication		Procurement office, Public-Private Partnership (PPP) Expert	Countries Policy, Regulatory and legal structure, DEWAT knowledge, English and other local language skills,	Provide an overview of PPP in the wastewater sector in the region, highlighting institutional, policy and operational constraints to PPP project development, Undertake policy dialogues and consultations with high-level representatives and the private sector regarding relevant issues on PPP development, Develop innovative service delivery mechanisms such as performance based management contract and PPP for O&M of public toilets, septage management and decentralised treatment; Work closely with the Team Leader as well as the executing and implementing agencies and other relevant stakeholders
Implementation Construction	Engineering, Construction, Capacity Building	Capacity Building, Capacity Development Officer	Construction sanitary infrastructure, Supervision and communication,	Close supervision and inspection of the project construction activities to ensure quality of work as provided in specifications, Conduct regular surveys of the construction work and work progress, Daily record keeping.
Services operation & maintenance		Collection worker	Work safety procedure, Sludge collection, Knowledge of handling of sludge collection equipment	Perform collection procedure as per schedule.

Source: Based on information obtained through consultations with CDD Society, 2016

If the skills mentioned in the preceding section are not available in the Urban Local Body, persons have to be procured as consultants. Major Steps in procuring the consultants are as follows:

Step	Activity	Responsibility
1	Preparation of Terms of Reference	Project Manager
2	Cost Estimate	Project Manager or Engineer
3	Advertisement	Project Manager
4	Short listing of Consultant	Evaluation committee
5	Request for Proposals	Project Manager
6	Receipt of Proposals	Project Manager
7	Evaluation of technical Proposals	Evaluation committee
8	Evaluation of Financial Proposals	Evaluation committee
9	Final Evaluation of Technical and Financial Proposals	Evaluation committee
10	Negotiation and Award of Contract	Evaluation committee and Project Manager

TYPICAL OUTLINE OF TERMS OF REFERENCE FOR PLANNING / DESIGN CONSULTANT



Stakeholder engagement with a slum community, Kachhpura, Agra, Uttar Pradesh

Chapter 5

Stakeholder Engagement

Stakeholder engagement is key for the successful implementation of projects on decentralised sanitation. It is the process to include stakeholders in planning and implementation and take into account their needs, priorities and interest to achieve consensus. Engagement allows all parties to understand the potential impacts of a proposed activity on the community. The first step in this process involves identification of key players, discussion on their key roles and responsibilities, organising them and finding ways for their proactive participation.

Any project on decentralised sanitation must coordinate and streamline a multitude of stakeholders. The active participation of different parties should cover the entire development process, beginning from the phases of preparation, planning, implementation, monitoring, and final evaluation. Participation improves the sustainability and performance of the project. Ownership ensures stakeholder commitment and participation, thereby reducing supervision costs.

TABLE 5.1 - PARTICIPATION LEVELS OF STAKEHOLDERS AT VARIOUS STAGES OF A DECENTERALIZESD SANITATION INITIATIVE

		Participation levels			
		Information	Consultation	Collaboration	Empowerment / delegation
Planning	Launch of the planning process	All stakeholders		Municipality, Utility	
	Detailed assessment of current situation		Key stakeholders	Municipality, Utility	
	Identification of service options		Key stakeholders	Municipality, Utility	
	Development of Action Plan	All stakeholders	End-users	Municipality, Utility, operators, NGOs	Empower weak & unorganised groups
Implementation		Households, opinion leaders	End-users	Municipality, Utility, operators, NGOs	Empower and delegate to Municipality, utilities, operators, NGOs
Monitoring and Evaluation		Key stakeholders	Households, operators, end-users	Municipality, Utility, selected NGOs	

Source: Fecal Sludge Management - systems approach for implementation and operation, Edited by Linda Strande, Mariska Ronteltap and Damir Brdjanovic, 2014

Organised involvement of different stakeholder groups is key to efficient, cost-effective and sustainable projects.

The role of stakeholders is summarized in Table 5.2

Stakeholder participation levels

Four main participation levels can be distinguished to ensure engagement:

(a) **Information** - All the stakeholders need to be properly informed to understand the roles and objectives of decentralised sanitation. First, it is those that are involved in the decision-making process. For others, it is limited to receiving information through awareness raising campaigns and information meetings (like launch workshops) and related field visits. This is one-way flow of communication.

(b) **Consultation -** The objective of this is to obtain the stakeholders feedback on the situation, options, scenarios and decisions. It allows interests, priorities, needs and concerns to be taken into account (e.g. through interviews).This is a two-way communication process.

