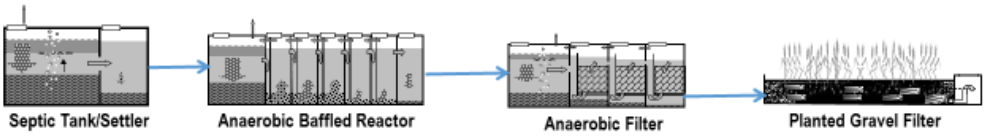
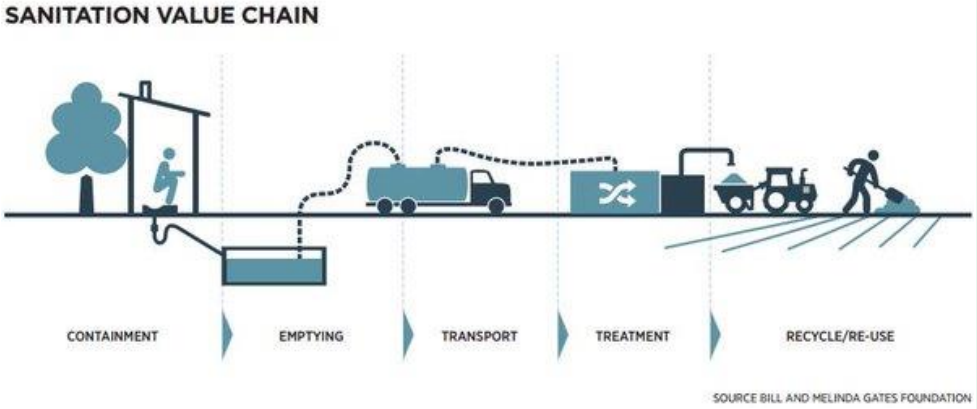
VOLUME – I

(MAIN REPORT)

A REPORT ON

DEWATS Modules





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The ENHPO team would like to thank a wide range of individual who assisted to conduct this "Training on DEWATS and FSM for Engineers" successfully. We owe particular tanks to BORDA which provided this opportunity for ENPHO. CDD Society's dedication in supporting ENPHO from the conceptualization to the finalization of the training agenda and providing support in conducting training by making resource persons available for the training. Particular thanks go to Mr. Andrews Jackob from CDD Society and Ms. Susmita Sinha from BORDA – SA for their inevitable technical supporting in facilitating the training in DEWATS and FSM discourse respectively.

Besides, we would like to express our sincere appreciation and gratitude to Mr. Gem Tshering from Ministry of Works and Human Settlement, Bhutan for his leadership and coordination for conducting this training.

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Special thanks go to all the participants including staff of ENPHO for their patience, learning attitude and proactive participation through interactions making the sessions of the training lively. Besides, the valuable inputs and discussions during the training enriched the environment for tapping the knowledge on DEWATS and FSM.

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Abbreviations

ABR	:	Anaerobic Baffle Reactor
AF	:	Anaerobic Filter
BOD	:	Bio-chemical Oxygen Demand
BORDA	:	Bremen Overseas Research and Development Agency
CDD Society	:	Consortium of DEWATS Dissemination Society
COD	:	Chemical Oxygen Demand
DEWATS	:	Decentralized Wastewater Treatment System
DPR	:	Detailed Project Report
DWSS	:	Department of Water Supply and Sewerage System
ENPHO	:	Environment and Public Health Organization
FSM	:	Faecal Sludge Management
FSTP	:	Faecal Sludge Treatment Plant
GOB	:	Government of Bhutan
GON	:	Government of Nepal
HPGF	:	Horizontal Planted Gravel Filter
KVWSMB	:	Kathmandu Valley Water Supply Management Board
LPCD	:	Litre per capita per day
MOWSS	:	Ministry of Water Supply and Sanitation
O&M	:	Operation and Maintenance
PGF	:	Planted Gravel Filter
PP	:	Polishing Pond
SA	:	South Asia
SDGs	:	Sustainable Development Goals
TM	:	Treatment Modules
WW	:	Wastewater
WWM	:	Waste Water Management

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1. Background

The South Asia (SA) region is witnessing rapid urbanization along with migration of rural population to urban areas. In recent years, sanitation progress made by SA region has been observed as a significant achievement as a result of its on-going sanitation movement and campaigns. Along with the growing urbanization, and increasing trend of sanitation coverage, Sustainable Wastewater Management (WWM) i.e. Decentralized Wastewater Treatment System (DEWATS™) and Faecal Sludge Management (FSM) are becoming growing issues in urban and peri-urban areas of this region, though they are considered as prime areas to address. The increase in the use of on-site sanitation systems such as pit latrines, septic tank demands quality FSM services even in rural areas. Despite of complexity of urban sanitation, it remains grossly undermined.

Around 2.6 billion people in low and middle income countries rely on on-site sanitation technologies that produce tons of Faecal Sludge (FS) every day. Most of the FS, yielded from pit latrines and septic tank, is dumped in the nature without proper treatment creating numerous water related diseases. The conventional treatment methods in sanitation system is becoming unpopular, especially for non-sewered communities due to its demand for large investment. The community based sanitation needs to find out the existing knowledge gap in DEWATS™ and FSM so that new innovations could be found to solve the problems related to DEWATS™ and FSM.

Lack of sufficient technical expertise for quality services, unclear policies, lack of monitoring system and lack of awareness among the general public are persistent issues. While problem is multifaceted, an overall conducive environment to deliver improved wastewater and FSM services mainly for urban areas needs to be established urgently. Strengthening local capacity that includes technical skills, private entrepreneurs, academic, research and policy support, will be a major step ahead.

Having said this, the proposed training for the engineers from Bhutan for 6 days will be one out of many steps towards strengthening the capacity of the actors in addressing the issues of urban sanitation; be it related to FSM or DEWATS™ or be it wastewater in a big picture.

2. About the Training

"**Training on DEWATS™ and FSM for Engineers**" is a platform for engineers engaged in the sanitation sub-sector to gain knowledge and skills to analyse the ground situation and promote decentralized sanitation solutions with proper DEWATS™ and FSM approaches according to the demand and site specific conditions. Appropriate and adequate off-site and on-site containment systems are imperatives for the protection of human and environmental health. The proposed training will address the current knowledge elements of this rapidly evolving field, and present an integrated solutions approach that includes technology, management and planning. The training will focus on the planning and organization of the entire sanitation service chain, from the collection and transport and treatment options, to the final end-use or disposal of treated effluent and sludge. In addition to providing fundamentals of technologies, the training will also provide guidance on how to plan a community based DEWATS™ or FSM with the involvement of all the stakeholders. This training is basically organized for building capacities of the engineers from Bhutan and Nepal in the discourse of DEWATS™ and FSM. Therefore, the training modules were developed particularly to address the needs of the training participants.

3. Objectives

The objectives of the training on DEWATS™ and FSM for engineers are primarily:

- Provide technical and practical knowledge and skills to the participants on:
    - concept and principles of DEWATS™ and FSM,
    - design and implementation aspects of DEWATS™ and FSM
- Enable participants to gain knowledge and skills for systematic planning and implementation of series of activities for collection, containment, transportation, treatment and safe disposal / reuse in FSM.
- Provide practical exposure to gain insights into the functioning of the decentralised wastewater, and faecal sludge treatment system.
- Build the capacities of trainees with analytical tools, and skills on how to select, plan, finance and implement the appropriate DEWATS™ modules[1] for wastewater treatment.
- The training sessions will be facilitated by National and International experts.

4. Structure of the report

The report is structured into two volumes, and they are:

Volume – 1: Main report – The details of the training from its opening ceremony till the closing day has been summarized together with the key discussion (Q&A) that took place between the participants and the session facilitators.

Volume – 2: Annexes of the report – The necessary supporting information and evidences are gathered for detail information in this volume of the report.

5. FACTs about the training

Facts about the training	Value	Remarks
Name of the training	Training on DEWATS™ and FSM for Engineers	
Location	Hotel Marshyangdi, Kathmandu	
Organizer Category	Not for profit organization	
Subject Category	DEWATS™ and FSM	
Target Audience	Practitioners from Govt. of Bhutan, Nepal, ENPHO and BORDA Nepal	
No of participants	18 (8 International and 10 national)	Refer Annex-2 for the list of participants
No of agencies represented	4 (2 Government Institutions and 2 Not for profit institutions)	
Duration of the training	6 days	
Dates	17 – 23 May 2017	
Evidences of the training	Photo, List of participants, Training evaluations (pre and post-test, overall training feedback etc.)	Refer Annex–1, & Annex-5

[1] *DEWATS™ Modules: Various components of DEWATS™*

6. Participant's Profile

A total number of 16 persons attended the training. The participants in total represented two countries. Participants originated from Nepal, Afghanistan, and different parts of India. Their representing organisation is as given below.

