

ADVANCED TRAINING ON DESIGN OF FAECAL SLUDGE TREATMENT SYSTEMS

ONLINE TRAINING PROGRAMME REPORT



National Institute of Urban Affairs



Sanitation Capacity
Building Platform



ECOSAN
SERVICES
FOUNDATION

ADVANCED TRAINING ON DESIGN OF FAECAL SLUDGE TREATMENT SYSTEMS

ONLINE TRAINING PROGRAMME REPORT

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IIHS, Chennai: Cotreatment of faecal sludge and septage at STP, Trichy

OWSSB and EY, Odisha: FSSM approach in Odisha and technical approach towards Bhubaneswar FSTP.

CWAS-CEPT, Ahmedabad: Wai and Sinnar, Maharashtra.

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CONTENTS

INTRODUCTION	7
AGENDA.....	9
SESSIONS	11
Day 1, June 17th, 2020	12
Session 1a: Introduction to Faecal Sludge and Septage.....	12
Session 1b: Characterisation of Faecal Sludge and Septage.....	12
Exercise: Part A & B - Section 1	12
Day 2, June 18th, 2020	13
Session 2: Quantification of Faecal Sludge and Septage	13
Case Study: Port Blair, Andaman and Nicobar Islands	13
Exercise: Part A & B – Section 2	14
Day 3, June 19th, 2020	14
Session 3: Emptying and Conveyance of Faecal Sludge and Septage.....	15
Case Study: Wai & Sinnar, Maharashtra	15
Reference Material	16
Day 4, June 22nd, 2020	16
Session 4: Treatment of Faecal Sludge and Septage	16
Case Study: Co treatment of FS & Septage at STP, Trichy	17
Exercise: Part A & B – Section 3	17
Day 5, June 23rd 2020	18
Session 5: Septage Receiving Station	18
Informational videos: Septage receiving station & integrated mechanized septage receiving station	18
Day 6, June 24th 2020	19
Session 6: Non-mechanized Treatment Units of Faecal Sludge & Septage & its Design	19
Case Study: Septage Treatment Plant, Bhubaneshwar, Odisha	19
Exercise: Part B – Section 4,5 and 6.....	20

Day 7, June 25th 2020	20
Session 7: Mechanized treatment of faecal sludge & septage	21
Exercise: Part A – Section 4, 5 and 6.....	21
Day 8, June 26th 2020	22
Session 8: Financial aspects of FSSM	22
Exercise: Part A & B – Section 7 & 8.....	23
Case Study: Port Blair, Andaman & Nicobar Islands	23
Day 9, June 29th 2020	24
Session 9: Siting & Layout Planning of Treatment Plant.....	24
Day 10, June 30th 2020	25
Session 10a: Construction, Quality Control & Commissioning of Treatment Plant.....	25
Session 10b: Operation & Maintenance of Treatment Plant	25
Day 11, July 1st 2020	26
Closing Session	26
FEEDBACK	29
Case study feedback	30
Training Feedback	31
Testimonials by the participants	33
LEARNING IMPACT ASSESSMENT	35
LEARNINGS AND WAY FORWARD	36
Agenda and schedule.....	36
Content	36
Exercises	36
Resources	36
Assessment	37
Platform	37
Learning Management System	37
ANNEXURES	39
Annexure 1: List of Resource Persons	40
Annexure 2: List of Participants	41
Annexure 3: Detailed Session wise Agenda	43

List of Figures

Figure 1: Section-1 Exercise from workbook.....	13
Figure 2: Section-2 exercise from workbook.....	14
Figure 3: Snapshots from case-study on Wai & Sinnar	15
Figure 4: List of reference material shared with the participants for further reading.....	16
Figure 5: Treatment chain of Faecal sludge & Septage.....	16
Figure 6: Snapshots from case-study of co-treatment in Trichy	17
Figure 7: Section-3 exercise from workbook.....	17
Figure 8: Snapshot of the session on Septage receiving station.....	18
Figure 9: Informational video on septage receiving station	18
Figure 10: Snapshot of the session on non-mechanized treatment of FSS.....	19
Figure 11: Snapshot from the Bhubaneswar case-study presentation.....	20
Figure 12: Exercise section-4,5 from workbook	20
Figure 13: Snapshot of the session on mechanized treatment of FSS.....	21
Figure 14: Exercise Section 6,7 From Workbook.....	21
Figure 15: Snapshot of session on financial models in FSSM.....	22
Figure 16: Exercise section 7,8 from workbook	23
Figure 17: Snapshot from the case study based on FSSM DPR for Port Blair	23
Figure 18: Q&A session undergoing after the session	24
Figure 19: Good design examples of treatment units are treatment plants.....	24
Figure 20: Agenda For The Closing Session	26
Figure 21: Doubt clearing session by Saurabh Kale & Dhawal Patil	26
Figure 22: Results of the live quiz	27
Figure 23: Live online feedback.....	27
Figure 24: Mr. Manoj Pandey sharing his feedback.....	28
Figure 25: Dr. Dayanand Panse & Mr. Depinder Kapur Sharing Their Vote Of Thanks To Everyone	28
Figure 26: Case Study Feedback.....	30
Figure 27: satisfaction with Overall Training	31
Figure 28: Feedback on Training content & training methods.....	31
Figure 29: Feedback on Online training program management.....	32
Figure 30: Different Challenges Faced by the participants in the Exercises.....	32
Figure 31: Challenges faced by Participants in Online Training Delivery Part.....	32
Figure 32: Further support required from NIUA/SCBP	33
Figure 33: Overview of course completion	35

List of Tables

Table 1: Agenda of the Training of trainers.....	9
Table 2: Testimonials from participants.....	33
Table 3: List of Resource Persons	40
Table 4: List of Participants.....	41

Abbreviations

AMRUT	Atal Mission for Rejuvenation and Urban Transformation
BIS	Bureau of Indian Standards
CEPT	Centre for Environmental Planning & Technology
CSP	City Sanitation Plan
CW	Constructed Wetlands
DPR	Detailed Project Report
DTS	Decentralised Treatment System
ESF	Ecosan Services Foundation
FS	Faecal Sludge
FSSM	Faecal Sludge and Septage Management
FSTP	Faecal Sludge Treatment Plant
Gol	Government of India
GoM	Government of Maharashtra
IHHL	Individual Household Latrine
IIHS	Indian Institute of Human Settlements
NIUA	National Institute of Urban Affairs
O&M	Operation & Maintenance
OWSSB	Odisha Water Supply & Sewerage Board
PBMC	Port Blair Municipal Corporation
PCB	Pollution Control Board
PMC	Pune Municipal Corporation
RAS	Rapid Assessment Survey
SCBP	Sanitation Capacity Building Program
SeTP	Septage Treatment Plant
SHG	Self-help Group
SOP	Standard Operating Procedure
STP	Sewage Treatment Plant
SWM	Solid Waste Management
ULB	Urban Local Body

INTRODUCTION

Introduction

The water and sanitation sector in India needs reforms if national and global benchmarks for service delivery are to be successfully met. The current state of the sanitation sector is such that huge gaps in the sanitation service chain are faced by a majority of the population of India. This highlights the need for not just institutional remodelling of the sector, but also for adopting a novel approach, innovative ideas and urgent decentralization if the sanitation services are to reach the last common denominator. For decentralization we need to focus on onsite sanitation systems consisting of containment and treatment units such as septic tanks and anaerobic settler, baffled reactor respectively. These units need to be desludged at a regular interval in order to maintain the treatment efficiency of the unit.

Faecal sludge & septage management (FSSM) refers to the removal, treatment, and disposal of sludge from containment and treatment units. Faecal sludge and septage is different from domestic sewage and contain mostly human excreta/waste rather than the waste that drains from kitchens, etc. The Government of India's (GoI) goal is for all cities to have networked sewerage connections, which would send liquid waste to a central location for treatment and disposal. However, such a centralized wastewater management system is not feasible for towns where the population density is low and financial management is not up to the mark.

Presently, majority of the urban local bodies (ULBs) do not have the required infrastructure for end to end management of liquid waste for their complete population. This means the sludge from the containment units has to be emptied and moved to a location that will process it further making it safe for reuse or disposal. This ensures that part of the pollution load is reduced and the health of the onsite containment units is maintained.

Most cities in India lack the capacity to regulate emptying, conveyance, treatment and dumping of faecal sludge and septage. Given these issues of collection, treatment, and disposal, it is exciting that innovators are starting to look to this waste as a resource rather than a burden. While there is value of innovation at each level of the sanitation chain, mostly due to the human resource and health potential in infrastructure building and collecting waste, there is additional value in turning the faecal sludge matter into an environmentally beneficial and profitable resource.

This online certificate course was developed to understand all aspects of FSSM across the service value chain.

Course Objective

To build the capacities of participants so that they can understand, analyze and apply learnings in real-life scenarios for technical and financial planning of Faecal Sludge and Septage Management at a city level, including designing of Faecal Sludge and Septage Treatment Plant.

The programme is based on the module developed by NIUA, New Delhi in partnership with ESF, Pune and endorsed by MoHUA. This report summarizes the learnings from the first training programme based on this advanced module. Given the situation due to COVID-19 Pandemic, SCBP has been trying to organize capacity building activities through online mode. This is the pilot attempt under SCBP for delivery of such advanced training programme through online mode. The report elaborates on the online training given to technical experts, practitioners from local or state government organizations, and PMUs or private consulting firms in India, on design of treatment systems for Faecal Sludge and Septage Management (FSSM). Being the first attempt to conduct an intensive training program on FSSM, it was important for organizing agencies to understand the learning impact of online training and the viability of continuing such online training till the time restrictions continue on conducting face to face training. The feedback from the training has also helped us in reviewing and updating the content of the module. The updated module can be accessed at the following link:

Part A- Presentation Slides: <https://scbp.niua.org/?q=content/faecal-sludge-treatment-systems-design-module-part-3a-presentation-slides>

Part B- Learning Notes: <https://scbp.niua.org/?q=content/faecal-sludge-treatment-systems-design-module-part-3b-learning-notes>

Part C- Workbook: <https://scbp.niua.org/?q=content/faecal-sludge-treatment-systems-design-module-part-3c-workbook>

The content of the module designed for Face to Face training (4 days training) was restructured for delivery through online mode. A 10-day course with a total duration of 20 hours was designed for online delivery. In order to engage participants and ensure that capacity is built to the level of practicing FSSM or conducting similar training, the course was developed using a case methodology and had a mix of presentations, case studies, exercises, information videos and quizzes. The Part A- Presentation Slides and Part B -Learning Note were shared with participants as reference materials. The online sessions were for 15 hours whereas the remaining 5 hours were dedicated to quizzes and exercises which participants had to attempt in order to complete the course. The exercises are based on the Part C of the module, the Workbook, various sections of this workbook were converted to assignments which the participants had to complete and submit in two phases. A separate session was arranged to conduct further discussions with participants to clarify their doubts and queries. A final online quiz was conducted during this session, where in the learning impact assessment was done. In order to successfully complete the course with certification, the participants had to attend all the sessions, attempt at least seven out of the ten session quizzes, complete the exercise and attempt the final online quiz.

Agenda

Following is the day wise agenda of the training. A detailed session wise agenda is available in the annexure.

Table 1: Agenda of the Training of trainers

Day	Session	Topic	Contents	Duration [min]
17 June 2020	1a	Introduction to Faecal Sludge and Septage Management	<ul style="list-style-type: none"> Sanitation System Approach Wet Sanitation Systems Sanitation Service Chain Challenges in Sanitation Services 	90
	1b	Characterisation of Faecal Sludge and Septage	<ul style="list-style-type: none"> Parameters for characterizing Categories of sludges Operational factors affecting the characteristics 	
18 June 2020	2	Quantification of Faecal Sludge and Septage	<ul style="list-style-type: none"> Need of quantification of sludge Methods of quantification of sludge Operational factors to be considered while quantification <p>Case Study: Port Blair, Andaman and Nicobar Islands</p> <p>Exercise: Quantification, Collection and Transport</p>	90
19 June 2020	3	Emptying and Conveyance of Faecal Sludge and Septage	<ul style="list-style-type: none"> Types of desludging methodologies Technical options for emptying and conveyance Optimizing emptying and conveyance <p>Case Study: Wai & Sinnar, Maharashtra</p> <p>Reading Material: Guidelines, Advisories and Manual Scavenging Act and Rules 2013</p>	90

20 June 2020	4	Treatment of Faecal Sludge and Septage	<ul style="list-style-type: none"> • Treatment targets and specific objectives • Approaches for faecal sludge and septage management • Treatment mechanisms • Driving factors for selection of treatment mechanisms <p>Case Study: Co treatment at Puri STP, Odisha</p> <p>Exercise: Decision Making Criteria for components of treatment</p>	90
21 June 2020	5	Septage Receiving Station	<ul style="list-style-type: none"> • Objectives and Design of septage receiving station • Components of septage receiving station • Type of septage receiving station 	90
22 June 2020	6	Non-mechanized Treatment Units of Faecal Sludge and Septage & its Design	<ul style="list-style-type: none"> • Stages of treatment of faecal sludge and septage • Non mechanized treatment units Designing of - • Settling Thickening Tank (STT) • Anaerobic Digester (AD) • Unplanted Drying Beds <p>Case Study: Bhubaneswar FSTP, Odisha</p> <p>Exercise: Designing of STT, AD, and Unplanted Drying Beds</p>	90
23 June 2020	7	Mechanized Treatment of Faecal Sludge and Septage	<ul style="list-style-type: none"> • Stages of treatment of faecal sludge and septage • Mechanized treatment units • Selection of - Dewatering technology, Drying technology Thermal treatment <p>Exercise: Mechanical treatment of Solids</p>	90
24 June 2020	8	Financial aspects of FSSM	<ul style="list-style-type: none"> • Financial components of FSSM • Financial and contracting models <p>Case Study: Financial Aspects of Port Blair FSTP, Andaman and Nicobar Islands</p> <p>Exercise: Revenue Streams and Project Life Cycle Cost Analysis</p>	90
25 June 2020	9	Siting and Layout Planning of Treatment Plant	<ul style="list-style-type: none"> • Site characterisation and evaluation • Site selection criteria • Safety planning at treatment plant <p>Importance of layout planning and examples</p>	90
26 June 2020	10a	Construction and commissioning of Treatment Plant	<ul style="list-style-type: none"> • Pre construction activities • During construction activities • Stages in commissioning of plant • Handover process of the plant 	90
	10b	Operation and Maintenance of Treatment Plant	<ul style="list-style-type: none"> • Integration of O&M with design of treatment plant • Introduction to asset management • Content of O&M plan for treatment plant • Monitoring and record keeping at treatment plant 	
			Total duration [hours]	15

SESSIONS

Sessions

Day 1, June 17th, 2020

The online training program was kicked off with a formal introduction of the Sanitation Capacity Building Platform by Mr. Depinder Kapur, Team Lead, NIUA. The training and online platform for all the practitioners hosted by NIUA was introduced by Ms. Jyoti Dash, Sr. Program Manager, NIUA. Ms. Sreevidya Satish, the moderator for the training, introduced Ecosan Services Foundation (ESF).