(c) **Collaboration** - The objective is to work as a partner with the stakeholders on various aspects, including the development of scenarios and identification of the preferred solution. The power of taking decisions is shared between the stakeholders.

(d) **Empowerment / delegation -** The objective is to build the capacity of stakeholders so that they are able to make informed decisions and take the final responsibility for decision-making and assume their roles and responsibilities once the Decentralised Wastewater Treatment Module is implemented.

Each level includes the previous ones; for example, collaboration cannot be done without consultation and there is no consultation without information.

TABLE 5.2 - ROLE OF VARIOUS STAKEHOLDERS IN THE CONSULTATIVE PROCESS

Stakeholder	Reason for consultation
Primary stakeholders Residents and direct users of the initiative	**They will** • use the sanitation facility – the facilities must fit their needs and practices • have to contribute significantly to the system – financially or in kind • may have an important role in the operation and maintenance of the sanitation and wastewater-treatment facilities. Women are often the household decision-makers with regard to domestic sanitation and sanitation practice. Therefore, they must be actively involved in determining problems, identifying underlying causes, recommending possible solutions and, ultimately, making decisions to solve the problems.
Secondary stakeholders Groups with a direct or indirect responsibility in the programme. These include the leading agencies (Urban Local Bodies, public, NGOs, etc.), planning authorities, and health and environmental departments	They are generally responsible for creating a demand for sanitation improvement through health and hygiene awareness programmes. Their role includes: • responding to demand by identifying appropriate sanitation options prioritising these options • integrating these working results into a planning process • allocating funds to achieve the planned objectives • ensuring there are enough appropriately skilled people to carry out the plan • implementing the plan • monitoring and reporting on the results and ensuring sustainability
Tertiary stakeholders Providers of special services for construction, maintenance and sludge management	They are generally responsible for operation and maintenance. They are in charge of: planning, designing and constructing sanitation infrastructure • planning, designing and constructing wastewater treatment infrastructure and manufacturing equipment • ensuring operation and maintenance of the overall scheme • operating desludging and sludge treatment facilities

The Stakeholder participation matrix

The stakeholder participation matrix provides a visual representation of the participation levels of stakeholders. This is based on the example of the situation of a medium sized city. The participation matrix is a dynamic tool and can be according to different situations. Refer Table 5.3 - Stakeholder Participation Matrix

Involvement Tools

Once participation levels for each stakeholder have been defined, the involvement tools can be selected. For each participation level, there can be a number of tools. There are many ways to involve people in the process of implementing decentralised sanitation systems and there is no ready-made formula for which tool to use and when. Decisions have to be context-driven. A few relevant tools are presented.

Individual meetings, informal or semi-structured interviews: Meetings with stakeholders allow information to be collected while at the same time build trust and personal relationships. They also provide an understanding of the needs, priorities and constraints. Meeting people individually may lead to more open discussion by avoiding peer pressure.

Focus Group Discussions: This consists of discussion in small groups, led by a moderator, whereby stakeholders express and discuss their opinions. This can lead to opinion forming in the group and can help in arriving at a decision together.

Workshops: A workshop aims to gather selected stakeholders together in order to push the process forward. It can be an information workshop, such as the initial launching workshop, aiming to communicate the plans, activities and current stage of the process. It can also be a consultative workshop, aiming to collect stakeholders' opinions and concerns, build consensus and formulate solutions. In some cases, workshops or focus group meetings can be held to acknowledge and reinforce the importance of the members in the process and strengthen associations.

Site visits: This is a powerful tool to expose all stakeholders to reality. Authorities, and people working in the office do not fully realize the situation until they can actually see and visualize it. When they understand, they are much more prone to action and change. Transect walks, where process leaders walk through the concerned neighbourhoods with relevant stakeholders, are also a recommended option.

Household surveys: In this tool, a representative sample of the population is questioned on a particular topic by means of a structured questionnaire. It can be conducted online, by post, using computer terminals, by telephone or in-person. If well designed and sampled it can provide statistically valid overview of stakeholder attitudes and opinions. It is useful for gathering baseline or standardized information that can provide good guidance for action. Given that it is 'one-way' communication, it does not directly contribute to building trust or developing consensus.