Agency	No of Participants	Remarks
Government of Bhutan	8	Department of human settlement and physical planning
Ministry of Water and Sanitation	2	
Department of Water Supply and Sewerage	2	1 from small town project and the other from Bagmati WW treatment project
Not for profit organizations	6	ENPHO and BORDA-Nepal
Note: List of participants is given in Annex - 1		

7. Training Design

The six days' training programme was designed in such a way that the participants could get in-depth knowledge about the concept, functioning, designing and implementation of DEWATS™ and FSM. The training programme followed a participatory learning methodology and adult learning principles combining input sessions, illustrations and field practical for the active participation of the trainees.

The training methodology included theoretical as well as practical sessions which were carried out in a participatory manner. The theoretical sessions were imparted through input presentations and case study discussions whereas work sheets were provided to every participant to carry out calculations to understand the sessions on design parameters.

Practical exercises in the field were conducted to help participants develop the skill of doing feasibility studies, analysing the data and proposing decentralised technical solution appropriate to the site conditions. Exposure visits to DEWATS™ and FSM sites were organised for participants to see successful DEWATS™ and FSM units on the ground.

The training programme covered sessions on the topics:

- Introduction to water, wastewater and its characteristics
- Wastewater treatment approaches
- DEWATS™ principles & modules
- DEWATS™ design parameters
- Design of primary treatment modules
- Design of secondary treatment modules
- Design of tertiary and post treatment module
- DEWATS™ feasibility – essential requirements
- DEWATS™ construction – main requirements & construction and supervision
- Commissioning, operation and maintenance
- Sectors of application
- Exposure visit to FS and DEWATS™ treatment plant
- FSM overview- relevance and value

- Understanding of faecal sludge characteristics
- Overview of treatment technologies
- Feasibility study
- FS quantification
- Faecal Sludge Treatment Plant case study –Gulariya, Bardiya
- Bhutan case study – design development
- Enabling environment

8. Day Wise Proceedings

8.1 Day I: 17 May, 2017

The training was inaugurated by Mr. Ashish Ghimire (Chief Guest), Joint Secretary, Ministry of Water Supply and Sanitation Division amidst a formal opening session. The opening session was chaired by Mr. Bipin Dangol, Executive Director of ENPHO. Mr. Ashish Ghimire, Joint Secretary, Ministry of Water Supply and Sanitation Division, Mr. Sanjeev Bikram Rana, Executive Director of Kathmandu Valley Water Supply Management Board (KVWSMB), Dr. Laxman Joshi, Managing Director of Eco-Concern Pvt. Ltd., and Mr. Andrews Jacob, Regional Manager of CDD Society – India, were the dignitaries present at the dais. Mr. Ash Kumar Khaitu, Training Centre Manager, at ENPHO was presented as master of ceremony at the event. The program was started with the welcome note which was delivered by Mr. Rajendra Shrestha, Outreach Director of ENPHO. All the guests of the opening ceremony provided their valuable remarks during their opening speech.

8.1.1 Key remarks by the Guests

Mr. Rajendra Shrestha (Resource Person), Outreach Director, Environment and Public Health Organization (ENPHO)

Mr. Shrestha expressed his warm welcome to all the guests, participants and trainers. Mr. Shrestha mentioned that," This is the third opportunity for ENPHO to conduct international training on water and sanitation and it would not be merely training but more like sharing program". He concluded his speech by saying, "Let's do something for nature something for nation."

Fig-1: Mr. Rajendra Shrestha delivering welcome note

Mr. Andrews Jacob (Resource Person), Regional Manager, CDD Society, India

Mr. Jacob commenced his speech by acknowledging the organizing team on behalf of BORDA and CDD Society. He briefly mentioned about the history, expertise and experience of CDD Society and BORDA and difficulty in managing the human excreta. He also shared the experience of providing training on DEWATS™ to more than 1000 professionals and he opined that FSM is more like approach than technology. "We want to come together to learn the approaches of technologies," commented by Mr. Jacob. At last, he ended his

Fig-2: Mr. Andrews Jacob delivering his special remarks

remarks with the statement, “We have to be very happy and proud to be one part among the small group of experts on DEWATS™ and FSM. And let’s take an oath to implement at least two DEWATS™ this year.”

Dr. Laxman Joshi, Director, Eco-Concern Managing

Dr. Joshi mentioned that during his tenure as executive director in ENPHO, he had realized the need of private sector and had lots of discussion with the team regarding the same. He also pointed out the discussion on involvement of private sector in sanitation sector happened in The Fourth International Conference in FSM in Chennai. He stated, “Involvement of private organization is relatively new and challenging in context of Nepal. But we are taking plunge into it. I will be part of training to learn about the DEWATS™ and FSM and how Eco-Concern will be the part of DEWATS™ and FSM in demonstrating these in near future.”

Fig-3: Dr. Laxman Joshi delivering his special remarks

Mr. Sanjeev Bikram Rana, Executive Director, Kathmandu Valley Water Supply and Management and Board

Fig-4: Mr. Sanjeev Bikram Rana delivering his special remarks

Mr. Rana briefly mentioned that faecal sludge management and wastewater management are challenging issues in context of Kathmandu Valley. He added that, “This training is a very good platform in sharing knowledge on FSM and DEWATS™ and I would like to thank ENPHO for organizing it and I will be waiting for other such events.”

Mr. Ashish Ghimire (Chief Guest). Joint Secretary, Ministry of Water Supply and Sanitation Division

On behalf of Ministry, Mr. Ghimire acknowledged the effort of ENPHO and participants to have interest on DEWATS™ and FSM. “I think it’s a right time of organizing this type of training as the Government of Nepal has also been initiating the wastewater and faecal management policy. I believe this training help to build up the capacity of the engineers and technical persons that will eventually support in achieving the national targets and SDGs,” commented by Mr. Ghimire. He ended his remarks with “Inputs from training will be incorporated in the FSM policy and have a pleasing stay to foreigner.”

Fig-5: Mr. Ashish Ghimire (Chief Guest) delivering his special remarks

Mr. Bipin Dangol, Executive Director, ENPHO

First of all, he welcomed all the participants especially the participants from Bhutan, then thanked Stanzin (from BORDA) and Gem (from Ministry of Bhutan) for their contribution in organizing the training and thanked Government of Nepal for sending four participants for the training. He mentioned the need of such training at present context as the problem of FSM and WWM is emerging and human capacity in sanitation sector is lagging. Adding to Mr. Ghimire's statement regarding FSM framework, he proudly mentioned after Bangladesh, Nepal is second country in forming FSM framework. He ended his remarks with, "This training will be very interactive and wish you all the best for the training and I sincerely request all the participants to be actively participated."

Fig-6: Mr. Bipin Dangol delivering his special remarks

8.1.2 Introduction, objective and expectation of the training:

Resource Person	**Detail**
Mr. Ash Kumar Khaitu	• Introduction • Expectation collection
Methods	Interaction

The registration of all participants was facilitated by Mr. Ash Kumar Khaitu, Manager, Training Centre of ENPHO. A training kit which included course materials, related reference materials, and stationaries was handed over to the participant.

Fig-7: Introduction of participants facilitated by Mr. Ash Kumar Khaitu

After formal opening session of training workshop, introduction session was started with an activity to introduce each other and to make the training environment more easy and comfortable. Mr. Ash Kumar Khaitu opened the session by welcoming the participants. Mr. Khaitu started introduction of the participants playing a game "Name Games".

For that, each participant was provided a piece of blank white paper. They were different colour of crayons to draw picture. After that a piece of paper with the name of a participant were provided to all participant randomly. Mr. Khaitu further draw an instruction for the game and share amongst participants. The participants were asked to draw the picture of participant within two minutes. Instructions for the game are mentioned below:

- Participants should pick up the cheat (name of the participants) and draw picture of the picked up participant name.
- Should share the first impression of another participant

After two minutes they were asked to show their drawing to other participant to guess who that is? After few guess, it was disclosed who is that guy actually. At the time of introducing, we were asked to share his or her impression about that guy during their first meeting. Same process was replicated till the last one. It was funny and entertaining to start up the training workshop.

The introduction round was quite interactive, the participants thoroughly enjoyed the sessions. The introductory sessions was followed by expectation collection. Few meta cards and marker were distributed to participant to write their expectations from the training workshop. Written meta cards were collected and pasted on the white board in front of all ensuring not repeating same expectation from different participant. Following are the list of expectation of participants from the training which was collected before the session starts:

1. Learn design of locally appropriate DEWATS™
2. Design of DEWATS™
3. Technical aspect of DEWATS™
4. Operation and maintenance of DEWATS™ and FSM
5. Manage operational challenges
6. Techniques to tackle challenges during DEWATS™ and FSM implementation
7. Field visit for practical idea or field based experience
8. Situation of DEWATS™ and FSM in Bhutan, Nepal and India
9. Sustainability aspect of system
10. Exchange knowledge and experience to get more knowledge
11. Field visit for practical idea and field based experience
12. Sustainable and acceptable methods of FSM in community
13. Benefits of DEWATS™ and FSM
14. Contribution of DEWATS™ in pollution control

He informed participants that their training expectations would be addressed in the training programme. A brief outline of the six days training programme was presented to the participants. Participants were informed that there would be a few lectures and many opportunities for experience sharing and practicing through exercises and case study analysis. Participants were motivated to participate actively in the training programme. Participants were also informed about basic housekeeping details.