The session began with the introduction to the course, course outline, structure and objectives of the course. The Microsoft Teams platform, being used to deliver the course, was introduced to the participants, along with a brief guide on how to utilise its features. Introduction of the lead trainers and facilitators was carried out, followed by setting the ground rules for all the participants and explaining the mandatory criteria for the successful completion of the course.

Session 1a: Introduction to Faecal Sludge and Septage Management

Mr. Dhawal Patil, Sr. Resource Person presented the first session on Introduction to Faecal Sludge and Septage Management. Session started with types of sanitation systems and its approaches and difference between sewerage and non-sewerage sanitation system. Following were the points of discussion from the slide-deck:

- ◆ Sanitation system components
- ◆ Sanitation services chain
- ◆ Challenges for FSSM
- ◆ Different sanitation systems
- ◆ Summary: Sanitation system approach helps to break down the system and understand its nuances

Session 1b: Characterisation of Faecal Sludge and Septage

The second session began with the presentation on basics of FSSM. Following were the points of discussion:

- ◆ Type of sludge: Faecal Sludge, Septage and Sewage Sludge
- ◆ Characterisation of sludge and ratios of sewage, septage and public toilet sludge
- ◆ Operational Factors: Toilet usage, storage, climate, infiltration and exfiltration, equipment used
- ◆ Sampling procedures
- ◆ Summary: Characteristics of sludge can change from city to city & varies with multiple factors

Following were the queries raised during the session:

- ◆ What is dewaterability?
- ◆ What are the parameters at the sampling level at the source?
- ◆ How is COD:BOD ratio helpful in determining whether DEWATS technology is suitable for faecal sludge/ septage treatment?

Exercise: Part A & B - Section 1

The lead trainer took all the participants through Part C: Design Workbook which was shared with all the participants. The workbook contained two parts dedicated to two different cases. The trainer briefed participants about the two cases and instructed them to go through Section 1 of both parts carefully.

Figure 1: Section-1 Exercise from workbook

1 Profile of the city

The city is situated in a union territory which is an island. In this case, one needs to take into considerations that extra compliances will have to be taken since the region falls in the Coastal Regulation Zone (CRZ)¹. The city falls under the CRZ-III category. Following are the details extracted after primary household survey, structured interviews of the desludging operators and service level benchmarking sheet provided by the Urban Local Body (ULB).

The climatic conditions prevailing in the region are dominated by high humidity (average of 75%) during summer and winter season and high intensity rainfall during monsoon season.

Table 1: Primary data collected from the surveys conducted at city level

Information	Unit	Data
Population	no.	1,20,000
Person per HH	ratio	4
Households (HH)	no.	30,000
Water supply	lpcd	105
HH dependent on Anaerobic On-Site Treatment System (OST)	%	85%
	no.	25,500
HH dependent on community toilet	%	5%
No. of community toilet blocks	no.	25
No. of public sanitation blocks	no.	10
No. of aerobic OST	no.	15

Note: Anaerobic on-site treatment system in this case refers to a septic tank; whereas the aerobic onsite treatment system refers to a decentralised wastewater treatment plant based on the aerobic process such as ASP, SBR, MBBR etc.

Further analysis was done to understand the Faecal Sludge and Septage Management status in the city. Following are the inferences drawn from the analysis;

Table 2: Observations drawn from the analysis of the data

Storage and Treatment	Unit	Data
Average size of Households anaerobic OST	cum	3
Frequency of desludging	months	60
Average size of Community Toilet anaerobic OST	cum	8
Frequency of desludging	months	12
Average size of Public Toilet anaerobic OST	cum	10
Frequency of desludging	months	4
Average size of aerobic OST	cum	10
Frequency of desludging	months	8
Collection and Transport	Unit	Data
Type of desludging		demand
No. of desludging operators	no.	6
Vacuum trucks	no.	10
Capacity of the trucks	cum	4
No. of trips of trucks per day	no.	12
Treatment	Unit	Data
No. of composting site	no.	3
No. of STP	no.	0
Capacity of the STP	MLD	0
Utilization of the capacity of STP	%	-
Disposal	Unit	Data
No. of disposal points	no.	1
Type of disposal point		MSW dumping site.

The session ended with Mr. Akshay Agarwal, Program Officer, NIUA briefing the participants on the session quiz. He introduced Classmarker, the platform used for conducting the quiz, and guided participants on how to utilise it for the purposes of the course.

Day 2, June 18th, 2020

The second day started with the recap of Day 1 by Mr. Dhawal Patil. He briefly summarised & discussed the presentation points covered the previous day on development of sanitation infrastructure in a rapidly urbanising country such as India. Following were some of the answers pertaining to the quiz raised by participants:

- ◆ How does COD:BOD ratio affect dewaterability?
- ◆ Explain the sludge accumulation difference for Leh & Devanhalli FSTP.

Session 2: Quantification of Faecal Sludge and Septage

Mr. Saurabh Kale, Sr. Resource Person was the lead trainer for this session on quantification of faecal sludge & septage. The following points were covered in this part of the session:

- ◆ Need for quantification of sludge
- ◆ Methods of quantification: Sludge production and collection method – To understand type of desludging and type of data collection methods. Data gaps and challenges were also presented to the participants. Each method was discussed in detail and parameters during estimation of sludge discussed
- ◆ Data points for quantification and factors affecting the collection
- ◆ Types of Stakeholders and data collection
- ◆ Challenges in appropriate data collection
- ◆ Operational factors to be considered
- ◆ Seasonal variations and causes of variation
- ◆ Peaking factor

Following were the questions that were asked by participants which were answered by the trainers:

- ◆ What is the septage accumulation rate?
- ◆ What is the significance of peaking factors of <1?

Case Study: Port Blair, Andaman and Nicobar Islands

Mr. Dhawal Patil was the speaker for this case study session. It was presented on the basis for Quantification Approach based on Sludge Collection Method. The data for the sanitation system profile was collected from the

Port Blair Municipal Corporation (PBMC). The steps which were taken during the process of planning of FSTP at Port Blair was explained. It also showcased the sanitation service chain of the city to explain sanitation scenario in the city. Quantification of sludge was done for the city in the form of daily collection frequency of trips to the disposal site. It explained about the seasonal variation, collection frequency in critical months & how winter season was the peak season for desludging due to the floating population/tourists. Optimising collection and conveyance were done as follows:

- ◆ Scheduled service for commercial and public properties
- ◆ PBMC recommended to add 4 KL vacuum truck
- ◆ Monitoring process: Stricter regulations & GPS on trucks
- ◆ Regulating the collection and conveyance
- ◆ Proposed fixed charges (INR/lit. considering the distance)

Design capacity was reached by following factors:

- ◆ Population growth
- ◆ Design capacity and period
- ◆ Faecal sludge & sewage sludge – 12 KLD
- ◆ Septage – 30 KLD

Following were the questions that were raised during this session:

- ◆ Why are trucks of capacity (>4KLD) being used at Port Blair?
- ◆ Can faecal and septage be treated in one treatment plant?
- ◆ Please clarify the calculation details of FS and septage in the ratio of 30 and 12 out of a total quantity of 42?

Exercise: Part A & B – Section 2

The exercise on Collection and Transport stage of FSSM was explained. The exercise comprised of comprehending the data from previous day's exercise and analysing it further to quantify the sludge and the vehicles required to provide service to the households.

Figure 2: Section-2 exercise from workbook

2 Collection and Transport

2.1 Type of desludging proposed

First, we choose one of the two desludging services which are (1) demand desludging and (2) scheduled desludging. In this case we choose demand desludging.

Can you state reasons for recommending demand desludging?

2.2 Frequency of desludging

In case of demand desludging, we assume the frequency of desludging to be equal to or less than that observed through the primary data collection.

Table 3: Frequency of desludging for proposed demand desludging

Types of On-site Sanitation System	Unit	Answer
HH anaerobic OST	months	60
Community toilet anaerobic OST	months	10
Public toilet anaerobic OST	months	2
Aerobic OST	months	8

Can you justify why did we choose the above-mentioned desludging frequency?

2.3 Number of units to be served

$$\text{Number of units to be served (no./month)} = \frac{\text{Total number of units (no.)}}{\text{Desludging frequency (months)}}$$

Calculate the following:

Table 4: Number of units to be served per month

Source of septage	Unit	Number of units to be served
HH anaerobic OST	no./month	
Community toilet anaerobic OST	no./month	
Public toilet anaerobic OST	no./month	
Aerobic OST	no./month	

2.4 Quantity of septage to be handled

$$\text{Quantity of septage received } \left(\frac{\text{cum}}{\text{d}}\right) = \frac{\text{Number of units to be served } \left(\frac{\text{no.}}{\text{month}}\right) \times \text{Average size of the unit (cum)}}{\text{Number of working days in a month } \left(\frac{\text{d}}{\text{month}}\right)}$$

Calculate the following:

Table 5: Quantity of septage received per day from different sources

Source of septage	Unit	Quantity of septage received per day
HH anaerobic OST	cum/d	
Community toilet anaerobic OST	cum/d	
Public toilet anaerobic OST	cum/d	
Aerobic OST	cum/d	
Total quantity of septage	cum/d	

Day 3, June 19th, 2020

The moderator started Day 3 with the feedback on previous 2 days' training sessions. A brief of the 3rd session along with the case study was then provided to the participants.

Recap of Day 2 was taken by Mr. Saurabh Kale, post which the emptying and collection exercise (Section 2) was explained by Mr. Dhawal Patil in detail to all participants before beginning the sessions for Day 3.

Session 3: Emptying and Conveyance of Faecal Sludge and Septage

The objective of the session was to introduce technology options for emptying and conveyance of FS and Septage. Mr. Saurabh Kale was the lead trainer for this session and the following topics were covered:

Types of collection and transportation:

Manually operated mechanical emptying

- ◆ Sludge Gulper, manually operated diaphragm pumps, MAPET

Motorised emptying

- ◆ Pit Screw Auger, Vacuum Trucks (suction truck or honey suckers), Vacutug

Transfer Station

- ◆ Types of transfer stations: networked connected, modular (detachable tanker), mobile transfer station

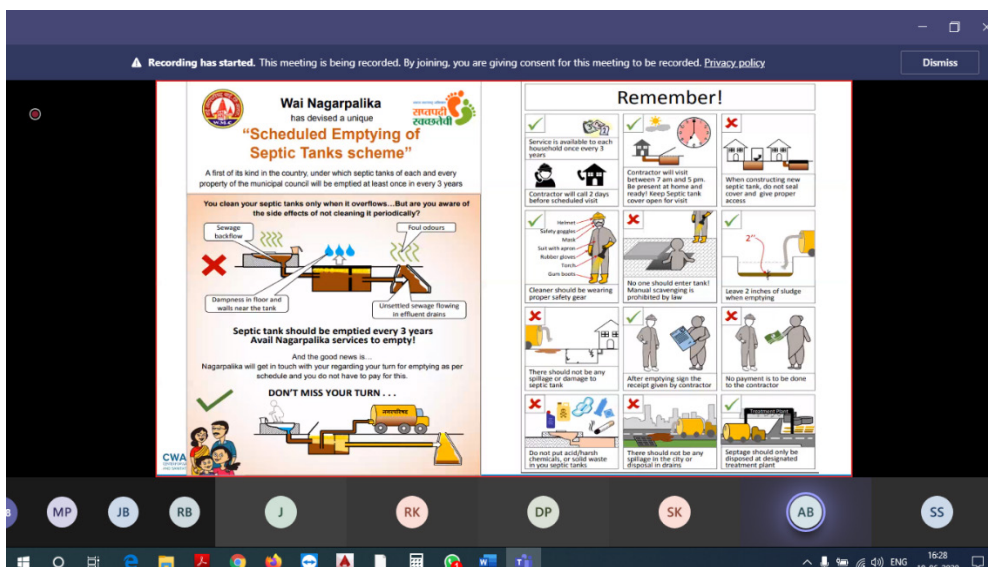
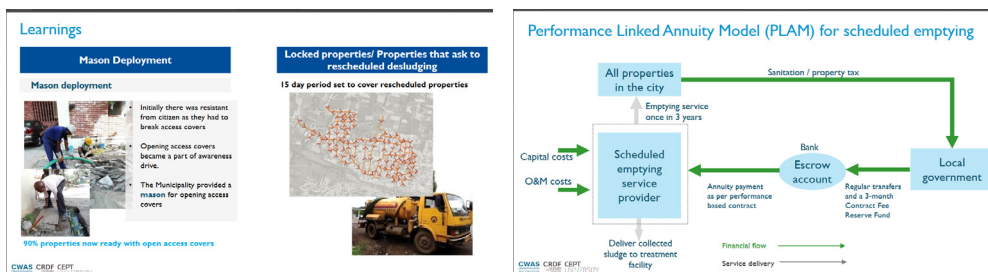
Dewatering Truck

Case Study: Wai & Sinnar, Maharashtra

Ms. Arwa Bharmal, Program Lead, CWAS, CEPT University, was the guest speaker for this case study on Wai & Sinnar, Maharashtra. She explained the setting up of scheduled emptying services at Wai, Maharashtra. She also discussed the current practices of desludging in Indian cities being mostly of complaint redressal and not a public service, as well as the way sewerage and SWM are handled. She also explained the adverse environmental impact due to poor quality of dumping of FS in the water bodies & the recent initiatives in Maharashtra under the Swachh Maharashtra Mission where subsidies are given for construction of IHHL.

The sanitation situation of Wai in 2013 of access to toilets, collection of sewage, conveyance, transport and treatment was explained & how private operators were assigned to collect FS from households. Doing so has enabled Wai to become the 1st city in India to follow scheduled desludging. Zoning of areas was done in Wai for better implementation of schedule desludging, and emergency desludging was also carried out by private operators.

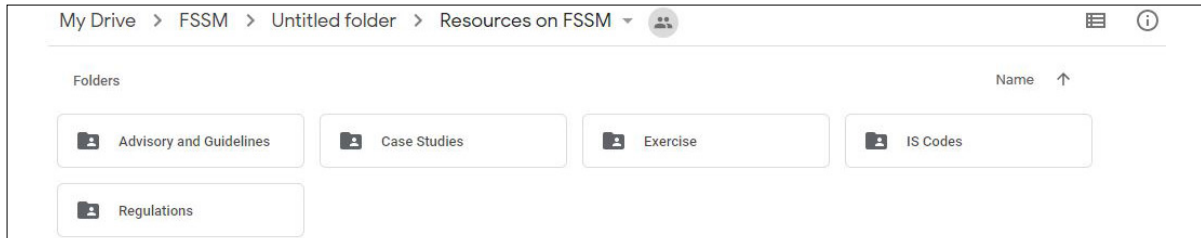
Figure 3: Snapshots from case-study on Wai & Sinnar



Reference Material

The participants were provided with reading and reference material after the session. The material consisted of Gol's Manual Scavenging Act, 2013, a primer on FSSM, ODF protocols and byelaws by government, SOPs for cleaning of septic tank and sewers, emergency response for sanitation units and IS codes by BIS, among others. The lead trainers suggested the participants to go through all such reference material to gain a better understanding about FSSM.