TABLE 5.3 - STAKEHOLDER PARTICIPATION MATRIX

	Information	Consultation	Collaboration	Empowerment / Delegation
Personal meetings				
Focus groups				
Workshops				
Site visits				
Media Campaigns				
Household surveys				
Advocacy / lobbying				
Mediation				
Logical framework				

Source: Fecal Sludge Management - systems approach for implementation and operation, Edited by Linda Strande, Mariska Ronteltap and Damir Brdjanovic, 2014

Mediation: In conflict situations, mediation through neutral third parties is the attempt to reach mutually agreed-upon solutions. The key issues and areas of conflict are stated and clarified (interests, aversions, and blockages) firstly. There is an attempt to find mutually satisfactory ways to resolve the conflict (evaluate options, and check for fairness).

Logical framework (LF): Logical framework can be used to communicate with the stakeholders by informing them what are the goals, objectives, inputs, outputs and activities of the projects. LF is also known as project framework, and it is a project planning and management tool. Log frame presents important components of a project in clear, concise, logical and systematic ways.

Media campaigns: It is a very effective tool to reach out the general public. Media campaigns aim to inform and make the public understand about the projects or programs, what the benefits that would bring, and also about what are the threats and risks of not having any system at all. They can also be used to promote behaviour change. Media campaigns are carried out by developing posters, creating and/or posting messages and advertisements on radios, TV, internet or cell phones.

Advocacy / Lobbying: This refers to convincing and persuading stakeholders. It ensures that the interests of non-organised and/or socially disadvantaged and less articulate groups within the population are considered in the planning process. The groups receive advice, and their interests are represented in the appropriate committees and bodies, either through representatives or through the voice of the process leaders.

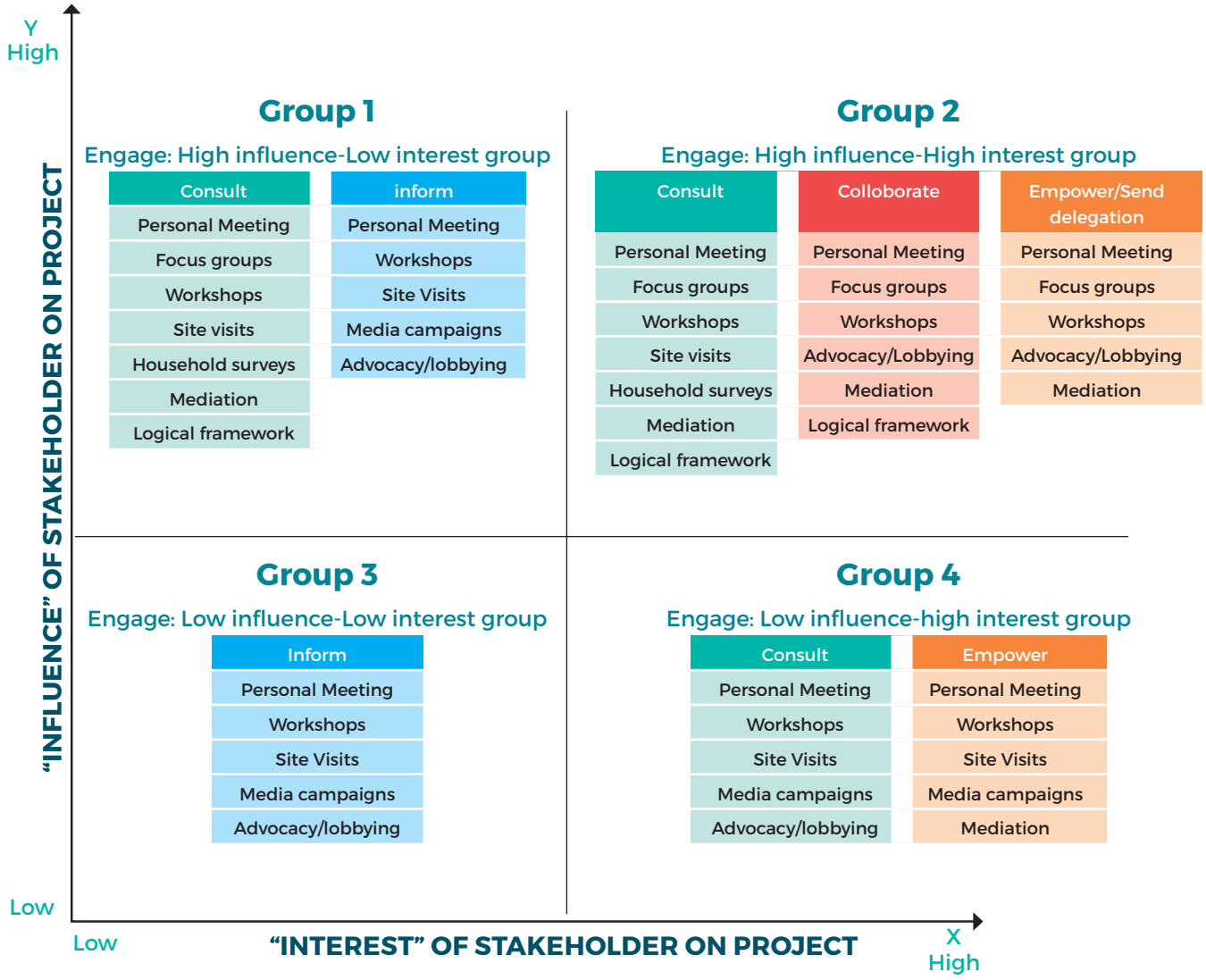
Stakeholder Analysis: Stakeholder analysis is one of the most important processes to the success of every project. It is also an essential tool for sanitation planning and lays the foundation and structure for follow-up activities of the project. This includes participatory planning, implementation, and monitoring. The stakeholder analysis process is mainly used to know who will involve at what level in a project, and understand who has the potential to influence and impact on a project. It is a powerful tool, and its findings help to draw stakeholder management plans – how to manage and communicate the different groups of stakeholders throughout the project for its highest success and less negative impacts. The stages in performing stakeholder analysis are:

1. **Identification of stakeholders** – This is an initial stage that identifies who to be involved in the projects. The methods used include using expert opinion, focus groups, interviews, etc.
2. **Characterization of stakeholders** – This involves collecting data on interest and power level of stakeholders on the project. The collected information can serve as the criteria to select them, and decide the most appropriate way to manage them throughout the project.
3. **Selection of stakeholders and laying out the management plan** – Based on the characteristics of identified stakeholders, the key stakeholders are prioritized. After that, the communication mechanism is determined for different groups of stakeholders.

The Stakeholder Matrix presents the analytical results. The tool can serve as a visual aid for users to determine who the stakeholders are at any stage of the projects or to draw up the stakeholder management plan. In this tool, the engagement options and tools are provided to support the decision making process in drawing up the stakeholder management plan.

The matrix displays four groups of stakeholders that are grouped based on their extent of interest and influence. The 'Y' axis represents the influence of the stakeholders on the project, from low to high. On the 'X' axis, the "interest" of the stakeholders is shown from low to high.

THE STAKEHOLDER MATRIX



Source: Fecal Sludge Management - systems approach for implementation and operation, Edited by Linda Strande, Mariska Ronteltap and Damir Brdjanovic, 2014

Conclusion

The disparities in sanitation in urban India is large, especially in access to toilets and treatment of waste. About 48 percent of urban Indian households depend on on-site facilities (largely septic tanks and pit latrines) for meeting their sanitation needs. With rapid urbanization and growth of cities, the dependence on such facilities is naturally increasing. Often toilets in houses are not connected to a collection and/or treatment system. Only 13% of wastewater generated in the country is actually treated. Therefore, citizens need alternative solutions that treat sewage at the source and lessen the load on transportation of sewerage to STP through machines.

Decentralised Wastewater Treatment Module represents a technical approach. Such applications are designed to be low on maintenance. A number of parts of such a system can work without any technical inputs of energy. A Typical module combines primary, secondary and tertiary treatments. The right combination and dimensions of modules make it successful. Several case studies highlight this aspect.

Various sources of funds are available - from the Government as well as from private sectors. Sources of funding from the National Government includes those from the main urban programs (AMRUT Mission, Smart Cities Mission, HRIDAY, PMAY), dedicated sanitation schemes (Swachh Bharat Mission), programs of other ministries (e.g. Namami Gange), finance commissions (Fourteenth Finance Commission) and private finance (that includes CSR, crowd-funding, micro-finance, housing finance institutions, commercial banks).

The capacity and skills required for implementing Decentralised Wastewater Treatment Module is not very complicated. The day to day operations are simple and require basic training. The Urban Local Body can either do it themselves or it can even be done at the institutional and community level.

Stakeholders engagement is very important for implementing such a module. This should be done in a systematic manner. The participation levels of different stakeholders will vary and so will the methods of engagement with them. It is very crucial to understand the influence and interest interpretation of various stakeholders for engagement to be effective and sustainable.

This handbook gives an overview for a decision-maker on the need for Decentralised Wastewater Treatment Module, its basic technical aspects, main sources of funding, necessary capacity and skills required for implementing and sustaining it stresses on the need for stakeholder engagement. Each of these aspects have detailed manuals, readings and reports. These have to be consulted in greater depth by the respective professionals in the team that will work for such an approach in a city.

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