After the collection of the pre-test forms, a brief outline of the six days training programme was presented to the participants along with the training schedule to briefly discuss on the scheduled sessions. Participants were informed that there would be a few lectures and many opportunities for experience sharing and practicing through exercises and case study analysis. Participants were motivated to participate actively in the training programme. Participants were also informed about basic housekeeping details.

8.1.3 Knowledge mapping

Mr. Ash Kumar Khaitu introduced the knowledge mapping exercise for self-assessment of participants' knowledge regarding wastewater treatment systems, DEWATS™ and FSM so far. For that, the participants were asked to fill up the pre-test form (a four paged objective questionnaires) which was distributed to all participants to access the existing knowledge on training topics and rate their present level of knowledge individually in the format provided to them. For comparing their knowledge pre and post training test, two forms (with the same objective questionnaires) were used. Refer Section-8 for the result of the both pre-test and post-test.

8.1.4 Session 1- Introduction to Wastewater and Its characteristics

Resource Person	**Details**

Mr. Rajendra Shrestha	Introduction to wastewater and its characteristics
Training method	Power Point presentation, Interaction

In the beginning of the training, Mr. Rajendra Shrestha briefed about the water availability in the global, use of the water in human daily context. Mr. Shrestha, highlighted the accessibility of water and safe water to the human beings that "one in six people worldwide doesn't have access to safe freshwater."

Fig-8: Mr. Rajendra Shrestha with the participants during session

He presented the most important facts about water and commented the world wide water availability in 1995 and the forecast for 2025. By 2025, the water availability will be appallingly low. As well he mentioned the different use of water like drinking, irrigation, industrial usage, process water and domestic consumption.

Furthermore, the sessions highlighted the fact that only 6% of people in worldwide have the access to safe water. Mr. Shrestha also explained about the per capita consumption of water and excerpts of it is mentioned below.

Use of water	**Ltr. per capita**
Drinking	5
Cooking	5
Bathing	55
Washing of clothes	20
Washing of utensils	10
Washing and Cleaning Houses	10
Toilet Flushing	30

The consumption of water in the global context, India, and Nepal was shared amongst the participants. Meanwhile in the training, Mr. Andrews Jacob, also provided insight to the fact that participants should know the consumption of water to actually know about the wastewater. Mr. Jacob shared that only 50% of water is being treated in the capital city of India, i.e. New Delhi and also Government of India make sure that 70 lpcd water is available before laying underground drainage system.

During the session, Mr. Shrestha shared about the scenario of wastewater generation, its current management and currently facing issues and challenges with the increment of human population. The sessions also underlined the global issues of water pollution and water crisis.

A brief interaction session on types of wastewater and physical, chemical and biological characteristics of wastewater was carried out. The characteristics (physical, chemical and biological) of wastewater were explained through interaction with the participants in a participatory approach. The physical characteristics of wastewater include the various types of solids present in the wastewater, its temperature, colour and odour, electrical conductivity and turbidity. The different types of solids (Total Suspended Solid (TSS), Total Dissolved Solid (TDS), Total Solids (TS), Total Settleable Solids, Volatile Solids and Fixed Solids) were also discussed. The chemical characteristics of wastewater such as pH, Bio-chemical oxygen demand (BOD), Chemical Oxygen Demand (COD), chloride, sulphate,

nutrients like nitrogen and phosphorus and metals like cadmium, calcium, silver, zinc, sodium, etc. were also discussed. Mr. Shrestha also highlighted the differences in temperature of water with environment and wastewater. To brief more about BOD and COD, Mr. Andrew Jacob explained the quantitative relation of BOD and COD. The biological characteristics of wastewater are defined by the presence of bacteria, protozoa, viruses, algae and helminths.

It was highlighted that reconsideration of the wastewater treatment approach was necessary to overcome the technological gap between pit latrines and conventional highly sophisticated wastewater treatment plants. The session was interactive. The points mentioned by the participants set the base to introduce DEWATS™.

8.1.5 Session 2 - Wastewater Treatment Approaches

Resource Person	**Details**
Mr. Rajendra Shrestha	Wastewater Treatment Approaches
Training method	Power point presentation, Interaction

Mr. Rajendra Shrestha geared up second session of the day by explaining the objective of the wastewater treatment approaches. The current practices of sanitation systems were briefly elaborated to the participants and urged the importance of wastewater management globally. Mr. Rajendra exposed the participants to the wastewater treatment methods, technologies and approaches. The importance of wastewater treatment was emphasised with regards to environmental protection, health, and economic development. She informed that inappropriate wastewater management has negative effects on environment, culture, economy and health. The percentage of wastewater treatment in different region of world as shared by him was presented below:

Fig-9: Mr. Rajendra Shrestha presenting his slide during the session 3

Waste water treatment worldwide

Low-income countries	8 %
Lower middle income counties	28%
Upper-middle-income countries	38%
High income countries	70%

The composition of wastewater was also briefly elaborated to the participants. Mr. Shrestha underlined the importance of the wastewater particularly from pollution perspectives by providing factual argument of “1 litre of wastewater pollutes 8 litres of freshwater”. The principal of treatment methods (Reduce, Recycle, treat, and safe disposal/reuse) were also discussed during the session. Physical treatment (sedimentation and screening), chemical methods (adsorption, flocculation, coagulation, pH adjustment) and biological treatment (aerobic, anoxic and anaerobic) principles were explained. During the discussion on biological treatment of the sessions, Mr. Shrestha informed that BOD is a measure of organic substances within a wastewater to the participants.

Furthermore, design on the basis of the level of treatment were elaborated. The level of the treatment includes preliminary, primary, secondary and tertiary treatment. The treatment process in each level of treatment were discussed. The sessions was quite interactive as participants took active participation in this session on "wastewater treatment approaches".

Some of the questions raised by participants and responses are given below.

Questions and Answers:

Q. What is the difference between Recycle and Reuse?

A. Reuse means using the things without changing its form and recycle means using the things after changing its existing form to new form.

Fig-10: Participants during the energizer

Energizer:

During the mid of session 2 and 3, an energizing activity was conducted to activate the participants and make them more attentive and energetic till the end of the day. During this energizing session, the participants were divided into six groups including three members in each groups. Instructions of the game was provided to participants as follows.

Instructions:

- Each group should have a leader who will blow a balloon without using hands, and the other members of the group should support the leader in blowing a balloon
- The groups who will have a bigger size of balloon and completes in time will be the winner.

8.1.6 Session 3 - DEWATS™ Principles and Modules

Resource Person	**Details**
Mr. Andrews Jacob	DEWATS™ principle and modules
Training method	Power point presentation, Interaction

The contents of this sessions include the following:

- Concepts
- Constructions
- Operation and Maintenance
- Sectors
- Fields

Fig-11: Mr. Andrews Jacob with the participants during the session 4

Participants were informed that DEWATS™ is led by principles such as; decentralization, simplification, and conservation/recycling. These principles become the guiding frame for the design of DEWATS™. Each of the attributes of DEWATS™ technology was presented by the resource person with adequate explanation. The attributes are as per the list given below.

- Treatment for organic wastewater from domestic and industrial sources
- Affordable prices
- Fulfilment of discharge standards

- Treatment of wastewater flows from 1-1000 m3/d
- Tolerance to inflow fluctuation
- No dependence on external energy
- Minimal maintenance
- Reliability and long-lasting
- Reuse of wastewater and its contents

Mr. Andrews Jacob started his session by providing a concept of DEWATS™ and followed by this elaborative explanation of DEWATS™ as an approach than technologies. Mr. Jacob highlighted that the wastewater management was given less priority, though they are technologies that could be handled within the premises and with low cost. The participants were informed on the DEWATS™ by explaining its fundamental principle such as decentralized, simplification and conservation/recycling etc.

The primary treatment procedure in DEWATS™ was explained with examples. The design of septic tank and biogas settler was shared amongst the participants as a primary treatment unit. Participants were also made aware that DEWATS™ was the major component in addressing the gap of wastewater management. He also differentiated between centralized and decentralized system with its pros and cons and merits and demerits. At the end of the session, participants were made aware that DEWATS™ is also being integrated into urban sanitation planning as a sustainable solution to on-going sanitation problems.

Mr. Jacob again went through the WW characteristics to recap at the beginning of his session to explain DEWATS™ principle, component modules and treatment steps. He added that the treatment system takes at least 3 months to perform to perform its design value.

Description of each DEWATS™ module was provided by the resource person. Explanation on what would each module consists of, the purpose of the module, type of wastewater treatment, how each module functions, wastewater treatment efficiency and desludging period were explained in this session. It was emphasised that right combination and dimension of the modules make DEWATS™ successful. Participants were made aware that DEWATS™ is also being integrated into city sanitation planning as an effective and sustainable solution to sanitation problems.

Some of the questions raised by participants and responses are given below.