Figure 4: List of reference material shared with the participants for further reading



Day 4, June 22nd, 2020

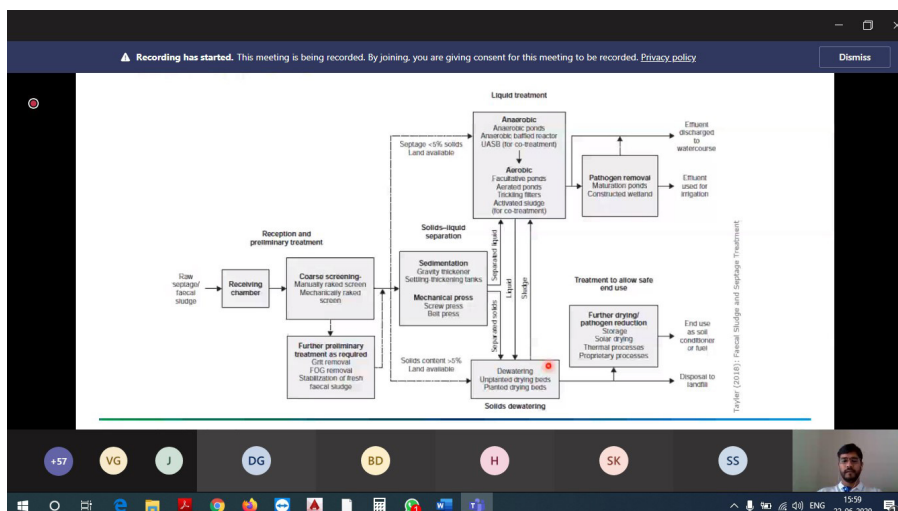
Day 4 began with general information regarding the technical part of the training & asked the participants to utilise the WhatsApp group created for the course for further doubts at any point during the course. The moderator introduced the guest speakers for the day with co-treatment case study, Trichy from IIHS. Mr. Saurabh Kale took a quick recap of Day 3 which covered emptying and conveyance of FS and septage so that participants had some revision for the upcoming session.

Session 4: Treatment of Faecal Sludge and Septage

The objective of the session was to introduce treatment targets and objective approach for FSSM, treatment mechanisms, stages, and chain and selection of treatment technology. Mr. Dhawal Patil was the lead trainer for this session & the following points covered in this session:

1. Treatment targets
2. Treatment Objective
 - Dewatering
 - Pathogen removal – reduce the pathogens completely
 - Nutrient Recovery
 - Stabilization
3. Approaches for FSSM
 - Deep Row Entrenchment
 - Co treatment in STP and MSW plant
4. Treatment Mechanism and its objective
5. Treatment Stages
6. Treatment Chain
7. Treatment Option depends on

Figure 5: Treatment chain of Faecal sludge & Septage

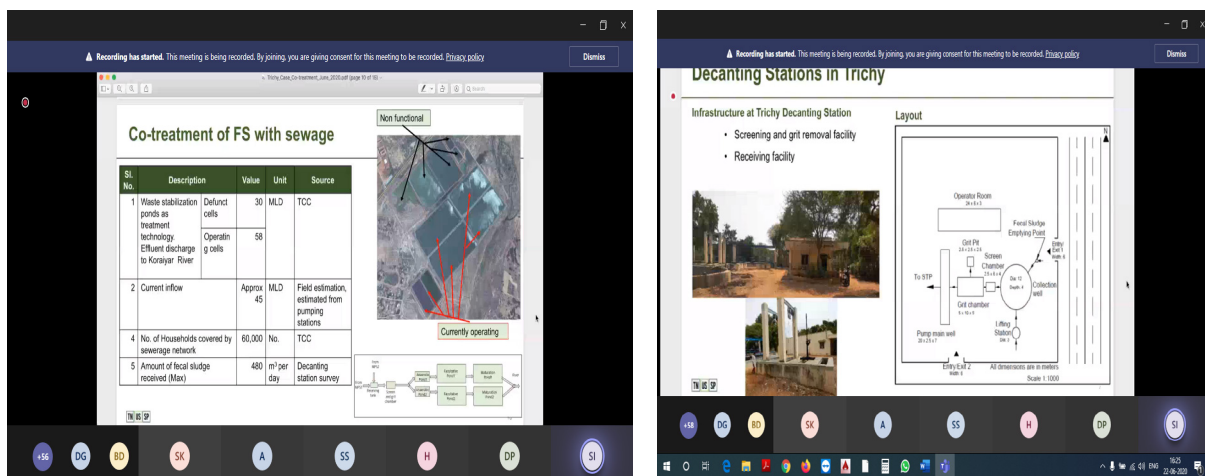


Case Study: Co treatment of FS & Septage at STP, Trichy

Mr. Santosh Raghavan from IHS was the guest speaker for this case study & presented the case study on co-treatment of FS & septage in STP, Trichy. The session started with some questions to all the participants about co-treatment. An overview of Trichy City was presented. Trichy has been practicing co treatment for more than a decade. Following were some of the major points discussed pertaining to the case study:

- ◆ Decanting stations & their guidelines
- ◆ Screening and grit facility and receiving facility
- ◆ Layout, infrastructure and O&M
- ◆ Demonstration
- ◆ Co-treatment of FS with sewage
- ◆ Checklist for assessment of pumping station
- ◆ ULB details
- ◆ Location and access details
- ◆ Availability of space and existing infrastructure

Figure 6: Snapshots from case-study of co-treatment in Trichy



Exercise: Part A & B – Section 3

Day 4 exercise was explained by the lead trainer regarding Section 3. This was based on the findings of the previous section and its interpretation to decide the requirement of treatment station units.

Figure 7: Section-3 exercise from workbook

2.5 Number of the vacuum trucks

The capacities of the vacuum trucks range from 1 cum to 11 cum, however the most common sizes available in market are 4 cum, 8 cum and 11 cum. Usually the 8 cum and 11 cum capacity trucks also comes with a jetting machine and hence are expensive.

Assuming the number of trips which the 4 cum, 8 cum and 11 cum truck can undertake are 4, 2 and 2 respectively, choose appropriate number of trucks of different capacities in such a way that the operator will not have to deny any desludging inquiry.

Table 6: Number of vacuum trucks required of different capacities

Capacity of vacuum trucks	Unit	Number of trucks
4	cum	
8	cum	
11	cum	

3 Treatment

3.1 Requirement of stabilization

If the desludging frequency is less than 24 months i.e. if the septage was retained in the onsite sanitation system (example: septic tank, baffled septic tank, anaerobic baffled reactor, imhoff tank etc) for more than 24 months, then it is assumed that the septage does not need to be stabilized.

Usually septage coming from OST linked to Community Toilet Blocks, Public Toilet Block or sludge originating from aerobic treatment of wastewater needs further stabilisation.

Stabilisation process can yield methane at an expected rate if operated and maintained well. The methane gas can thus be potential source of revenue for the Faecal Sludge and Septage Treatment Plant (FSTP) operator.

Table 7: Need of stabilisation for septage from different source

Source of septage	Stabilization required
HH anaerobic OST	(YES / NO)
Community toilet anaerobic OST	(YES / NO)
Public toilet anaerobic OST	(YES / NO)
Aerobic OST	(YES / NO)

3.2 Volume of septage

Determine the volume of septage that needs to be stabilised (Vd) and the one which can be directly sent for solid liquid separation (Vs).

Table 8: Volume of septage for stabilization and solid liquid separation

Volume of septage	Unit	Volume
Stabilization (Vd)	cum/d	
Solid liquid separation (Vs)	cum/d	

Day 5, June 23rd 2020

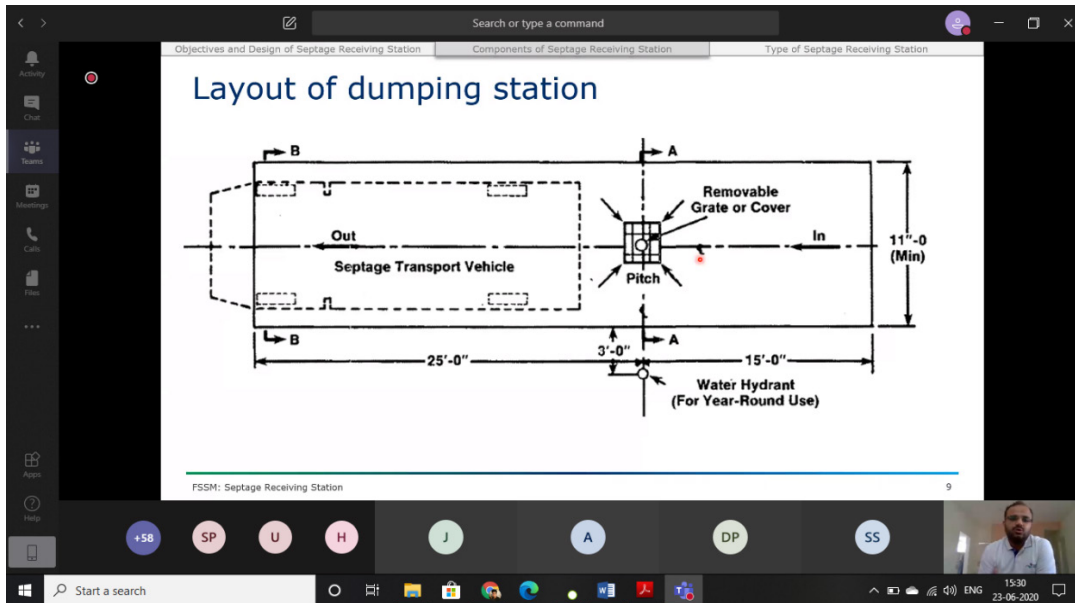
A brief recap of the previous session was given to the participants. The guidelines on how to attempt the quizzes & exercises & their importance was reiterated.

Session 5: Septage Receiving Station

Mr. Saurabh Kale was the lead trainer for the session. Septage receiving station & its different components were explained in the session. The main aim of the septage receiving station is to reduce the impact on the treatment plant. The layouts of dumping stations were explained through schematic diagrams.

The different options of receiving stations were covered along with the working diagram of each type.

Figure 8: Snapshot of the session on Septage receiving station

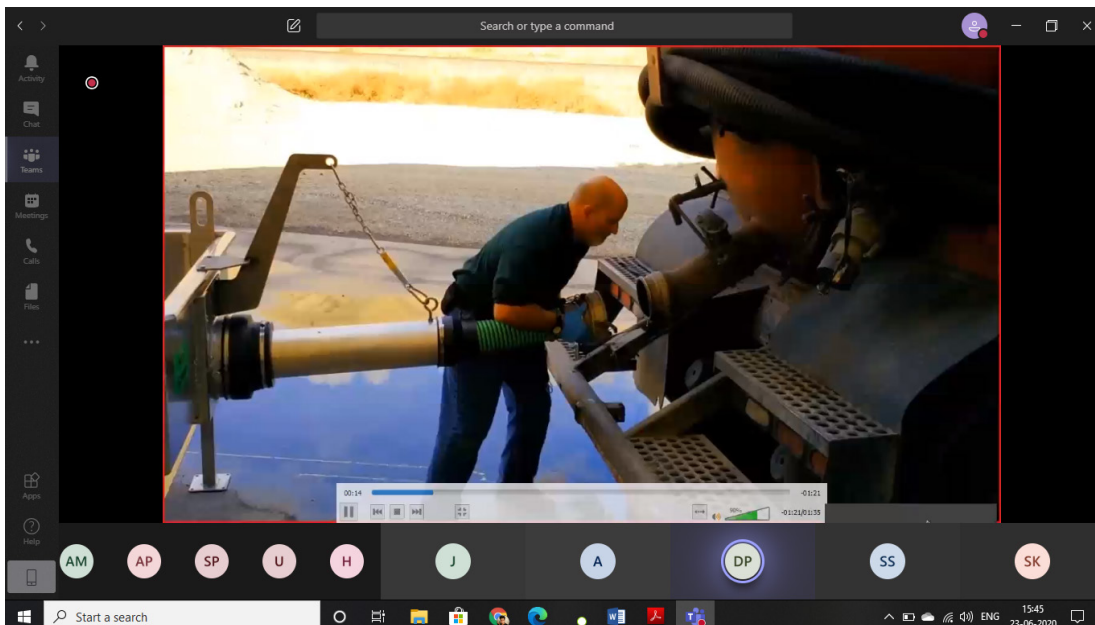


The lead trainer also discussed about the reference material that had been shared with all the participants.

Informational videos: Septage receiving station & integrated mechanized septage receiving station

Mr. Dhawal Patil conducted this session with the ongoing presentations. A video regarding working of the mini screens was shown. The trainer explained the working of the various equipment shown in the video.

Figure 9: Informational video on septage receiving station



Videos of the grit removal chamber and mechanized receiving station were shown. The final video contained the design & implementation and other factors which are considered for the receiving station.

Some of the questions by participants included:

- ◆ What if the septage of the truck needs to be stored temporarily, is it advisable to consider a holding tank at the inlet?
- ◆ Is there any specific material used for the pre-fabricated bar screen for handling septage?

Day 6, June 24th 2020

Mr. Saurabh Kale gave a recap of the previous session on the design aspects of septage receiving station.

Session 6: Non-mechanized Treatment Units of Faecal Sludge & Septage & its Design

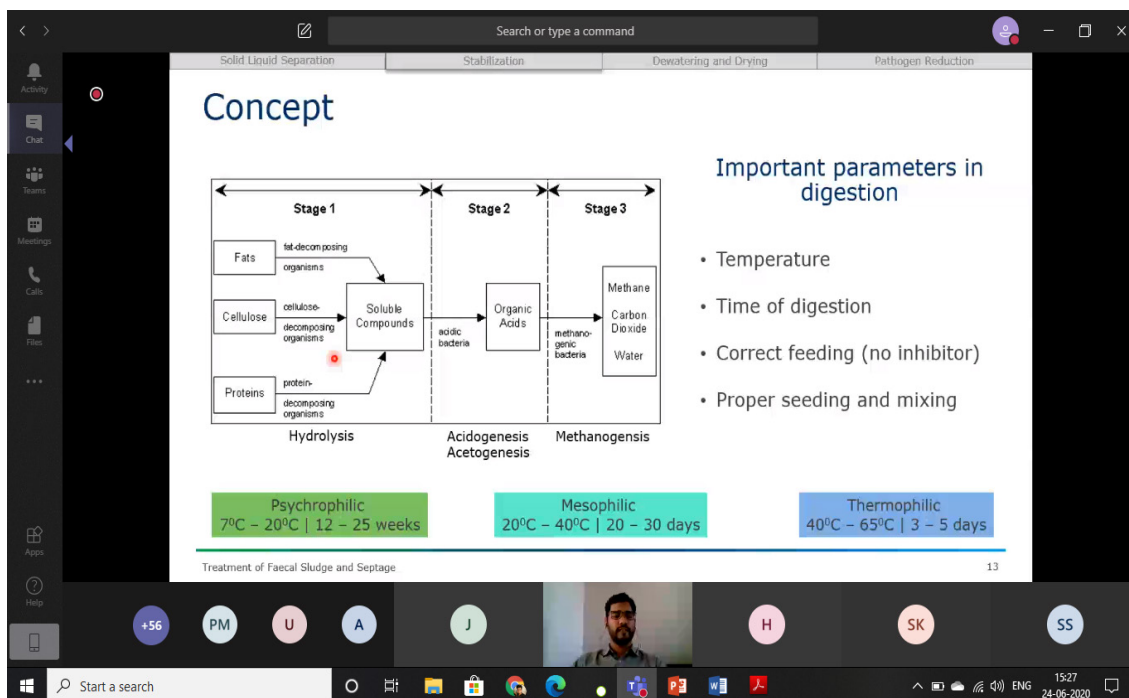
Mr. Dhawal Patil was the lead trainer for this session. Following were the points that were explained in the session-

- ◆ Solid liquid separation
 - Geo-bags
 - Settling thickening tanks
- ◆ Stabilization
 - Anaerobic digester
- ◆ Dewatering & Drying
 - Planted & Unplanted drying beds
- ◆ Pathogen reduction
 - Co-composting & Extended storage

The following were some of the questions that were raised by the participants:

- ◆ What is supernatant?
- ◆ Is there any specification for sand used in drying beds?
- ◆ Is 7 days drying period enough for sludge drying bed?