Questions and Answers:

Q. What is the difference between decentralized and centralized wastewater treatment plants?

A. Decentralized WWTP: collects wastewater within premises with low operation and maintenance cost; less volume-easy management; unsophisticated technology

Centralized WWTP: Collects large volume of wastewater with high operation and maintenance cost; sophisticated technology

Q. Can we get the continuous supply of gas from biogas digester?

A. More during afternoon and night time.

Q. Earlier DEWATS™ was called Low operation of maintenance Wastewater Treatment System (LOWATS), why the name was changed?

A. LOWATS stands for Low operation of maintenance Wastewater Treatment System. To this, people usually understood “no maintenance” so no attention was given to the treatment plant once it was constructed. So the changed the name to DEWATS™.

8.2 Day II - 18 May, 2017

8.2.1 Session 4 - DEWATS™ Design Parameter

Resource Person	Details
Mr. Andrews Jacob	• Dimensioning parameter • Additional design parameter • Design description of DEWATS™ TM modules
Training method	Power point presentation, Interaction

Mr. Andrew Jacob started the session by collecting the views of participants in designing DEWATS™. The participants suggested the following parameters that need to include while designing DEWATS™.

- Flow rate/ quantity
- Population
- Slope
- BOD, COD and solids
- Pipe chamber
- Space
- Discharge standards
- Strength of wastewater
- Rainfall data

The dimensioning parameter of each DEWATS™ were briefed to the participants. The parameters that had been discussed during the session are mentioned below:

- Hydraulic load

Standard deign parameters which need to be considered during dimensioning:

- Daily flow
- Peak flow
- Up-flow velocity
- Hydraulic retention time
- Hydraulic conductivity of filter media

Fig-12: Mr. Andrews Jacob with the participants during session 5

An example on calculating household wastewater generation was discussed and let the participants to work out the calculations on a given arbitrary example. The reading materials were given to the participants and according to that the participants performed individual exercise particularly the calculation. The additional deign parameters of DEWATS™ were also discussed with the participants. The session also includes the designs aspects for the settler, baffle reactor, anaerobic filter, planted gravel filter and polishing pond. At the end of the sessions, Mr. Jacob also elaborated the different combination of modules considered during the design of DEWATS™.

Some of the questions raised by participants and responses are given below.

Questions and answers:

Q: Can we avoid entry of storm water to sewerage?

A: In DEWATS™, yes. But in centralized wastewater system, the storm water bypass.

Q: Do we considered design time period?

A: Two design period can be considered. DEWATS™ is constructed for 20 to 25 years.

Q: In terms of population growth, is it feasible to construct the DEWATS™ for only 20 to 25 years?

A: The water budget scheme is there. They need to see the population trend and growth and provide the water supply.

Q: If input is more than 6 kg in DEWATS™?

A: Reduce the cost by increasing the settler

Q: Is it will be difficult to construct settle if we go deeper?

A: No. It will not. If we go deeper, the surface area will be increase.

Q: Is septic tank and settler tank is similar?

A: Septic tank has two compartment but settler has single compartment. So treatment efficiency of the septic tank is more than that of settler.

Q: Can't we make some washing arrangement in anaerobic filter at the bottom?

A: No. the sludge has to be pumped.

Q: When do we require a polishing pond?

A: When we have to store a water for reuse. It's optional choice; in many cases, after the gravel filter, it directly went to the sources.

Q. Optimal Desludging Period

A. Varies with the components.

Q. From the economic point of view, when should be the desludging done in settler?

A. Once in a year is good.

Q. If there is no gradient in septic tank, what will happen?

A. Choked and backflow

Q. Would it be good suggestion to provide components above ground level?

A. As long as there is space available and structure is strong, there won't be a problem.

8.2.2 Session 5 - Design of Primary Treatment Modules

Resource Person	**Details**
Mr. Andrews Jacob	Calculation on designing primary treatment modules
Training method	Power point presentation, Exercise and Discussion

The session was facilitated by Mr. Andrews Jacob. The session was particularly focused on the steps of designing primary treatment module i.e. Settler.

Participants were made to understand that the Settler tanks are underground or closed tanks with two or three compartments, which are designed to retain wastewater for a required period of time (retention period) and allow heavy solids to settle at the bottom. Due to the anaerobic condition settled solids are partially decomposed resulting in the formation of sludge which settles at the bottom. Grease and light particles floats and scum are formed at the surface of the wastewater.

Fig-13: Participants during calculating the exercises

The first compartment occupies more than half of the total volume of settler as it retains most of the scum and sludge, whereas the following compartment(s) ensures smooth undisturbed flow (avoid turbulence) into the next treatment module. To prevent scum and solids entering the next treatment module the partition or baffle wall is built. For easy access into the treatment system manhole openings are provided.

With regard to the treatment efficiency, in settler, the optimal sedimentation takes place when the wastewater flow is smooth and undisturbed. The treatment efficiency of the settler will range from 20 – 45 %.

After the input session the participants were given certain parameters based on which they carried out the stepwise calculations for designing the settler. Participants were facilitated by Mr. Andrews Jacob to complete the calculations by going through step by steps.

8.2.3 Session 6 - Design of Secondary Treatment Module

Resource Person	**Details**
Mr. Andrews Jacob	Calculation on designing secondary treatment modules
Training method	Power point presentation, Exercise and Discussion

This session was also facilitated by Mr. Andrews Jacob and was particularly focused on the steps of designing secondary treatment modules i.e. Anaerobic Baffle Reactor (ABR).

Participants were informed that the purpose of secondary treatment process is to remove the organic pollution like; BOD, COD (Chemical Oxygen Demand), suspended and settleable solids, nutrients and pathogens. A detailed explanation on ABR is as the following.

Baffle reactor tanks are constructed underground. It will have at least four chambers in series. Each of the chambers is designed to take care of required hydraulic and organic loading. The purpose of designing chambers in series is to help digest difficult biodegradable substances. The anaerobic bacterium is responsible for the removal of organic pollutants (suspended and dissolved) from the wastewater that lives in the sludge at the bottom of the tank. While the wastewater flows through the sludge the bacteria will consume the organic pollutants (degradation of pollutants) and convert it into sludge. The length and width (area) required for each of the chamber/s is derived from the peak hour flow as well as the defined velocity of wastewater within the chamber. The baffle walls or pipes (down shaft pipes) are laid to ensure the direction of wastewater flow within the tank and through the activated sludge accumulated at the bottom of each chamber. The number of chambers required is decided based on the hydraulic retention time. The wastewater flows from bottom to top with the

effect that sludge particles settle against the up-stream of the liquid. This provides the possibility of intensive contact between resident sludge and newly incoming liquid.

Participants were told that the Baffle reactor is one of the most efficient anaerobic treatment modules under DEWATS™ ™ principles. The efficiency increases with higher organic load. Here, the wastewater treatment efficiency is in the range of 65-90% COD removal and 70-95% of BOD removal.

After the input session the participants were given certain parameters based on which they carried out the calculations for designing ABR. Participants were facilitated by Mr. Andrews Jacob to complete the calculations by going through step by steps.

Energizer:

Between the sessions 6 and 7, energizer was conducted to activate the participants. Mr. Andrews Jacob facilitate the energizer. The participants were ark to form a circle and the instruction of the game were given:

Instruction:

- Participants need to form a circle
- Counting of numbers should be done, but when comes multiple of 5, the participants need to clap instead of calling the numbers
- Whoever, win at the last, declared as a winner

Fig-14: Participants taking participate during energizer conducted by Mr. Andrews Jacob

8.2.4 Session 7 - Design of Tertiary and Post Treatment Module

Resource Person	Details
Mr. Andrews Jacob	Calculation on designing secondary treatment modules
Training method	Power point presentation, Exercise and Discussion

This session was particularly focused on the steps of designing tertiary and post treatment modules of DEWATS™ which are Planted Gravel Filter (PGF)[2] and Polishing Pond (PP). Mr. Andrews Jacob facilitated this session. Participants were explained about the main purpose of these modules which is polishing of wastewater by removal of colour and odour through root zone treatment.

PGF also removes pathogens, and organic pollutants like BOD and COD. During the treatment process the nutrients such as phosphorous, potassium and nitrogen are removed, the treated effluent is stored for reuse.

Planted gravel filter tanks are shallow open tanks filled with graded filter material (substrate) and are above the ground. In PGF, the wastewater introduced into the tanks flows through the substrate and is discharged out of the tank through the structure which controls the depth of wastewater in the filter tank. Two types of flow (subsurface) directions in the wetlands can be seen. The Horizontal flow is mostly

Fgi-15: DEWATS feasibility study session taken by Mr. Rajendra Shrestha

[2] Also called constructed wetland

preferred than the Vertical flow. Here, the filter materials used are; river pebbles or construction gravel and planted with vegetation. As wastewater flows through the filter media it comes in contact with aerobic, anoxic and anaerobic zones. Attached and suspended microbial growth is responsible for the removal of soluble organic compounds, which are degraded biologically both aerobically as well as anaerobically. The oxygen required for aerobic degradation is supplied directly from the atmosphere by diffusion.

With regard to the treatment efficiency, the quality of treatment in well-operated planted gravel filters is in the range of 50% - 60% BOD removal. PGF is suitable for domestic wastewater which has a lower content of suspended solids. It should be kept in mind that pre-treatment in settlers or baffle reactors is necessary to eliminate solids of larger size before they are allowed to enter the filter.

In case of DEWATS™, PGF is used for removal of odour, and colour rather than for removal of organic pollutants as the PGF is fed with wastewater with very low organic loading. Enrichment of dissolved oxygen occurs in this to a large extent.

The participants were asked to calculate to design Horizontal Planted Gravel Filter (HPGF) with a step by steps guidance from Mr. Andrews Jackob. The participants were provided with necessary information for the design exercise. The participants designed HPGF according to the correct water depth and sludge level, amount and size as well as maintenance of filter material.

8.3 Day III - 19 May, 2017

8.3.1 Session 8 - DEWATS™ Feasibility

Resource Person	**Details**
Mr. Andrews Jackob	• DEWATS™ feasibility • Implementation of DEWATS™ • Sources of water and wastewater
Training method	Power point presentation, Interaction

In this session the fundamental requirements for carrying out DEWATS™ ™ feasibility study was explained by Mr. Andrews Jackob. During the beginning of the sessions, Mr. Jackob cleared about the meaning of the feasibility. He highlighted that DEWATS™ feasibility is required for convenience and ease the project. The major objective of the feasibility study was elaborated to the participants explaining that it is conducted for understanding the project area for preparation of wastewater design. He said that feasibility study implies collection of data from the project site for conception, design and construction of wastewater treatment unit.

Fig-16: Mr. Andrews Jacob during the session 10

The data collected from the project site is used for preparation of concept by analysing them to determine the feasibility of the project from technical, practical and economical point of view, selection and design of treatment modules, construction design requirements and framing the operation and maintenance guidelines. Feasibility study is conducted for preparation of project proposal and understanding the project area for preparation of wastewater treatment design.

The prioritized categories for data collection was discussed during the sessions. The data collection was mainly prioritized for five main categories and the methods for collecting information under each of these categories were explained to the participants in detail.

1. **Information related to source:** With regard to the data related to source one has to look for available sanitary infrastructure, its condition, wastewater quantity and its quality. Source of portable water, accessibility have to be understood.
2. **Conveyance:** Information related to wastewater conveyance consists of existing collection and conveyance system (if any) and data related for selection of possible path for availability of land, land use, gradient, soil condition, ground water table and flood condition.
3. **Treatment:** Data collection about wastewater treatment should focus on existing treatment system, open area available in the project area, its nature and climatic condition.
4. **Disposal:** Data collection on wastewater disposal concerns, reuse requirements, options for sources for disposal, flood condition in the disposal area and requirement of pump.
5. **Others:** In addition, information related to plan for operation and maintenance, solid waste management practices at present, proposed construction period, source of finance for implementation, project area map, drawings of existing conveyance and wastewater infrastructure, soil test, water test and wastewater reports have to be gathered. It is helpful to enquire about locally available construction materials, etc.

Mr. Jackob explained the necessity of feasibility study for any project prior to implementation as data collected will be required for conceptualization of treatment system; selection and design of treatment modules; construction design requirements and forming the operation and maintenance guidelines.

Some of the questions raised by participants and responses are given below.

Questions and answers:

Q: Is feasibility study is only require for the detail preparation of construction?

A: Feasibility study will help you to estimate, and can know about the wastewater conveyance.

8.3.2 Group Works and Presentations on DEWATS™

Unfortunately, the feasibility exercise in a specific site could not be conducted as planned. Therefore, the participants were asked for a group work. Accordingly, the participants were divided into the following three groups and were provided background information of their respective sites. Each group were provided with an assignment of different cases as mentioned below:

Group – 1: 'Blue Poppy'- Kengeri Government High School

Group - 2: 'Rhododendron' - Beedi workers colony Phase 2, Kengeri Satellite Town, Bengaluru

Group – 3: 'Lotus' - K.H.B (Karnataka Housing Board) Diamond Township BSM Extension, Kengeri Satellite Town, Bengaluru

The group work session was facilitated by Mr. Andrew Jacob who provided the criteria that need to be incorporated while undertaking the feasibility exercise of the given topic and during the presentation:

1. Understanding of the project (Team discussion, possible solution)
2. Proposed DEWATS™ concepts
3. Financial requirements for the project/ administration concepts
4. Sustainability of DEWATS™ (O&M strategies)

The participants in each group analysed the information provided in each case as a feasibility information of the DEWATS™ project. The information was analysed from technical, social and economic point of view. They prepared the required concept and designed a suitable decentralised wastewater treatment module for the project location they visited.

The groups were provided a time limit of one hour to complete the assignment. Participants discussed on the groups and prepared a technical feasibility report of DEWATS™ for location provided in a given case. Accordingly the groups discussed among each other to complete the tasks and finally prepared a power point presentation to share among the participants in the plenary. One participant from each group presented their works in plenary.

The outcome of each group work was presented in a plenary as below:

- **Blue Poppy:** As per the given condition of hydraulic loading 4.75 cubic meters per day and BOD_{in} 150 mg/l, the team has selected settler, ABR, PGF and polishing pond (PP) to get BOD_{out} 30 mg/l . Financial support for the construction of treatment plant within the premises of school is 50% from the school and 50% from the education board.
- **Rhododendron:** As per the given condition of hydraulic loading 118 cubic meters per day and BOD_{in} 300 mg/l, the team has selected settler, ABR and PGF to get BOD_{out} 20 mg/l. For the construction of units of treatment plant, the team has estimated the cost of INR 5180000, which will be funded by the Government of India.
- **Lotus:** As per the given condition of hydraulic loading 151.6 cubic meters per day and BOD_{in} 500 mg/l, the team has selected settler, ABR, HPGF and collection chamber to get BOD_{out} 30 mg/l. The team has provided the total DEWATS investment as NPR 4548000, which will be invested by Housing Board.

The group Blue Poppy and the group Rhododendron have provided similar approaches for operation and maintenance but the group Lotus has not mentioned anything about the operation and maintenance of the treatment plant in their presentation.

At the end of presentation all the groups were applauded for making good presentations. Mr. Jacob appreciated the participants for their hard work in completing the group assignment and ended the session with, “Try to think how to make your DEWATS™ beautiful but not as just the backyard thing.”

8.3.3 Session 9 - DEWATS™ Construction – Main Requirements

Resource Person	**Details**
Mr. Andrews Jacob	• Construction requirements • Construction of DEWATS™ modules • Construction supervision
Training method	Power point presentation, Interaction

The main requirements for construction of a DEWATS™ were explained in detail by Mr. Andrews Jackob. The construction process comprises of preparation of site for construction, creating awareness about DEWATS™, construction details for the contractor, gathering of construction materials, ensuring agreements, site clearance and levelling. The construction period of DEWATS™ is 3 to 6 months in ideal project schedule.

Different steps involved in the construction of different modules of DEWATS™ such as excavation, setting up of base slab, masonry for wall construction, fixing up of different wastewater pipes, internal and external plastering, setting up of top slab and fixing of manhole covers was explained. Participants

were informed that for the inoculation of anaerobic baffled reactor, sludge from existing treatment plants or clean slurry of cow dung can be used. Mr. Jacob emphasized the fact that cow dung are rich in microbes and breakdown the microbes very faster.

The number of chambers in the anaerobic baffle reactor is determined by the quantity and quality of the influent wastewater and the desired treatment. However, based on the experience of number of DEWATS™ projects implemented, treatment in anaerobic baffled reactor is good if number of chambers provided is 5 to 6 numbers. The sludge that is removed from the DEWATS™ modules after 2-3 years of operation can be reused only after proper treatment.

In construction of Planted Gravel Filter, tank has to be ensured to be leak proof and slope has to be maintained in the base slab for flow of wastewater from inlet to outlet of PGF. Different types of filter material used in PGF were shown to the participants.

There are various methods available for treatment of sludge. The simple method could be excavating a pit of required depth to accommodate the sludge and composting the sludge for 2 - 3 months for treatment. This treated sludge is good manure for the plants and can be directly used.

Some of the questions raised by participants and responses are given below.

Questions and answers:

Q: What should be the gap between water pump slab and end of point?

A: 10 cm.

Q. Where is polishing pond located?

A: At the end of the treatment plant.

8.3.4 Session 10 - Commissioning, Operation and Maintenance

Resource Person	Details
Mr. Andrews Jacob	• Tests for baffled reactor • Wastewater monitoring • Sampling flow chart
Training method	Power Point presentation, Interaction

Mr. Andrews Jacob explained about the precise test required for a commissioning process. The purpose of Operation and Maintenance (O&M) to ensure the smooth functioning of DEWATS™ was discussed in this session. The techniques of testing the baffle reactor, planted gravel filter, sewer pipes were explained. Mr. Jacob in his presentation, explained about the methods of checking the level of conformation and leakage test. Furthermore, the discussion about the objectives of O&M of the DEWATS™ took place to ensure its sustained functioning. He further clarified that the operation and maintenance is necessary for sustainability of the project, long term quality assurance, monitoring environmental and hygiene standards and knowledge transfer into the new projects. He emphasized that the regular and qualitative O&M activities will ensure the high performance of DEWATS™.