Figure 10: Snapshot of the session on non-mechanized treatment of FSS



Case Study: Septage Treatment Plant, Bhubaneswar, Odisha

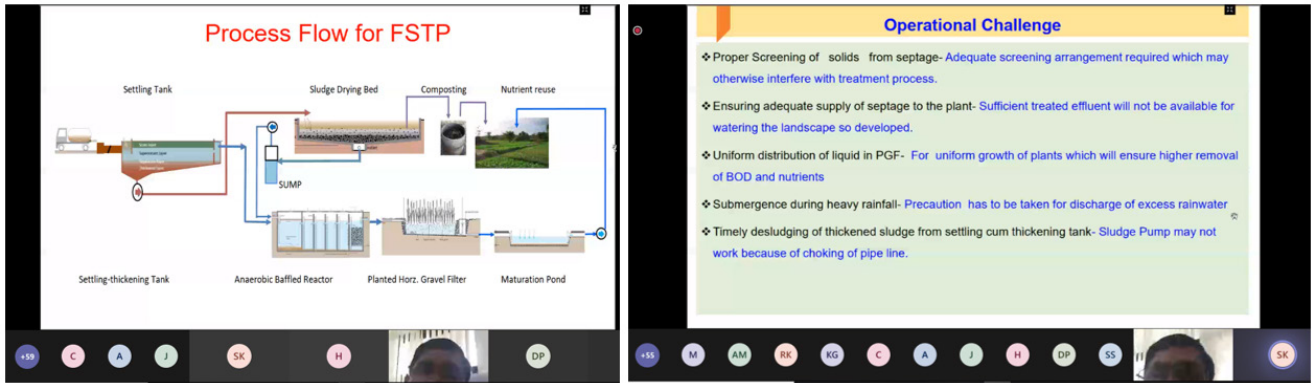
Mr. Binod Kumar Sahoo, Project Director, OWSSB was the guest speaker for this session & presented the case study on FSSM approach in Odisha and technical approach towards Bhubaneswar FSTP. Non-mechanized septage treatment plant (SeTP) has been set up at Bhubaneswar by OWSSB. The SeTP is very efficient under extreme climatic conditions as well. The FSTP at Bhubaneswar is gravity-based. He explained the working & operational aspects of the plant at Bhubaneswar. The scaling up of FSSM in the state of Odisha is currently being implemented on a large scale. The government of Odisha along with OWSSB has spearheaded this project

of bringing the state of Odisha under FSSM. Self-help groups have been engaged and trained specifically to run the treatment plants thus increasing awareness among people.

Following are the learnings from the case study that was shared:

- ◆ FSSM can be adopted effectively in towns & cities for liquid waste management in the absence of sewerage system
- ◆ Non-mechanised treatment/natural treatment systems should be adopted as far as possible since O&M is very simple and less costly
- ◆ Pollution of water bodies can be prevented to a great extent with proper treatment of septage

Figure 11: Snapshot from the Bhubaneswar case-study presentation



The moderator appreciated sharing the experiences pertaining to FSSM in the state of Odisha. The participants expressed their appreciation for Mr. Sahoo sharing OWSSB's experiences and congratulated him for the work done in Odisha.

Exercise: Part B – Section 4,5 and 6

The lead trainer explained the participants how the sections 4, 5 and 6 of Part B of the exercise were to be done & what all assumptions for the calculations should be considered. The exercise was based design of the non-mechanized treatment units such as settling thickening tank, anaerobic digester, unplanted sludge drying bed.

Figure 12: Exercise section-4,5 from workbook

5.2 Sizing of the settling thickening tank

$$q \left(\frac{\text{cum}}{h} \right) = \frac{Q_p \left(\frac{\text{cum}}{d} \right)}{h \left(\frac{h}{d} \right)} =$$

Where;
q: hourly peak flow

$$S \text{ (sqm)} = \frac{q \left(\frac{\text{cum}}{h} \right)}{V_u \left(\frac{m}{h} \right)} =$$

Where;
S: required surface area of the settling thickening tank

Assume the width of the settling thickening tank to be x, hence the length will be 5x. Surface area of the tank will be 5x².

$$5x^2 = S \text{ (sqm)} =$$

$$x = \sqrt{\frac{S \text{ (sqm)}}{5}} =$$

Hence, width of the settling thickening tank =
Length of the settling thickening tank =

It is always recommended to round of the dimensions to higher side.

$$V_t(\text{cum}) = \frac{Q_p \left(\frac{\text{cum}}{d} \right) \times Ct \left(\frac{h}{d} \right) \times e \text{ (%) } \times N \text{ (days)}}{Ct \left(\frac{h}{d} \right)} =$$

Where;
Vt: Volume of thickened sludge

$$Hst \text{ (m)} = \frac{V_t \text{ (cum)}}{S \text{ (sqm)}} =$$

Where;
Hst: Height of the thickened sludge layer in the tank

If the height of the thickened sludge layer in the settling thickening tank is too high then adjust the width and length of the tank, so that the height of the sludge layer fits the site constraints. However, keep in mind that the width to length ratio should be between 1:5 to 1:10.

Hence, revised width of the settling thickening tank =
Revised length of the settling thickening tank =
Area of the settling thickening tank =

Volume of zone (cum) = Height of the zone (m) X Area of the tank (sqm)
Calculate volume of different zones in the sludge settling and thickening tank;

Table 14: Volume of different zones of settling thickening tank

Notation	Description	Volume	Unit
V _{sc}	Volume of scum zone		cum
V _{sn}	Volume of supernatant zone		cum
V _{se}	Volume of separation zone		cum

Total volume of settling thickening tank = V_{sc} + V_{sn} + V_{se} + V_{sl} =

5.3 Diagram

Day 7, June 25th 2020

Mr. Dhawal Patil gave a recap about previous session on non-mechanized treatment units and explained the solution of the exercise workbook for the previous sections.

Session 7: Mechanized treatment of faecal sludge & septage

Mr. Dhawal Patil was the lead trainer for this session. The stages of treatment for faecal sludge & septage, the mechanized treatment units & the system description, performance parameters, design considerations for all of the treatment units were explained in this session. Following were the topics that were focused in the presentation:

- ◆ Solid liquid separation
 - Screw press
 - Belt press
- ◆ Drying
 - Solar drying
 - Belt dryer & Paddle dryer
 - Thermal drying

Figure 13: Snapshot of the session on mechanized treatment of FSS

Pyrolysis

- Heating in an oxygen depleted environment
- Temperature- 200 – 300°C
- Organic molecule is chemically altered
- Yields carbon based end products- bio char, oils, gases or soil additive
- Types: Dry & Hydro thermal

Thermal decomposition of organic matter

Oxidation: Carbon combines with oxygen, and is driven off as CO and CO₂. (NO_x, SO_x and other oxides also form)

Pyrolysis ("bio-entrainment"): Organic molecules are chemically altered, then mostly driven off

Evaporation and Vapourization: Volatiles are driven off, but not chemically altered

Graph showing temperature (0 to 500°C) and processes: Water freezes, water boils, large amount of latent energy absorbed, ignition or oxidation releases more heat than pyrolytic char is absorbed (reaction is self-sustaining), Organic matter fairly stable, Charring (carbonization), De-carbonization reduced to ash.

At the end of the session, Q&A session was undertaken by the moderator & lead trainers.

Exercise: Part A – Section 4, 5 and 6

Figure 14: Exercise Section 6,7 From Workbook

Where;

$$W_{be} (m) = m \left(\frac{kg}{h} \right) / 2s \left(\frac{kg}{h \times m} \right)$$

W_{be} – Required width of the belt press based on solid loading rate capacity

$$W_{bv} (m) = q \left(\frac{cum}{h} \right) / 2l \left(\frac{cum}{h \times m} \right)$$

W_{bv} – Required width of the belt press based on volumetric loading rate capacity

The manufacturer choses the bigger width of the two and rounds it off to a standard width available. It is advisable to have two belt filter press of required design capacity and belt width (one stand by and one operational)

Table 17: Design capacity of the belt filter press

Symbol	Description	Answer	Unit
q	peak daily volume of sludge to be dewatered		cum / h
m	peak daily dry solids loading		kg / h
W_{be}	Width of the belt filter press		m

In both cases, polymer dosing is recommended to condition the sludge. This ensures the consistency of the sludge which also gives desired dewatering efficiency.

$$m (kg) = Q \left(\frac{cum}{d} \right) \times TSS \left(\frac{gm}{l} \right) \times Cp \left(\frac{gm}{kg \text{ of solids}} \right)$$

Where;

m – daily requirement of polymer for dewatering

$$M (kg) = m (kg) \times N (d)$$

Where;

M – annual requirement of polymer of dewatering

N – number of operational days in a year

Diagram

6.4 Thermal drying unit

There are various options available for thermal drying unit such as; (a) rotary dryer, (b) belt dryer, (c) paddle dryer and (d) fluidised bed dryer. The selection of the instrument is based on the availability of the human resource and spares for O&M, OPEX and CAPEX. However, what we are interested to know if how much energy will be required for drying the solids to required solid content.

Table 18: Input data for thermal drying equipment

	Energy required to heat water	4.186	kJ/kg °C
	Energy required for vaporization	2260.00	kJ/kg
ϵ	Efficiency of drying process	60.00%	
T_a	Ambient temperature	25.00	°C
C_i	water content of dewatered solid	80%	
C_f	water content of dried solid	5.00%	

This section was dedicated to designing of treatment components for the FSTP in Part A. The treatment components to be designed were settling thickening tank, anaerobic digester, screw press, belt press and calculation to understand the energy balance in drying and incinerating the biosolids. Energy balance calculation helps to understand the feasibility of employing thermal treatment of biosolids.

Day 8, June 26th 2020

The lead trainer began day 8 with a recap of the previous session & discussed the solutions for the exercise from the workbook.

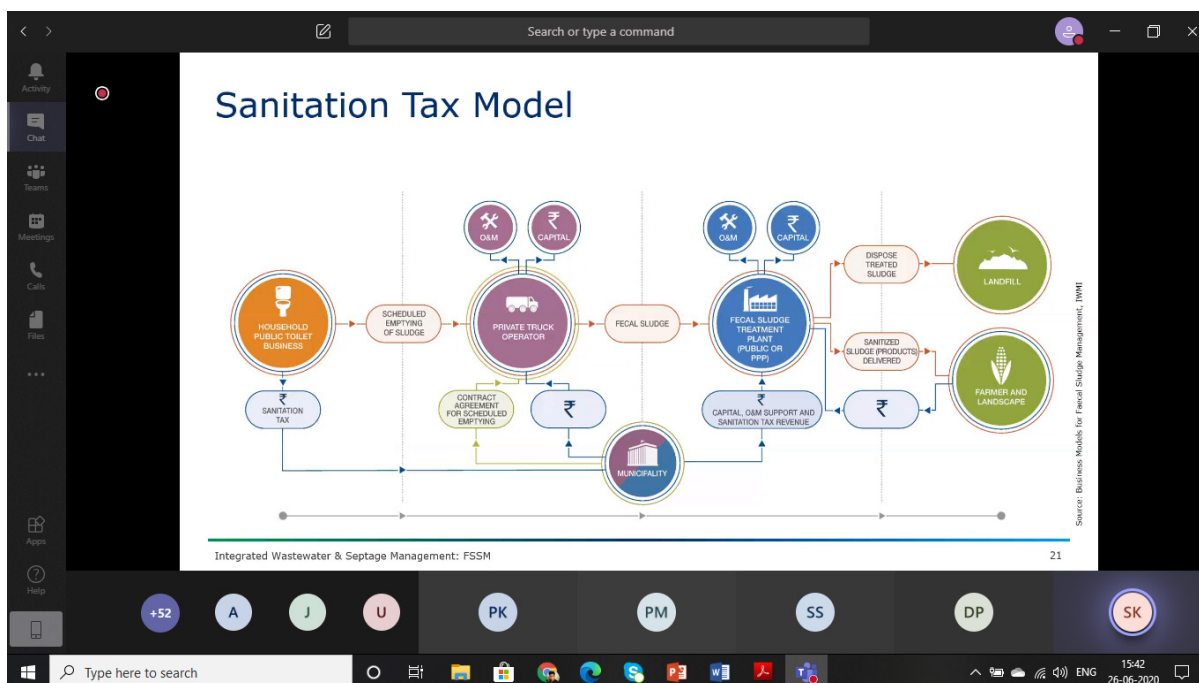
Session 8: Financial aspects of FSSM

Mr. Saurabh Kale was lead trainer for this session. Participants were posting their questions & doubts in the chat box of Microsoft teams while the session was ongoing and these queries were being answered by other trainers during the session. All the participants were encouraged by the trainers & the moderator to ask any questions they had pertaining to the ongoing sessions.

The main learning from this session was to understand the importance of different financial transactions. As a consultant, it was important to know these aspects with the relevant stakeholders in order to reduce the risk to the sustainability of the project. Following were the topics explained in this session:

- ◆ Financial aspects
 - Capital expenditure
 - Operational expenditure
 - Income & revenue
 - Annualized cost
- ◆ Financial flow models
 - Private service model
 - Licensing model
 - Sanitation tax model
 - Incentivized disposal model

Figure 15: Snapshot of session on financial models in FSSM



Following were some of the questions raised by the participants during the session:

Aren't the discharge fees, purchase price & budget support considered as revenue?

Following were the questions that were raised during the session:

- ◆ What will be the cost analysis with respect to a mechanised treatment plant & a natural treatment plant?
- ◆ Explain more about equalisation tank?

Figure 18: Q&A session undergoing after the session



Instructions pertaining to the final submissions of the exercises & how it should be compiled & submitted was explained by the moderator.