It was mentioned that the Operation and Maintenance (O&M) tasks are simple and required training would be provided to the caretakers and operators of DEWATS™. List of specific operational tasks which have to be performed were presented to ensure that the DEWATS™ modules functions properly. For each task Mr. Andrews informed where exactly the tasks have to be done, the periodicity, the purpose of carrying out this task and more importantly how it should be done.

The sessions also includes the session on wastewater monitoring. Mr. Jacob explained that monitoring the performance of a DEWATS™ is an important and a key factor for sustainable operation and maintenance. Furthermore, he briefed about the types of the operation and maintenance i.e. regular and periodic, and mentioned that the efficiency of the treatment plant will be seen only after 1 to 3 months and it increases with the age of system if the system is operating as per design. He added that proper and timely monitoring along with sampling to check the efficiency of the plant is required.

8.3.5 Session 11 - Sectors of Application

Resource Person	Details
Mr. Andrews Jacob	• DEWATS™ Application • Prefabricated DEWATS™
Training method	Power point presentation, Interaction

The session was focused on the application of DEWATS™ for organic wastewater treatment in various sectors including housing colony, institutions, hospitals, hotels, community toilets, school, slums, small and medium enterprises, individual houses, etc. Mr. Jacob showcased the pictures of DEWATS™ that has been in operation in different parts of India. This sessions also provided brief introduction, advantages, types and implementation of prefabricated DEWATS™. In this session, the participants were made to understand the purpose/s with which the DEWATS™ was implemented at different sectors. Participants were informed about the DEWATS™ implemented by BORDA and CDD Society in sectors.

Unique feature of some of the DEWATS™ units were also highlighted during this session. Mr. Andrews Jacob briefly introduced about prefabricated DEWATS™ modules. For better understanding of the modules, participants were taken to the pre-fab section.

8.4 Day IV - 20 May, 2017

8.4.1 Session 12 - DEWATS™ and FSTP Exposure Visit

Resource Person	Details
Ms. Reetu Rajbhandari	Briefing of treatment system- DEWATS™ and FSTP
Training method	Guided visit, personal observation and interaction

8.4.1.1 Exposure visit to DEWATS™ treatment plants in Sathya Sai Sikshya Sadan School

The fourth day of the training was dedicated to the field exposure visit. On this day, participants visited two sites; one is DEWATS™ at Tokha and the other is FSTP at Lubhu. The exposure visit was facilitated by Ms. Reetu Rajbhandari, Sanitation Engineer at ENPHO. The main objective of this exposure visit was to provide the practical observation of DEWATS™ and FSM. Participants interacted on different aspects including technical and operation in both the sites and participants were found enthusiastic and were found inquisitive to learn.

Fig-17: Dr. Narottam Prasad Upadhyaya explaining about DEWATS treatment plant at Sathya Sai Sikhshya Sadhan, Tokha

On the first part of the fourth day of the training, participants visited to the DEWATS™ treatment plants in Sathya Sai Sikshya Sadan School at Tokha. ~~The exposure visit was guided by Ms. Reetu Rajbhandari, Sanitation Engineer at ENPHO.~~ In the Sathya Sai Sikshya Sadan School, participants observed DEWATS™ plant. The principal of school Dr. Narottam Prasad Upadhyaya explained the history of the plant along with the objective of treatment plant. He briefed about the treatment plant system and explained how it operates and how it is functioning. He was so excited while he explained about the use of the treated water from the treatment plant for recharge and irrigation purpose. Each participants were provided with a brief note (refer annex) with salient features of this DEWATS™ in Satay Sai Sikshya Sadan School.

Some of the questions raised by participants and responses are given below.

Questions and answers:

Q: How many chambers are there in ABR?

A: 5 chambers

Q: How much money do you invest for operation and maintenance?

A: For cleaning purpose, the whole system is maintained NRS 50,000 per year.

Q: Any issues that you have been tackled in operation and maintenance?

A: No any issues has been arrived yet.

Q: Do your treatment plant have dedicated plumber?

A: Yes. We do have. Mr. Bhimeshowr, a dedicated plumber look at everything of treatment plant system.

8.4.1.2 Exposure visit to Feacal Sludge Treatment Plant (FSTP), Lubhu

2nd half of this 4th day was dedicated for the field visit to Lubhu to observe FSTP. The care taker of the treatment plant Mr. Surya Prasad Ghimire was introduced with the participants of the training. Mr. Ghimire has been operating the treatment plant since its operation. Ms. Reetu Rajbhandari explained the overall features of the FSTP in Lubhu, its coverage, capacity, process of this treatment plant, and how it currently functions etc. Each module (component) of the FSTP was explained to the participants along with the schematic flow diagram to make them clear about each modules installed there. Each participants were provided with a brief note (refer annex) with salient features of this FSTP in Lubhu.

Fig-17: Mr. Surya Prasad Ghimire, caretaker of FSTP, Lubhu explaining about stabilization tank of treatment plant.

Some of the questions raised by participants and responses are given below.

Questions and answers:

Q: How many valve are there in feeding tank?

A: 3 valve in feeding tank.

Q: What are the advantages of having faecal sludge treatment plant?

A: The treated faecal sludge produces manure and treated the wastewater. The produced manure are used in plants and vegetables and the treated water is use for agriculture purpose.

Q: How do you distribute feacal sludge to ABR and sludge drying bed?

A: 80 % of water from feacal sludge is sent to ABR and 20% of water sent to sludge drying bed.

Q: Which water is passed to ABR from the feeding tank?

A: The water in feeding tank directly passed into the ABR.

8.5 Day V - 22 May, 2017

8.5.1 Session 13 - FSM Overview – Relevance and Value Chain

Resource Person	Details
Mr. Bipin Dangol	• Introduction to FSM • Opportunities • Problems • Solutions
Training method	Power Point presentation, Interaction

Mr. Bipin Dangol, started the presentation by comparing the sample collected water from DEWATS™ treatment plant and FSTP. The main aim of this session is to make the participants aware on the types of sanitation system, overview of FSM and FSM value chain as these are pre-requisite for design of FSTP.

The session on FSM overview was more dedicated towards the brief introduction of FSM, approach and its management. He further explained about an off-site and an on-site sanitation systems to the participants. He also explained the necessity of contextualizing the treatment options for whom and where it is targeted.

He primarily focused his session on on-site sanitation system and FSM. He explained about the opportunities, problems and solutions of faecal sludge management all over the world and added that "present scenario demands the shift from pit management to shit management." He further explained this shift and the necessity by sharing the global data of sanitation facilities and FSM status.

He also shared the problems associated with onsite and offsite sanitation system was also shared during the sessions.

Fig-18: Mr. Bipin Dangol with participants during session on FSM overview

Meanwhile in the session, Ms. Sushmita Sinha, presented the case study on sewerage and septage management of Bangalore, India. The relevant data and major obstacles in managing the faecal sludge were presented during the sessions.

Furthermore, Mr. Dangol shared the status of FSM (emptying frequency, private operators in FS emptying services, current feacal disposal practices) of Kathmandu Valley.

The session also incorporated introduction and objective of FSM value chain. The government initiatives in Nepal, India and Bhutan towards FSM and urban policy were also discussed in the plenary and during presentation facilitated by Mr. Dangol.

Some of the questions raised by participants and responses are given below.

Questions and answers:

Q: What is emptying frequency of septic tank?

A: 3 to 5 years

Q: What are the problem associated regarding onsite sanitation system?

A: Desludging the waste.

Q: In which cases feacal is undigested?

A: In public toilet – if there is user is high, we have to de-sludge every week.

And during emergencies

8.5.2 Session 14 - Understanding Faecal Sludge Characteristics

Resource Person	Details
Mr. Bipin Dangol	• FS contents • FS quantification • Influencing factors on FS characteristics • FS characteristics and fractionation
Training method	Power Point presentation, Interaction

The "Understanding feacal sludge characteristics" sessions were specifically focused on the feacal sludge, influencing factors of FS characteristics and FS fractionation. The distribution and amount of contents (water, organic material, nutrients – NPK content, pathogens and chemical) on feacal sludge were discussed. Mr. Dangol additionally highlighted the driving factors of quality of feacal sludge i.e. (tank emptying technology, pattern, storage duration, and performance of septic tank, admixtures to FS, temperature, and intrusion of groundwater). He further explained about the composition of the faecal sludge and steps in sludge production and sludge collection methods under FS quantification methods. Then he explained about the six major influencing factor as per Heinss et al., 1998 on faecal sludge characteristics before explaining about the faecal sludge characteristics followed by FS characterization showing the faecal sludge and wastewater samples collected in sample bottles. He compared the FS characteristics with wastewater for clear understanding to participants.

Some of the questions raised by participants and responses are given below.

Questions and answers:

Q: In case of septic tank, can we mix grey water to black water or not?

A: From the perspective of engineering principal, we don't recommend because the chemical additives such as shampoo, soap and detergents are very high.

Q: In what condition we can design either wastewater treatment plant or feacal sludge management?

A: All depend upon the treatment objective.

8.5.3 Session 15 - Overview of Treatment Technologies in FSM

Resource Person	Details
Mr. Bipin Dangol	• Treatment Options • Treatment Objectives

Training method	Power Point presentation, Interaction

This sessions were more focused on discussion on several available treatment options. The possible treatment option (primary and secondary) and it objectives were discussed in detail. A case study from AIT, Bangkok was presented. The data of activate sludge plant of South Africa, Netherlands, Palestine, Philippines were shared. The methods FS co-composting, anaerobic based approach for faecal sludge treatment plant were also presented. At the end of the sessions, the criteria for selection of appropriate technology were discussed.

Fig-19 Ms. Susmita Sinha with the participants during faecal sludge quantification sessions

8.5.4 Session 16 - Planning for Faecal Sludge Management

Resource Person	**Details**
Ms. Susmita Sinha	• Need for Planning • FSM Planning Framework
Training method	Power Point presentation, Interaction

Ms. Susmita Sinha, briefed about the need for planning in FSM to the participants. Additionally, the sessions were more focused on to the steps of FSM planning framework. The steps of FSM planning mentioned below were discussed during the session.

Step I: Exploratory study: This step includes making stakeholders aware about the purpose of intervention and the preliminary assessment of the area.

Step II: Preliminary or pre-feasibility study: This step gives out preliminary ideas of concept, key stakeholders and location for intervention.

Step III: Feasibility study: In this step, the sites for treatment will be identified and characterisation and selection of key stakeholders will be done.

Step IV: Detailed project document: In this step, the system developed and confirmed along with the action plan with the validation from all related stakeholders.

Step V: Implementation: In this step, construction of the system, transfer of roles and responsibilities, capacity building of related stakeholders and handover of project and the system takes place.

Step VI: M&E: In this step, monitoring of the running system in terms of technical stability, satisfaction of stakeholders and cost recovery, which ensures the sustainability of the system.

The guides of implementation process i.e. Detailed Project Report (DPR) preparation in order to expresses the rationale behind the various assumptions were shared and explained the method adopted. She explained FSM planning framework to be followed by any planners or implementers in detail, which gave the clear understanding to the participants.

8.5.5 Session 17 - Faecal Sludge Quantification

Resource Person	**Details**
Ms. Susmita Sinha	• Factors affecting the quantity • Techniques of Quantification • Exercises

Training method	Power Point presentation, Interaction

Ms. Susmita Sinha took the sessions on FS quantification. Ms. Sinha explained about the factors affecting the faecal sludge and techniques of quantification as a revision for calculating the design flow to be considered while designing FSTP. She provided participants with worksheets and taught three calculation methods to calculate the volume of sludge in a year. As this session involved the work of each individual, the session was very interactive. Ms. Sinha added that the actual purpose of the calculation was to actually know about quantity of FS. The calculation of sludge generation to transportation and quantity for treatment of FS were done. Participants actively participated and completed the exercise instructed by Ms. Sinha.

8.6 Day VI - 23 May, 2017

8.6.1 Session 18 - Faecal Sludge Management Case Study: Gulariya, Bardiya

Resource Person	Details
Mr. Rajendra Shrestha	• Case study of FTSP –Gulariya, Bardiya
Training method	Power point presentation, Interaction

Case study of FSTP of Gulariya, Bardiya, Nepal was presented by Mr. Rajendra Shrestha. Mr. Shrestha highlighted about the importance of management of sludge within the area. The sessions further provided an information on FSM contents, design and construction, working process of constructed wetland, sustainability mechanism of FSTP – Gulariya. Additionally, the approach adopted for sustainability mechanism of FSTP was also shared with the participants.

Some of the questions raised by participants and responses are given below.

Questions and answers:

Q: What was the total investment cost?

A: Total cost of FSTP – Gulariya was NPR 27 Lakh

Q: What are the maintenance strategy of the treatment plant?

A: Out of the total cost, 5 – 10 % of construction cost was separated for O&M cost.

Q: What is the capacity of the treatment plant?

A: 1 truck per day.

Q. In your design, did you consider full cost recovery or only O&M?

A. Unlike water supply system, we cannot expect 100% cost recovery and it is not a charming business.

8.6.2 Session 19 - A case study on Faecal Sludge Treatment Plant at Samtse, Bhutan

Resource Person	Details
Ms. Susmita Sinha	• Situation analysis across the sanitation value chain- shit flow diagram • Characteristics of faecal sludge • FS quantification • Criteria for technology selection • Selection of treatment technologies • Construction and operation of FSTP

	• Photo Diary
Training method	PowerPoint presentation, Interaction

Ms. Sinha explained from planning stages to construction of FSTP in detail thereby presenting the steps to be followed during intervention in a new city for the construction of treatment plant. She further added the critical points to be taken care of during operation and maintenance.

Some of the questions raised by participants and responses are given below.

Questions and Answers:

Q. Why truss should not be used in drying beds?

A. No proper growth of plants so precipitation should be considered while designing the beds. And, truss is recommended for Unplanted Sludge Drying Beds than in Planted Sludge Drying Beds.

Q. Which bed is more preferable?

A. Completely depends on what you need at the end, resource available and operation and maintenance.

8.6.3 Session 20 - Enabling Environment

Resource Person	**Details**
Ms. Susmita Sinha	• Enabling Environment Framework (CLUES)Government Support
Training method	Group Work, Interaction and Presentation

Ms. Sinha initiated the session by briefly going through "Enabling Environment Framework of CLUES (Community-Led Urban Environmental Sanitation)" that includes government support, legal and regulatory framework, institutional arrangements, skill and capacity, financial arrangements and social-cultural acceptance. She further explained how the enabling environment for the FSTP in place could be made by at":

CLUES enabling environment framework (Source: EAWAG-SANDEC, 2011)

a. State Level: One should consider the administrative boundaries (catchment), city level rules and regulations, (such as standard drawings, detailing of design and construction of septic tanks and pits, etc.) operational safety guidelines and standard operating procedures, preparing effluent standards for treatment (to make them locally relevant and acceptable) to reduce potential environmental threats from the effluents, and need of financing etc.

Fig-23: Participants discussing in group activities

b. City Level: This includes the practical implementation of the faecal sludge management such as quality assurance of the containment systems, truck authorization, regular desludging, regular monitoring of treatment plants and cost recovery and behavioural change. Also she added that the enabling environment for the town varies with the context and their specific needs.

Ms. Sinha then, divided all participants into four groups and provided the worksheet with common scenario. The main aim of this group work was to analyse the given scenario and identify actions to prevent the occurrence of such problems in their specific context considering the ground reality.

Fig-24: Participants presenting their group work findings in a plenary

Every group was very interactive and as each participants being the practitioner involved directly or indirectly, pointed out and presented insights of the situation which were very practical and important. They gave their opinion in planning, policy making and their enforcement, operational and maintenance of each component of FS value chain, monitoring and even regarding incentives to the practitioner for better services.

So identified problems and suggestions by each group had slight disparity, which is obvious.

9. Evaluation of the Training

The evaluation of the training was conducted from the following three aspects:

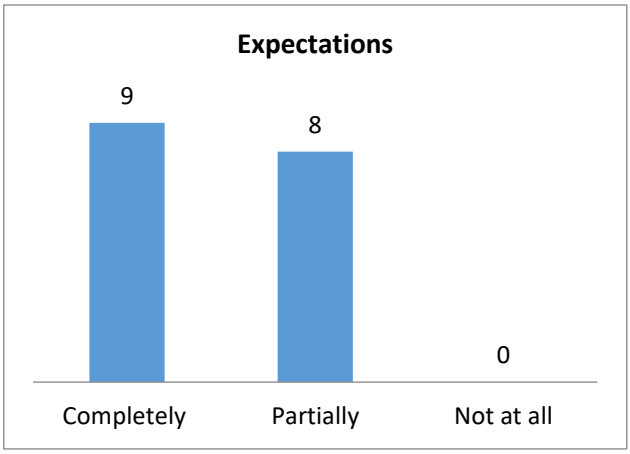
a. **Feedback to the session facilitators:** This was conducted for each session to understand the efficacy of the session in terms of contents, facilitation and knowledge relevancy for the participants. The feedback session format was annexed in Annex - …. but were not compiled and attached in this training report.

b. **Pre and Post Test of the training:** Knowledge mapping exercise through for self-assessment of participants' by filling up a Pre and Post-test form (a four paged objective questionnaires) were carried out to map their knowledge on wastewater treatment systems, DEWATS™ and FSM. During this exercise, the participants filled up the pre-test form (during the start of this training) and post-test form (during the concluding session i.e. training evaluation session) to assess the existing knowledge and knowledge they gained after participating in this training and rate their level of knowledge individually before and after the training. For comparing their knowledge through pre and post training test, same questionnaire form was used. This exercise helped to understand the level of knowledge of participants and also helped to reflect whether knowledge of the participants increased or decreased after completion of the training when compared with their knowledge status before. This is really an exciting part of the training. Kindly refer the annex for the pre-test and post-test result of the training.