Day 9, June 29th 2020

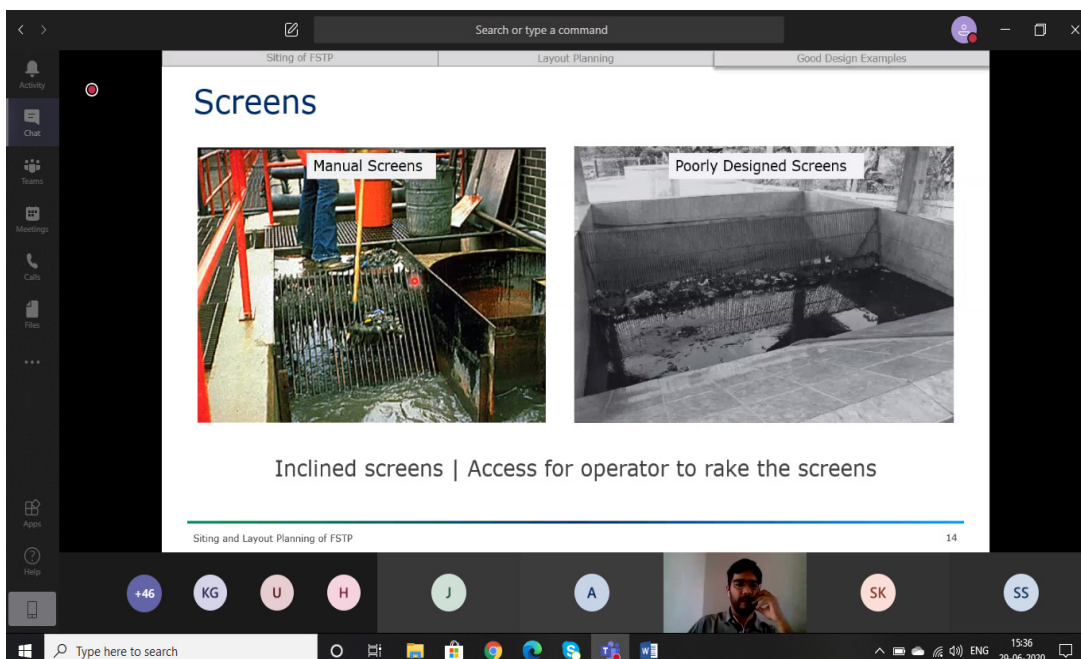
Mr. Saurabh Kale gave a recap on session for financial aspects. While the recap session was going on, Mr. Dhawal Patil had requested all the participants in the chat box to fill the feedback forms related to case studies taken. Later the solutions for the exercise Sections 7 & 8 were also discussed.

Session 9: Siting & Layout Planning of Treatment Plant

Mr. Dhawal Patil was the lead trainer for this session. He discussed & showcased good design examples & practices being followed currently. Following were the topics covered in this session:

- ◆ Siting at FSTP
- ◆ Layout planning

Figure 19: Good design examples of treatment units are treatment plants



Most of the session was covered using pictures to better illustrate the good as well as not so good design of various units in a treatment plant. The design of units becomes utmost important for proper operation and maintenance and safety of the workers.

Following were some of the questions that were asked during the session:

- ◆ Do we require any license or environmental clearances to run the plant?
- ◆ Can we have provisions for a rainwater harvesting system at the FSTP?
- ◆ Is there any FSTP where methane gas is extracted commercially?

Day 10, June 30th 2020

Mr. Dhawal Patil began the session with a recap of the previous session. The solutions to the exercise were shared with the participants. The participants were requested to check the solutions and post the queries for discussion during the 11th session.

Session 10a: Construction, Quality Control & Commissioning of Treatment Plant

Mr. Dhawal Patil was a lead trainer for this session. He explained the purpose of a contract & how important it is to state the responsibilities and duties among all the parties who are getting together for the said project/contract. The session described the various stages for the pre-construction, construction, post-construction & handover stages. Following were the topics of the session that were explained:

- ◆ Pre-construction
 - Contract documentation
- ◆ Construction
 - Site supervision
 - Sound construction
 - Accurate construction
- ◆ Post-construction
 - Pre-commissioning tests
 - Process commissioning
 - Process performance test
- ◆ Handover documentation

Following points can be summarized from the session:

- ◆ Contract documentation is important before starting the construction of the treatment facility
- ◆ Site supervision is required for monitoring of the construction process & quality of it
- ◆ Commissioning of treatment facility has multiple steps & might be time consuming process, however it needs to be completed before introducing any waste & handing over
- ◆ Handing over documents is an important link between the designer, contractor & the organization performing the O&M

Following were some of the questions raised during the session:

- ◆ Was there any SeTP/STP in India where dried sludge is made 100% pathogen-free & sold directly to the customers?

Session 10b: Operation & Maintenance of Treatment Plant

Mr. Saurabh Kale was a lead trainer for this session. Following points were discussed in detail for this session:

- ◆ Integrating O&M with planning & design
 - Considerations for O&M planning
 - Need of O&M plan
- ◆ O&M Planning
 - Content of O&M plan
 - Asset management
- ◆ Monitoring & record-keeping
 - Chain of custody

Following were some of the questions that were raised during the session:

- ◆ What all provisions of O&M should be included in the contract?
- ◆ What is defect liability period?
- ◆ Does the FSTP go for quality system certifications?

After the session, the moderator addressed the participants about the next day's Q&A session.

Day 11, July 1st 2020

The moderator began the last session by welcoming the participants for the closing session & instructed the participants about the quiz & feedback session. The agenda was shared with the participants on screen.

Figure 20: Agenda For The Closing Session

Time	Activity	Resource Person
3.00 to 3.05	Welcome Remarks & agenda for the day	Sreevidya Satish
3.05 to 3.35	Q & A session	Dhawal Patil & Saurabh Kale
3.35 to 3.50	Live Quiz through Class Marker	Akshay Agarwal
3.50 to 4.00	Feedback through www.menti.com	Akshay Agarwal
4.00 to 4.10	Feedback by individual participants	Sreevidya Satish
4.10 to 4.20	Announcement on Certificate Issue Process	Sreevidya Satish
4.20 to 4.30	Closing Remarks and Vote of Thanks	Dayanand Panse & Depinder Kapur

Closing Session

Both the lead trainers started this session with answering the questions raised by the participants over the whole training period through emails & on the WhatsApp group. They clarified all doubts raised by the participants through the session.

Following were some of the topics covered:

- ◆ Characterization of sludge, based on COD
- ◆ Treatment of sludge
- ◆ Thermal drying of bio-solids
- ◆ Thermal treatment of bio-solids
- ◆ Defect liability period
- ◆ Sludge loading rate comparison

Figure 21: Doubt clearing session by Saurabh Kale & Dhawal Patil

Thermal Treatment of Bio Solids

$$\frac{4.186 \times (100 - 30) + 2260 \times (C_i - 0.05)}{0.60} = (1 - C_i) \times 12000 \times 0.85$$

$$293 + 2260C_i - 113 = 6120 - 6120C_i$$

$$2260C_i + 6120C_i = 6120 + 113 - 293$$

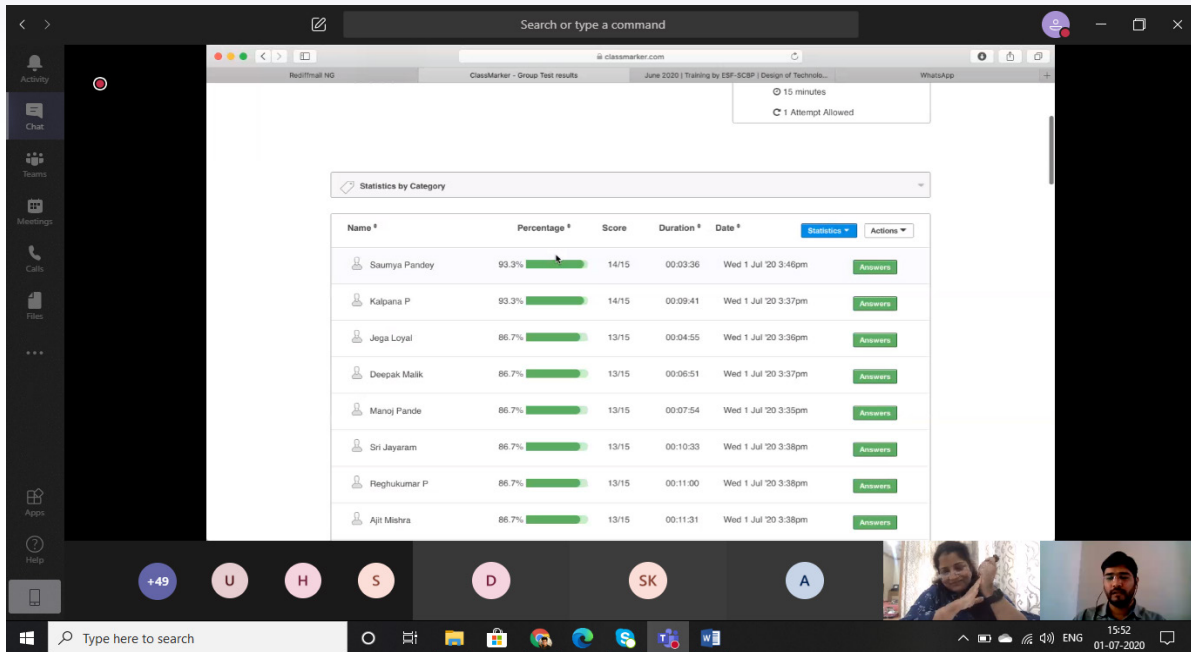
$$8380C_i = 5940$$

$$C_i = 0.70 = 70\%$$

Thus, the solid content of dewatered solids should be at least 30%.

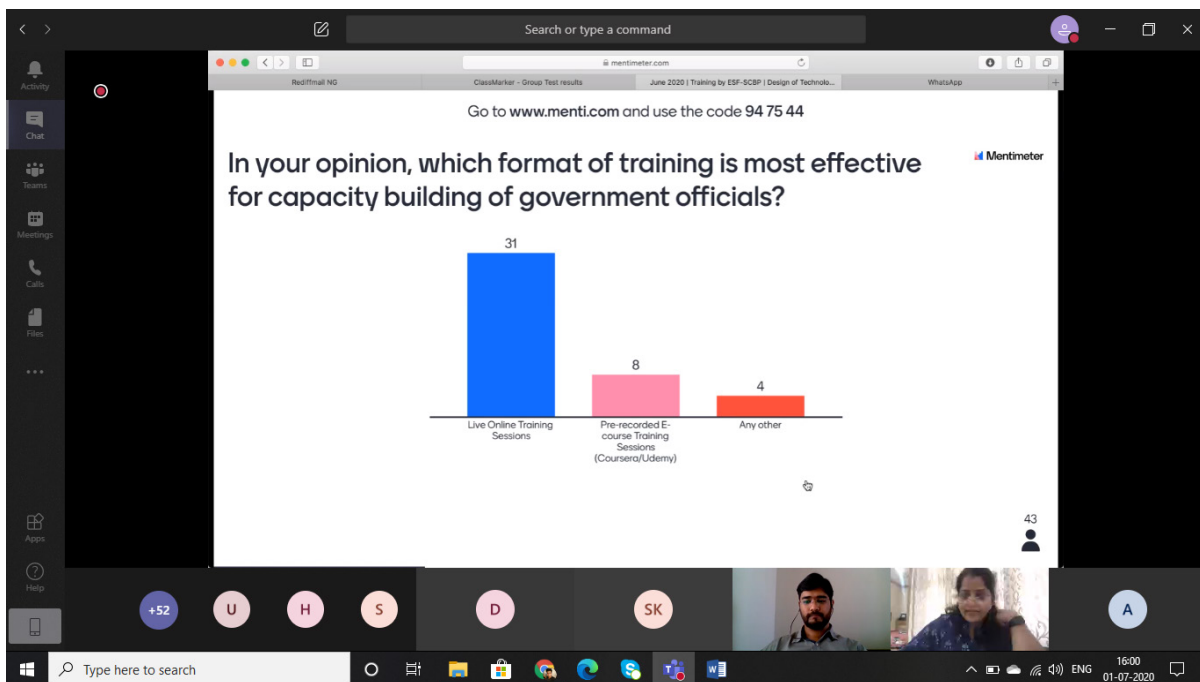
After the Q&A session, live quiz covering the topics for the whole training was conducted for all participants present.

Figure 22: Results of the live quiz



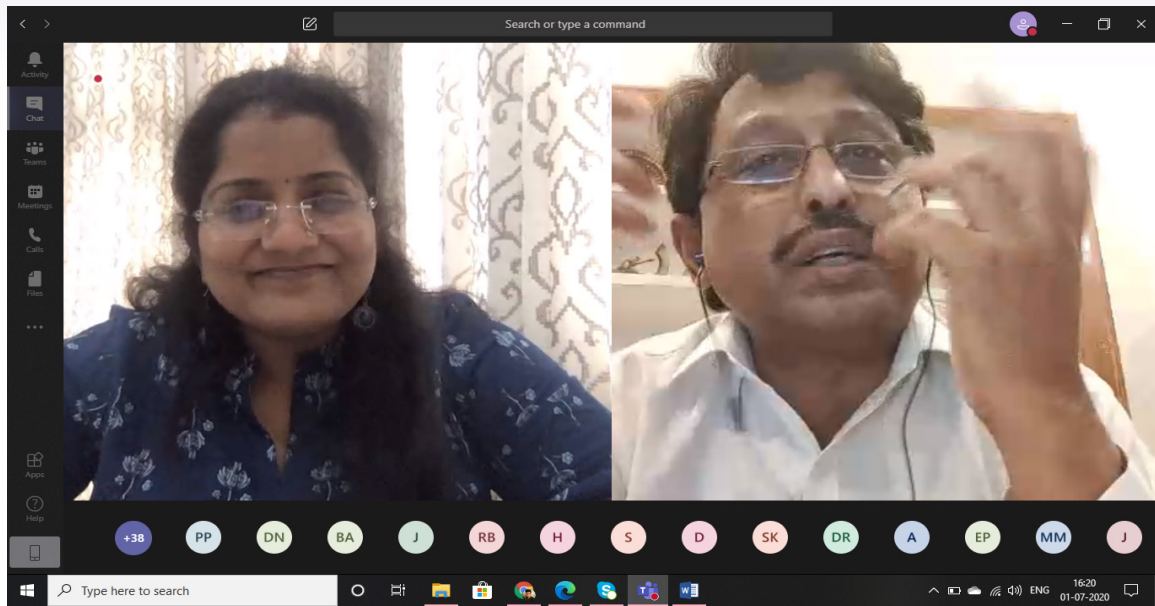
After the online quiz, a live feedback was taken from all the participants through Mentimeter platform.

Figure 23: Live online feedback



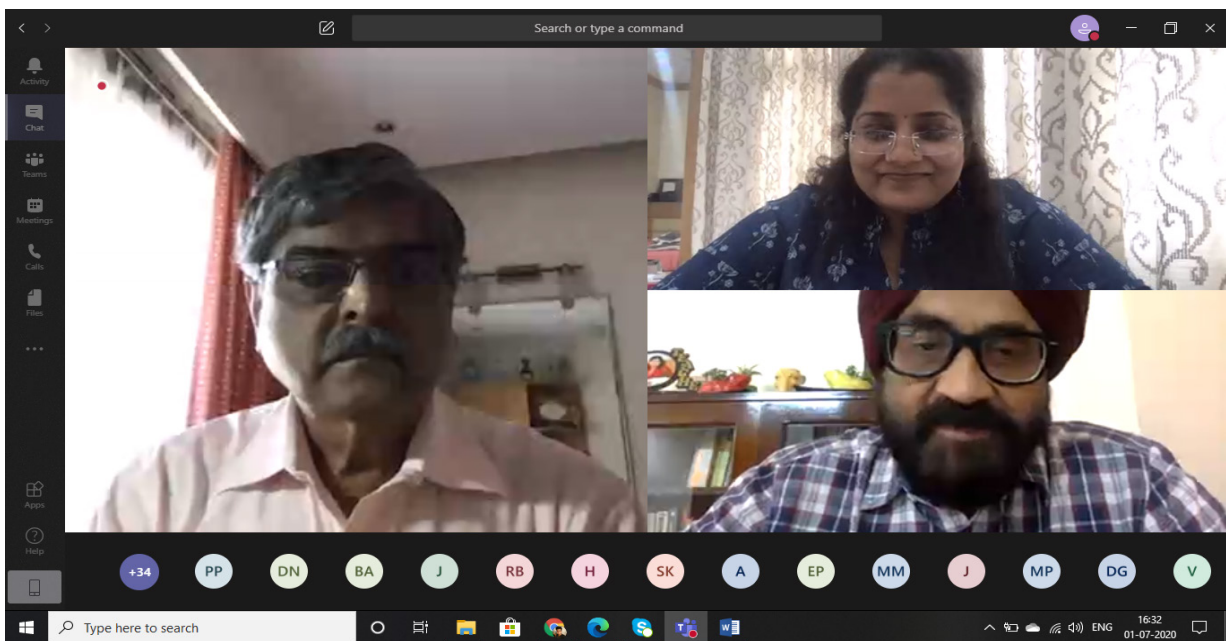
After the feedback, the certificate issuance criteria & it's process was explained by the moderator to all participants. Some of the participants were requested to share their live feedback, their whole experience & learnings from this training.

Figure 24: Mr. Manoj Pandey sharing his feedback



After the feedback session, the moderator invited Dr. Dayanand Panse, Director, ESF & Mr. Depinder Kapur, Team Lead, SCBP, NIUA for a vote of thanks to end this training program.

Figure 25: Dr. Dayanand Panse & Mr. Depinder Kapur Sharing Their Vote Of Thanks To Everyone



FEEDBACK

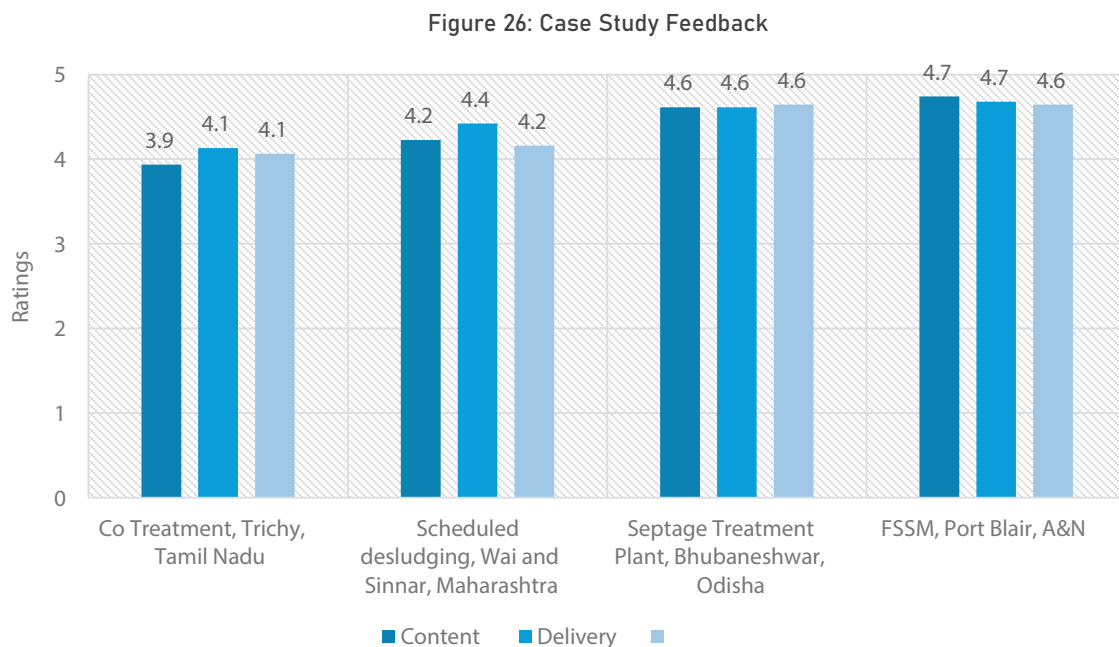
Feedback

Providing feedback towards the training as well as case studies shared during the training program was voluntary. Up to 60% of the participants have shared their feedback.

Considering the feedback carried out for case study and the overall training, following inferences were drawn.

Case study feedback

The chart below depicts the overall ratings received from the participants for the case studies that were showcased during this training. The ratings are out of 5. Overall, the participants liked the different case studies presented by the respective experts.



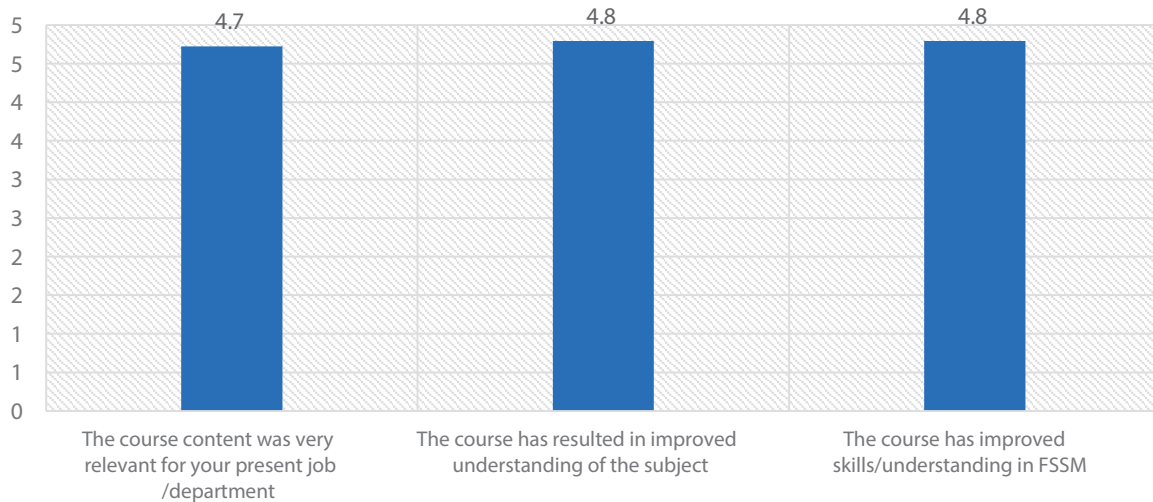
Following is the feedback with respect to each case study which was provided by the participants:

- ◆ Co treatment, Trichy: The case study included basic information regarding the receiving station and the co-treatment of septage with sewage at the STP. However, most of the time was spent on the theory part of co-treatment rather than focusing on the interventions done to set up a decanting station at the pumping station and the impact and mitigation of co-treatment at the STP.
- ◆ Scheduled desludging, Wai: The case study included ODF and ODF+ journey of Wai, operation of the scheduled desludging, treatment plant and learnings. Participants expressed their willingness to know more about the planning and monitoring of the scheduled desludging at city scale.
- ◆ Septage Treatment Plant, Bhubaneswar: The case study focused on selection of the technology, photos from the actual plant, data from monitoring of the plant and operational and maintenance challenges and their mitigation. Participants found the case study to be very helpful and requested to get in touch with the resource person for getting further details on design of the treatment units.
- ◆ FSSM, Port Blair: The case study was based on DPR preparation of FSSM for city of Port Blair. In this study, focus was given on each stage of DPR preparation – data collection, analysis of data, selection of technology, financial calculation of life cycle cost, cost recovery options for the ULB. Participants took interest in the case study and had requested for the copy of the DPR to get in-depth knowledge about each component of the DPR.

Training Feedback

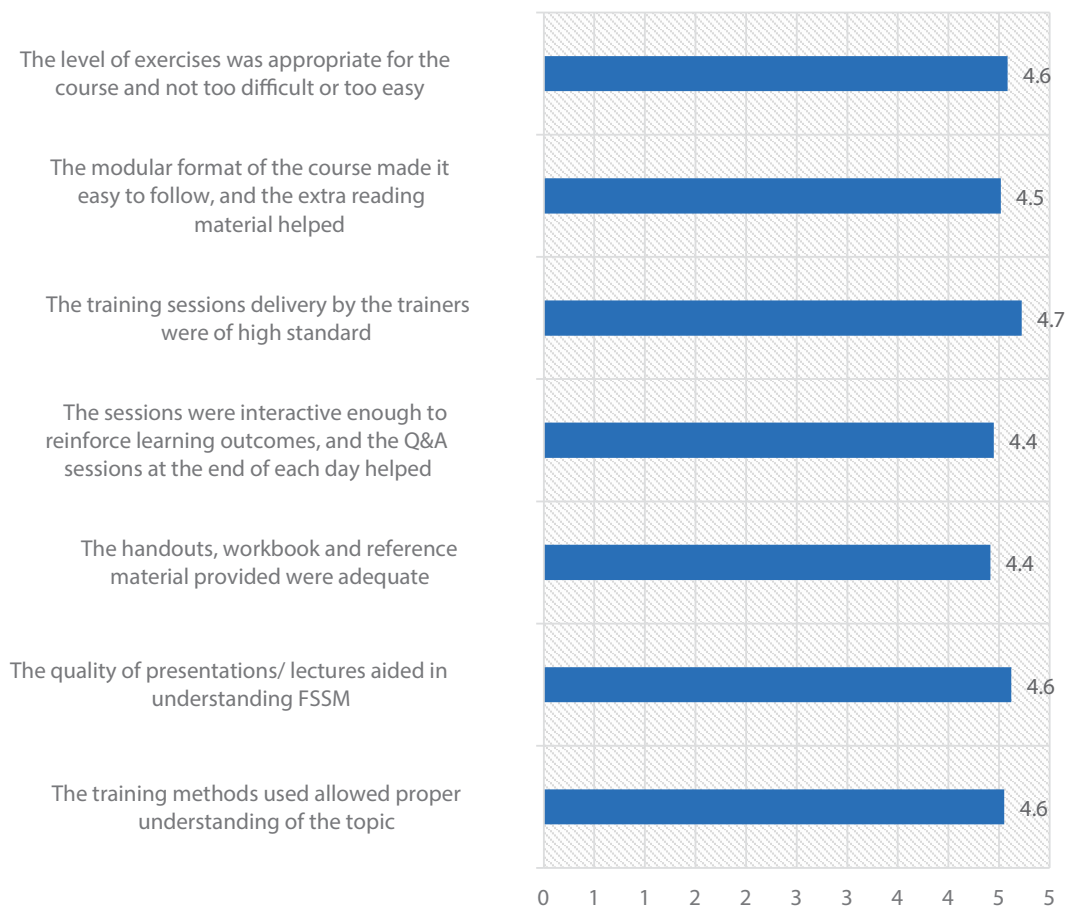
The table below represents the feedback of the participants where they have indicated their satisfaction from this training program. The ratings are out of 5. It has been observed that all participants have approved of the course content which is related to their current work profiles and the course has improved their understanding about FSSM.

Figure 27: satisfaction with Overall Training



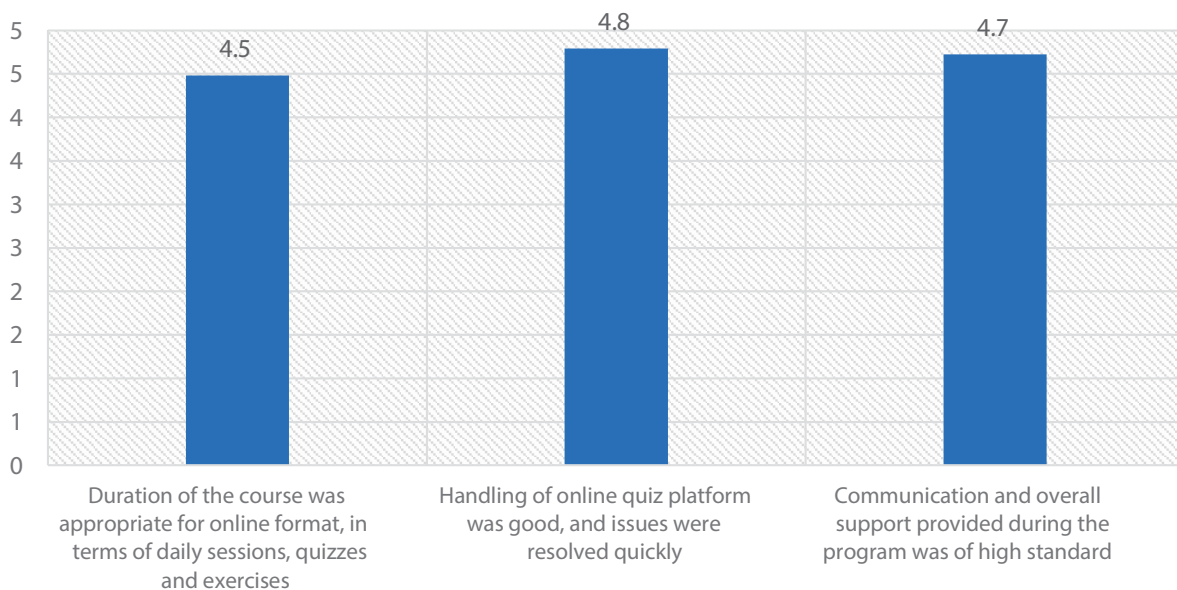
The table below shows the ratings for various aspects while conducting this training. The total ratings are out of 5. It has observed that all the ratings are in the range of 4 - 5, which infers that all the participants were satisfied with the training content and methodology for delivery.

Figure 28: Feedback on Training content & training methods



The chart below displays the overall ratings pertaining to the online training program management. The total ratings are out of 5. All the participants were very satisfied with this whole training scheduling & its management.

Figure 29: Feedback on Online training program management



The table below showcases the challenges participants faced or experienced during this online training course & their count for each of those challenges. Being an intensive course with consecutive 10 days of sessions, the participants found the duration provided for completing the exercises inadequate. Participants were working professionals and hence, time management was quite critical. A similar feedback was received pertaining to the time slot (schedule) of the sessions.

Figure 30: Different Challenges Faced by the participants in the Exercises

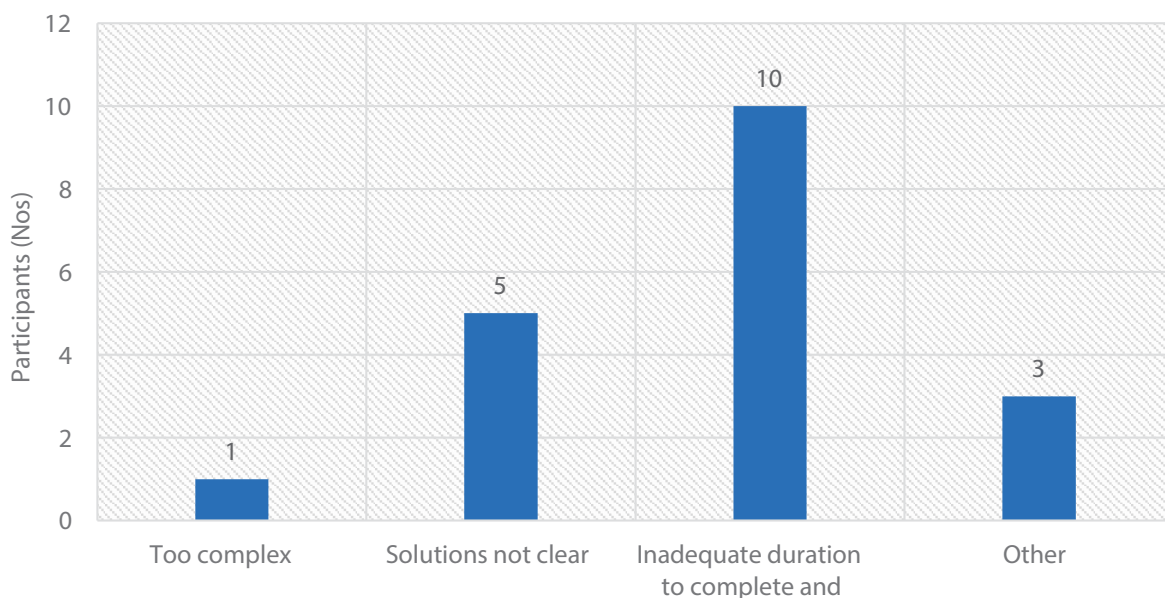
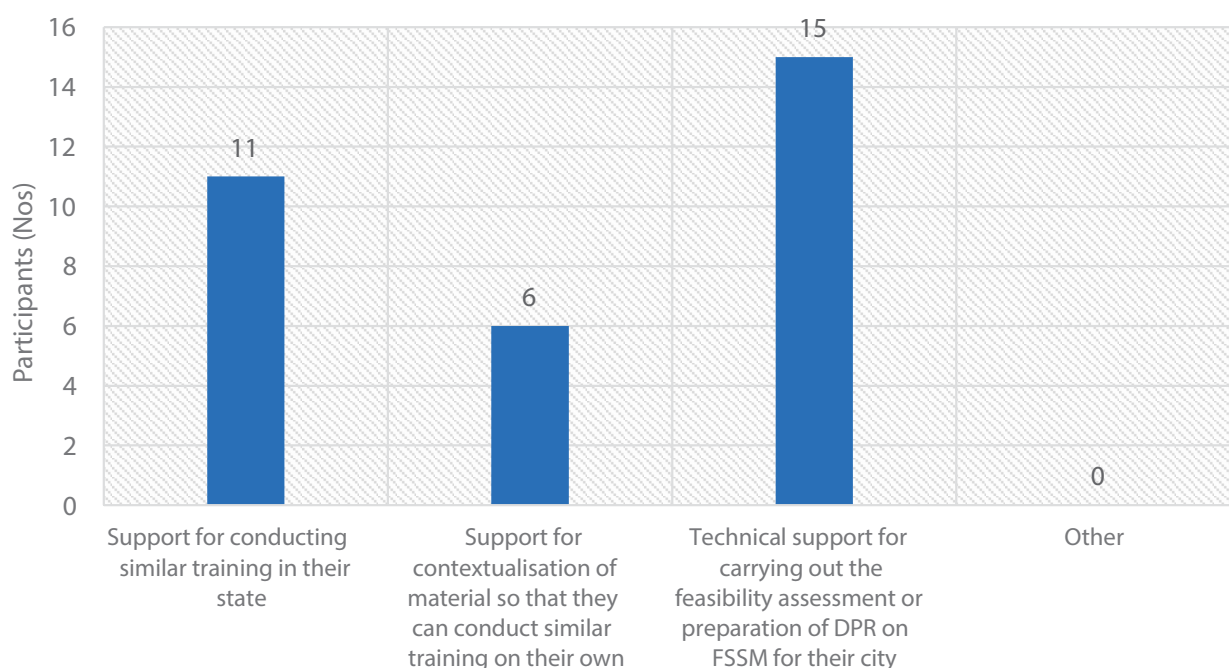


Figure 31: Challenges faced by Participants in Online Training Delivery Part

The chart below shows the results for all the participants who require support further in various capacities for implementation activities in their respective states. The total number of participants who require such support for such capacities has been given below:

Figure 32: Further support required from NIUA/SCBP



Testimonials by the participants

The table below presents some of the valuable comments that have been shared from the participants in their feedback forms.

Table 2: Testimonials from participants

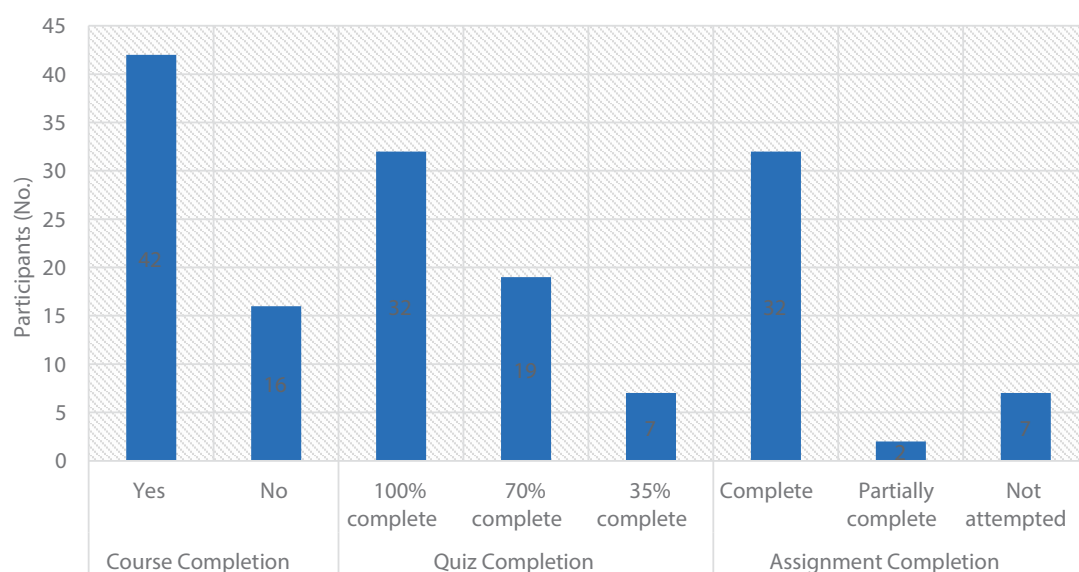
SR. NO	NAME OF THE PARTICIPANT	ORGANIZATION	Testimonial
1	Ms Pushpa Martin	Jharkhand state sewerage department	The FSSM online Certificate Training Program was very effective and helpful for professional working on FSSM.
2	Ms Anisha Dey	WASH Institute	Wonderful programme, the interactive session and it was very helpful in clearing the doubts. Congratulation to the organizing team.
3	Mr Vivek Raj Pandey	IPE Global	This online training exceeded my expectations and changed my thoughts for such online platforms! It was extremely well-planned with engaging materials. What impressed me the most about this course is the quality of the presentation, the interesting case studies of Andaman and the way team NIUA planed and arranged all the training materials within timeframe. The timely support on queries offered by presenter on the online forums e.g. WhatsApp has been great. Inclusion of specifically tailored suggested readings have made this training, quizzes and exercise truly innovative. I would recommend others taking similar training. It's super intensive with lots of reading involved. The time slot for working professionals like us was challenging yet very rewarding! Thank you NIUA & ESF for all your support. Hope to see more of you in future.
4	Mr. Manoj Pandey	ATI, Nainital, Uttarakhand	The training was wonderful and very engaging. There was lot of in-depth learnings about FSSM from the practioners perspective. The resource persons had good understanding of the subject matter and never left the questions unanswered or unattended. The buddy system between Mr Dhawal and Mr Saurabh for clarifying the doubts in the chat box helped the participants while conducting the sessions. Overall, the training will definitely help us to conduct similar training in the state to build capacities of officials at state level.

5	Mr. Kaushik Ghosh	ATI, Kolkata, West Bengal	The training was interesting and provided lot of useful information. Due to the mix of case studies and videos, the session was made engaging. The exercise made sure that the concepts explained in the session could be put to use and applied to solve the problems. Thus, ensuring holistic learning.
6	Ms. Jega Loyal	Indian Institute of Human Settlement (IIHS)	The exercise was very engaging and helped practioners like us to apply the knowledge gained and test it out. The doubts and queries raised while solving the exercise offline were clarified by the resource person through chat without any delay even on weekend. This allowed us to solve the exercise smoothly.

Learning Impact Assessment

The training program saw active participation by 58 participants from different organisations. The overview of this is presented below:

Figure 33: Overview of course completion



As per the overall course statistics, it can be interpreted that the course was successfully completed by 72% (42 out of 58) of the participants over the period of 11 days. The basis of completion of the training course was determined by (a) attendance for the sessions, (b) evaluating the participants attempt to 10 session quizzes, (c) submission of the solutions to the exercise and (d) scores of the final quiz (which was conducted live during the closing session).

The participation of women in the online training was significantly higher as compared to a face to face training. In this online course 33% (19 out of 58) of the participants were women. It is also interesting to note that 79% (15 out of the 19) women participants completed the course successfully whereas only 69% (27 out of 39) men completed the course. It was also noted that most of the women participants had given a sincere attempt to the exercise and had actively engaged with the resource persons by asking relevant questions.

The learning impact of the training program was assessed depending upon same criteria listed above. 96% of the participants scored more than 1/3rd of the total marks i.e. more than five in the final quiz. Approximately 40% of the participants who attempted the final quiz, scored more than 2/3rd. The highest score of 14 out of 15 was received by 3 participants.

It was observed that all the participants who had attempted all the quizzes and the completed the exercises scored well, thus reinforcing the fact that participants who showed interest and dedication towards the training program benefited significantly in terms of improving their knowledge about FSSM.

Learnings and Way Forward

In a face to face training programs, the participants are motivated to attend the training and learn. In this case, the participants are away from day to day work and hence, it is relatively easy to capture their attention and maintain their interest for the trainers. The trainer as well as trainees are connected in person and hence, the learning is accelerated and ensured. Following are the learnings from the online training conducted:

Agenda and schedule

The agenda should be tailored for the target audience. A training program having focussed topic for appropriately targeted audience has more impact.

The schedule of the session needs to be carefully planned. If the sessions are to be conducted during weekdays, the time slot should be either start of the working hours or the end of the working hours. This allows the participants to manage their time well with the daily work.

The orientation training having 5-6 session in case of face to face training should be condensed into 3-4 sessions (60-90 minutes in each) and conducted over a duration of 2-3 days.

The advanced trainings which are usually conducted for up to 3 days in face to face format should be ideally split into 10 -12 session (60-90 minutes each). The duration of such courses can be based on the type of the target audience. In case of working professionals in private organizations, the course can be conducted in 10-12 days. However, in case of government officials belonging to parastatal agencies and ULBs, the same course should be conducted over a longer period.

Content

The content of the sessions needs to be adapted for the online delivery of the sessions. It is recommended to use images and illustrations to state the point. The flow of the topics plays an important role to retain the attention of participants. The session should begin with easy to grasp concepts leading into more detailed and important points. Each session should focus on not more than 5 points.

The duration of the session can be up to 90 min, provided the session is a good mix of PowerPoint presentation, audio visual aids such as information videos, case studies, quiz etc.

Exercises

All the activities and exercises conducted in face to face training cannot be conducted in online training program. The exercises should be split in such a way that they go along with the session.

Simple and basic exercises can be conducted online during the session, however, for more elaborate exercises, it is recommended that they be attempted offline by the participants. For this, the trainers need to ensure that participants understand the concepts needed for solving the exercise during the online session.

Resources

For an online training program, it is recommended that there is moderator. The moderator's job is to put together different elements of the session together and introduce to the participants. Moderator also plays an important role in case there is technical glitch at the resource person's end.

For each session of the training program, it is recommended to have at least 2 resource persons. While one

resource person is engaged in the delivering the session, the other resource person can answer the queries, which the participants are posting in the chat box. Clarifying the queries of the participants when they are raised is important to maintain their interest in the session. The questions, which are not related to the topic of discussions are noted by the moderator and discussed with the lead trainer after the presentation is done.

Assessment

Assessment in the form of quizzes is important. Ideally short quizzes (up to 10 questions) with multiple choice questions should be conducted on each session. The formation of the questions is dependent on the level of the blooms' taxonomy. There should be a time duration for each quiz. For multiple choice questions, 1 to 1.5 min per questions (depending upon the difficult level) is suggested.

In case of orientation training program, the aim is to introduce the participants to the concept and make them aware about certain approaches. For such training the questions should be direct. This allows the organizers to check, the participants have grasped and retained the key message from the session.

In case of advanced courses, the aim is to enable the participants not only to grasp and retain but to apply the concepts for solving a problem. Hence, in this case, indirect questions should be used in the quiz. This requires the participant to retrieve the information from memory, analyse the question at hand, apply the concept and solve the question.

It is recommended that the session quizzes be conducted offline in order to save time during the online session.

The final quiz consisting of all the questions on all the topics covered in the online training program can be conducted online. In this case, the time duration given should be not more than 1 min per question. This ensures that the difficulty level is not increased when compared to usual session quiz.

Platform

The platforms used for conducting the online sessions, quiz and feedback play an important role to determine the user experience of the participants. A good user experience ensures and maintains interest of the participants in the various elements of the training program.

Microsoft Team was tested during the first training. The platform is user friendly and was easy for the participants to adapt. Despite this, the participants were frequently facing issues with the audio and video quality due to network issues which was also mentioned in the feedback.

Another popular platform is Zoom. Zoom does not consume higher bandwidth and also gives an option to switch off the audio/video of the participants by the host. Thus, improving the audio/video quality of the online sessions. It also has features such as breakout rooms, white board, dedicated Q&A box and chat box for participants.

Classmarker proved to be very resourceful platform for conducting quizzes. The summary of the quizzes was provided on dashboard and could also be exported in various formats for further use.

For online polling, Mentimeter is a good platform. The representation of the polling is through interactive illustration which is nice for the participants and the organizer to see.

For feedbacks, there are multiple platforms, however Google Forms are the most convenient platform. Feedbacks can be used not only to improve the further training but also to allow the participants to self-assess their individual learnings from the training program.

Learning Management System

A Learning Management System (LMS) or a portal can be developed which will eliminate the need of using different tools and platforms. The LMS can integrate the following tools:

- ◆ Training calendar with brief information about each training consisting of Introduction to the course, resource persons, profile of the organizers etc.
- ◆ Registration portal with online payment gateway.
- ◆ A repository of the resources pertaining to all the trainings (accessible only after registration to the training).
- ◆ Integrated online training platform to live delivery of the sessions.
- ◆ Question and answer section/discussion forum dedicated for participants to post queries during the training.

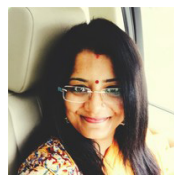


- ◆ Exercise can be also converted in to an online format where in the participants have tools such as calculator ready on the screen for use.
- ◆ To reduce the number of queries, hints can be provided at certain stages of the exercise which will help the participants to smoothly carry out the exercise.
- ◆ Forums on discussing the topics and sharing of knowledge during and after the training.
- ◆ Quiz platform for the participants to attempt the quizzes.
- ◆ Feedback portal for the training.

The LMS not only improves the user experience for the participants during the training but also eases the efforts of the organizer to put together various lists containing information of the participants and the results from various platform. Such a platform can be also made mobile friendly, so that participants can use the forum and other tools easily.

ANNEXURE

Annexure 1: List of Resource Persons

Table 3: List of Resource Persons

SR NO.	NAME OF THE RESOURCE PERSON	ORGANIZATION	ROLE	Profile Photo
1.	Ms Sreevidya Satish	Ecosan Services Foundation	Moderator	
2.	Mr Dhawal Patil	Ecosan Services Foundation	Lead Trainer	
3.	Mr Saurabh Kale	Ecosan Services Foundation	Lead Trainer	
4.	Mr. Santhosh Ragavan K V	Indian Institute of Human Settlement (IIHS)	Guest Speaker	
5.	Ms. Arwa Bharmal	Centre for water and Sanitation (C-WAS)	Guest Speaker	
6.	Mr. Binod Kumar Sahoo	Odisha Water Supply and Sewerage Board (OWSSB)	Guest Speaker	

Annexure 2: List of Participants

The following table presents the details of the officials, staff with whom we have discussed about the design of treatment systems for Faecal Sludge and Septage Management (FSSM).

Table 4: List of Participants

No.	Organisation Name	Nominations	Email Id
1	RCUES Lucknow	Dr. Rajeev Narayan	narayanrajeev1963@gmail.com
2		Dr. Alka Singh	alka.rcueslko@gmail.com
3		Mr. Ajit Mishra	ajit.rcueslko@gmail.com
4	UP Jal Nigam/Jal Sansthan	Mr Naushad Ahmed	naushad.kaif7@gmail.com
5		Mr Sani Singh	up30j9400@gmail.com
6		Mr Ajmal Hussain	azmalhussain2390@gmail.com
7		Mr Mohd Adeem	adeem.jn@gmail.com
8	Jharkhand State Sewerage Department	Mr. Navneet Kumar	navneetmswm@gmail.com
9		Mr. Brajesh Ranjan	ranjan1001057@gmail.com
10		Mr. Chandan Kumar	chandanp2003@gmail.com
11		Ms Pushpa Martin	martin_pushpa@yahoo.com
12	KILA/ Suchitwa Mission	Er Resmi PS	aeresmi@gmail.com
13	ATI Mysore	Mr Chandra Naik O	chandranayaksiud@gmail.com
14		Mr Alec Lobo	aleclobo@gmail.com
15	ATI Nanital	Mr Manoj Pande	manojpande64@gmail.com
16	UDD Uttarakhand	Mr Ankit Bhandari	amrutuk.udd@gmail.com
17	Uttarakhand Jal Nigam (Uttarakhand Peyjal Nigam)	Mr Madhukant Kautiyal	eepeyjalnigam_ksp@yahoo.in eepiuamrutksp@gmail.com
18		Er. Deepak Malik	dmalik.ce@gmail.com
19		Er. Sandeep Kashyap	gangarishikesh2017@gmail.com
20		Er. Meenakshi Mittal	meenakshimittal16@gmail.com
21		Er. Diksha Nautiyal	nautiyaldiksha31@gmail.com
22	Uttarakhand Jal Santhan	Mr Anuj Kumar Pandey	anujujs@gmail.com
23	ATI Kolkata	Mr Kaushik Ghosh	kaushik.gh@gmail.com
24	EY Odisha	Mr. Shougat Sathapathy	Shougat.Satpathy@in.ey.com
25		Mr. Pavan Kumar	Pavan.Kumar2@in.ey.com
26	OWSSB, Odisha	Mr Basanta Prased Dakua	basantaprasaddakua@gmail.com
27		Ms Suryabarti Majhi	smajhi17hud@gmail.com
28		Mr Rajendra Kumar Sethy	rajendrasethy77@gmail.com
29	IPE Global	Mr Muqthar Ahmed	mahmed@ipeglobal.com
30		Mr Vivek Raj Pandey	vpandey@ipeglobal.com
31		Mr Suraj Kumar	surajkumar@ipeglobal.com

32	KPMG	Mr Ranjit Kumar	raj.passion232@gmail.com
33	WASHI	Ms Janani R	janani@washinstitute.org
34		Ms Sana Salah	sana@washinstitute.org
35		Ms Pooja Saini	pooja@washinstitute.org
36		Mr Abesh Das Gupta	abesh@washinstitute.org
37		Dr. Priya Goyal	priya@washinstitute.org
38		Mr Pankaj Kumar	pankajkumar@washinstitute.org
39		Mr Nadeem Khan	nadeem@washinstitute.org
40		Ms Swati Bhatia	swati@washinstitute.org
41		Ms Saumya Pandey	Saumya.pandey@washinstitute.org
42		Ms. Anisha Dey	Anisha@washinstitute.org
43		Mr Vipul Gulati	vipul@washinstitute.org
44		Mr Sampath Gopalan	sampath@washinstitute.org
45		Ms Jayashree	Jayashree@washinstitute.org
46		Ms. Snehlata Jaiswal	snehlata@washinstitute.org
47		NIUM	Ms Prasanna
48	Ms Nazma		nazma.s@nium.org.in
49	CED	Mr Reghukumar	reghukumar@cedindia.org
50		Dr Radhakrishnan	radhakrishnan@cedindia.org
51		Mr Sri Jayaram	jayarams_1958@rediffmail.com
52	ESCI	Ms Anita Agarwal	em@escihyd.org
53	MCRHRD	Mr B.Vijaykumar reddy	vijay2761@gmail.com
54		Mr Rambabu	rambabuc@mcrhrdi.gov.in
55		Mr Prasanna Kumar	mlprasannakumar@gmail.com
56		Mr Subramanyam	ssmanyamstp2@gmail.com
57		Mr Bhaskar Reddy Sane	segwmc@gmail.com
58	IIHS	Mr Sivaraj	sivarajdcebe@gmail.com
59		Mr Fayaz	fayazdil.rpt@gmail.com
60		Ms Jega Loyal	enlit.iihs@gmail.com
61		M Monissha	mmonissha@iihs.ac.in
62		Ms Kalpana	kalpanapalanisamy@gmail.com
63		Mr Shrinivas Tarnalkar	shrinivastvg@gmail.com
64	Delhi Jal Board	Mr. Ashish Kumar Gupta	ashishkr.gupta88@gov.in
65		Mr. Anirudh Dube	anirudh.dube88@gov.in
66	Athena	Mr. Arjun Sharma	arjun.sharma2011@vitalum.ac.in
67	Ecosan services	Mr Abhishek Sakpal	abhishek.sakpal@ecosanservices.org
68		Ms. Radhika Boargaonkar	radhika.boargaonkar@ecosanservices.org
69	NIUA	Mr Shantanu Padhi	spadhi@niua.org
70		Mr B. Ashwin	bashwin@niua.org
71	Consultant	Mr Parth V Kamath	parthvk@outlook.com

Annexure 3: Detailed Session wise Agenda

Date	Session	Topic	Contents	Resource Person	Duration [min]
17 June 2020		Introduction	Introduction to the training module Getting acquainted with the training platform Setting up the ground rules	Ms. Sreevidya Satish	15
	S1a	Introduction to Faecal Sludge and Septage Management	Sanitation System Approach Wet Sanitation Systems Sanitation Service Chain Challenges in Sanitation Services	Mr. Dhawal Patil	50
	S1b	Characterisation of Faecal Sludge and Septage	Parameters for characterizing Categories of sludges Operational factors affecting the characteristics		
		Question and answer		Mr. Dhawal Patil & Mr. Saurabh Kale	10
	Q1	Quiz (Multiple choice questions)		Ms. Sreevidya Satish	5
	E1	Introduction to the exercise	Profiling the region for FSSM, Understanding the demographic and climatic conditions Realizing the constraints for FSSM	Mr. Dhawal Patil	10

18 June 2020		Recap of session 1		Mr. Saurabh Kale	5
	S2	Quantification of Faecal Sludge and Septage	Need of quantification of sludge Methods of quantification of sludge Operational factors to be considered while quantification	Mr. Saurabh Kale	40
	C2	Case study - Port Blair, Andaman and Nicobar Islands	Quantification Approach based on Sludge Collection Method.	Ecosan Services Foundation	20
		Question and answer		Mr. Saurabh Kale & Mr. Dhawal Patil	10
	Q2	Quiz (Multiple choice questions)		Ms. Sreevidya Satish	5
	E2	Introduction to the exercise	Quantification of faecal sludge and septage at the city scale Understanding the requirement of emptying and conveyance of sludge Assessing the quantum of sludge to be treated	Mr. Dhawal Patil	10
19 June 2020		Recap of session 2		Mr. Saurabh Kale	5
		Solutions for the exercise	Workbook: Part A & B Section 2	Mr. Dhawal Patil	10
	S3	Emptying and Conveyance of Faecal Sludge and Septage	Types of desludging methodologies Technical options for emptying and conveyance Optimising emptying and conveyance	Mr. Saurabh Kale	30
	C3	Case study - Wai & Sinnar, Maharashtra	Planning of scheduled desludging, Number and types of vehicles used, Contracting and financing, Learnings and challenges.	CEPT / AILSG (TBC)	20
		Question and answer		Mr. Saurabh Kale & Mr. Dhawal Patil	10
	Q3	Quiz (Multiple choice questions)		Ms. Sreevidya Satish	5
	E3	Further reading material	Guidelines, Advisories and Manual Scavenging Act and Rules 2013	Mr. Dhawal Patil	10
20 June 2020	Submission of the solutions for the exercise conducted in the after session 2. The submissions of the solutions to the exercise are mandatory for completion of the course.				

22 June 2020		Recap of session 3		Mr. Dhawal Patil	5
	S4	Treatment of Faecal Sludge and Septage	Treatment targets and specific objectives Approaches for faecal sludge and septage management Treatment mechanisms Driving factors for selection of treatment mechanisms	Mr. Dhawal Patil	40
	C4	Case study - Co treatment of septage at STP	Mode of addition of faecal sludge & septage, Standard operating procedure, Impacts of co treatment at STP, Financial aspects of co treatment.	IIHS / OWSSB (TBC)	20
		Question and answer		Mr. Dhawal Patil & Mr. Saurabh Kale	10
	Q4	Quiz (Multiple choice questions)		Ms. Sreevidya Satish	5
	E4	Introduction to the exercise	Decision making criteria for components of treatment at the treatment plant. Do we need a digester or a stabilization tank?	Mr. Dhawal Patil	10
23 June 2020		Recap of session 4		Mr. Dhawal Patil	5
	S5	Septage Receiving Station	Objectives and Design of septage receiving station Components of septage receiving station Type of septage receiving station	Mr. Saurabh Kale	60
	E5	Informational videos	Septage receiving station Integrated Mechanized Septage Receiving Station	Mr. Dhawal Patil	20
		Question and answer		Mr. Saurabh Kale & Mr. Dhawal Patil	10
	Q5	Quiz (Multiple choice questions)		Ms. Sreevidya Satish	5

24 June 2020		Recap of session 5		Mr. Dhawal Patil	5
	S6	Non-mechanized Treatment Units of Faecal Sludge and Septage & its Design	Stages of treatment of faecal sludge and septage Non mechanized treatment units Designing of - Settling Thickening Tank Anaerobic Digester Unplanted Drying Beds	Mr. Dhawal Patil	40
	C6	Case study - Septage Treatment Plant, Bhubaneswar, Odisha	Selection of treatment technology, Scaling up of technology, Implementation, O&M of the plant, Financial aspects	Odisha Water Supply & Sewerage Board	20
		Question and answer		Mr. Dhawal Patil & Mr. Saurabh Kale	10
	Q6	Quiz (Multiple choice questions)		Ms. Sreevidya Satish	5
	E6	Introduction to the exercise	Designing of Settling thickening tank, Anaerobic digester, Unplanted drying beds for treatment plant	Mr. Dhawal Patil	10
25 June 2020		Recap of session 6		Mr. Dhawal Patil	5
		Solutions for the exercise	Workbook Part A: Section 4 & 5 Part B: Section 4, 5 & 6	Mr. Dhawal Patil	10
	S7	Mechanized Treatment of Faecal Sludge and Septage	Stages of treatment of faecal sludge and septage Mechanized treatment units Selection of - Dewatering technology, Drying technology Thermal treatment	Mr. Dhawal Patil	50
		Question and answer		Mr. Dhawal Patil & Mr. Saurabh Kale	10
	Q7	Quiz (Multiple choice questions)		Ms. Sreevidya Satish	5
	E7	Introduction to the exercise	Understanding sludge dewatering equipment and its input design criteria, How to assess the type of equipment required for sludge drying? How to carry out feasibility of thermal treatment of sludge?	Mr. Dhawal Patil	10

26 June 2020		Recap of session 7		Mr. Dhawal Patil	5
		Solutions for the exercise	Workbook Part A: Section 6	Mr. Dhawal Patil	10
	S8	Financial aspects of FSSM	Financial components of FSSM Financial and contracting models	Mr. Saurabh Kale	40
	C8	Case study - Port Blair, Andaman and Nicobar Islands	Annualized Cost method for calculating the project cost, Reuse of end product, Recommended financial model.	Ecosan Services Foundation	10
		Question and answer		Mr. Saurabh Kale & Mr. Dhawal Patil	10
	Q8	Quiz (Multiple choice questions)		Ms. Sreevidya Satish	5
	E8	Introduction to the exercise	To calculate the revenue stream from sale of end products, To calculate the project life cycle cost using annualized cost method.	Mr. Dhawal Patil	10
27 June 2020	Submission of the solutions for the exercise conducted in the after session 7 & 8. The submissions of the solutions to the exercise are mandatory for completion of the course.				
29 June 2020		Recap of session 8		Mr. Dhawal Patil	5
		Solutions for the exercise	Workbook: Part A & B Section 7 & 8	Mr. Dhawal Patil	10
	S9	Siting and Layout Planning of Treatment Plant	Site characterisation and evaluation Site selection criteria Safety planning at treatment plant Importance of layout planning and examples	Mr. Dhawal Patil	60
		Question and answer		Mr. Dhawal Patil & Mr. Saurabh Kale	10
	Q9	Quiz (Multiple choice questions)		Ms. Sreevidya Satish	5
30 June 2020		Recap of session 9		Mr. Dhawal Patil	5
	S10a	Construction and commissioning of Treatment Plant	Pre construction activities During construction activities Stages in commissioning of plant Handover process of the plant	Mr. Saurabh Kale	35
	S10b	Operation and Maintenance of Treatment Plant	Integration of O&M with design of treatment plant Introduction to asset management Content of O&M plan for treatment plant Monitoring and record keeping at treatment plant		35
		Question and answer		Mr. Dhawal Patil & Mr. Saurabh Kale	10
	Q10	Quiz (Multiple choice questions)		Ms. Sreevidya Satish	5



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