c. **Overall evaluation of the training**: During the last day of the training, small assessment was conducted for evaluating the training on the whole, though the feedback of participants for each session were taken at the end of each successive sessions. This exercise helped to understand the how effective the training had been from different perspective of the training and also paved the way for further improvement while organizing similar trainings. A template with 9 questions was provided to the participants to express their feelings in these 9 different aspects and the response of the participants are mentioned below:

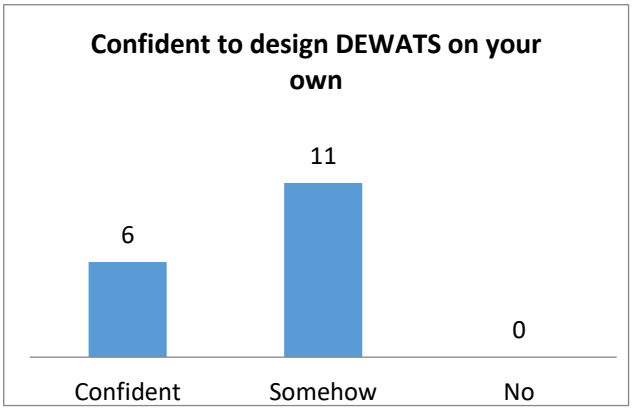
Q1. Did the workshop meet your expectation?

Out of 17 participant, 9 participant express that they completely satisfied with the workshop as it meet their expectation completely because it able to address their all the queries about DWATS and training methodology (exposer visit, participative and interactive class) supportive for that. In the meantime, 8 participant reported that workshop meet their expectation patricianly as still they are looking for some more information city scale planning, some more examples with clarity, etc.



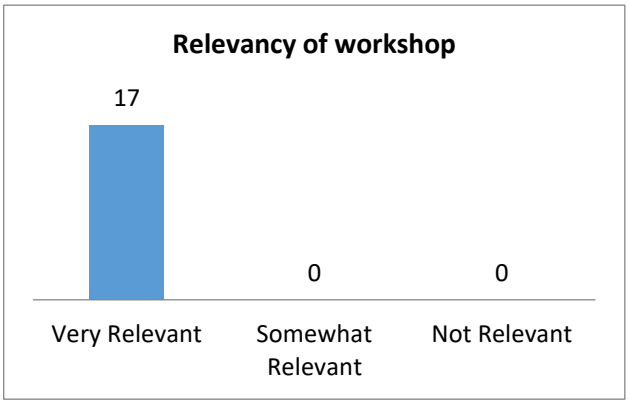
Q2. After the training how confident do you feel to design DEWATS on your own?

The overall workshop was able to build up the confidence level of 6 participants and the reason behind that are easy and handy design methods, practice time, etc. but meanwhile 11 participant still stated that they are confident somehow only because of confusion on design parameter, facilitator went so briefly and provided less time for briefing.



Q3. Which part of the workshop was the most useful? Please explain.

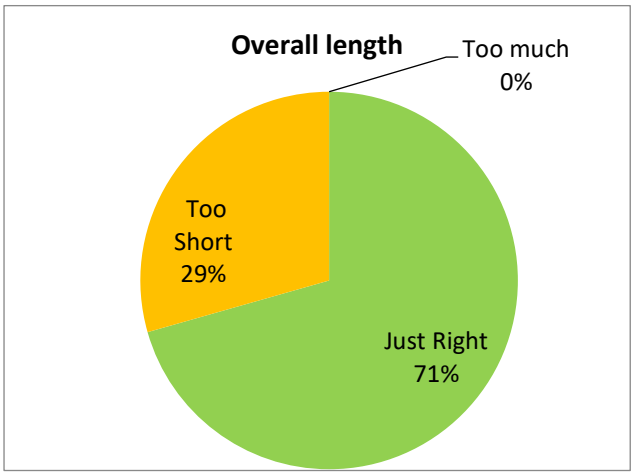
Most the participant mentioned that design option of DEWATS and FSM was most useful portion of the training. Likewise, they have listed feacal sludge quantification, feasibility of FSM, exposure visit, design of sludge drying bed as most useful part for the workshop.



Q4. How relevant was the workshop to your needs or your organization's needs?

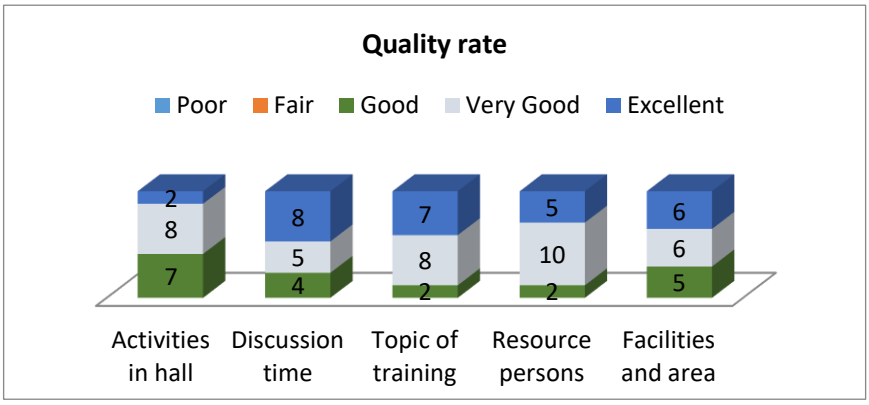
All the participant of this workshop mentioned that the workshop was quite relevant with their organization need as one the area of their organization is urban sanitation and feacal sludge management of one of the key issue they want to deal with.

5. What do you think about the overall length of the workshop, considering the limits on your time and the topics discussed?



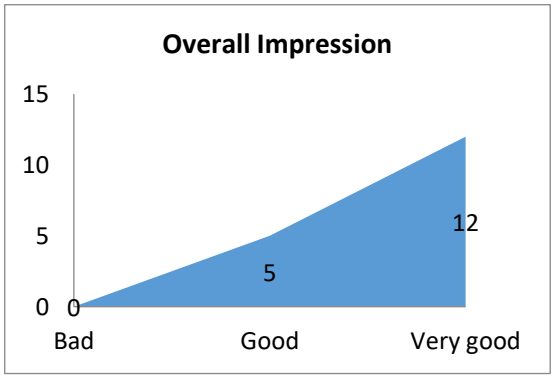
About the length of training workshop, 71% of participant reported specified time was just right but remaining participants reported that time was too short because of intensive and compressed training sessions. Also they it was mentioned that eight hour continuous session was long time to grab the attention of participants.

Q6. How would you rate the quality of the items below?



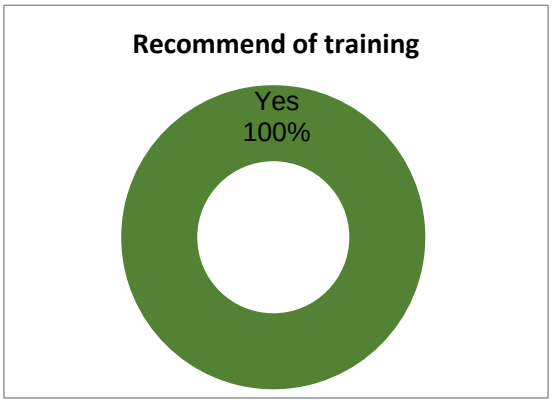
The quality rating of result show that hall activities, discussion time, topic, resource person and facilities were good enough. Out of 17 participant, 8 participants rated that discussion time was excellent whereas 10 participant rated that resource persons were very good.

Q7. What is your overall impression of the training?



Out of 17 participants, 12 participant and 5 participants reported that the overall training workshop was very good and good respectively because it was well managed, useful for organizational growth, useful for new sanitation movement and informative. So, training workshop was quite impressive.

Q8. Would you recommend this training to anyone else?



Based on the impression of training workshop, all the participant love to recommend other to this training.

Q9. Do you have any other comments about the workshop to organizer? If yes, Please explain.

The major suggestion provided by participant to workshop organizer were:

- Additional session regarding waste water chemistry and tests of parameter will add additional value.
- Presentation slides should be provided earlier so that participant can study, search information prior to class.
- Capacity development is the most important factor to enhance the implementation of FSM and DEWATS technology. So, it can be organize frequently.
- Request for another refresher training with enough time.

10.Concluding (Closing) Session

Fig- 24: Dignitaries present at the dias during the closing ceremony

The training programme was concluded by handing over the certificates to the participants by Mr. Prem Krishna Shrestha, chief environmental section of DWSS, MOWSS. Participants were also provided with a flash drive that includes reading material, reference material, group work presentations, DEWATSTM design concept, FSM planning (primarily feasibility planning) and some selected photos of the training programme for the memory of the participants.

The training programme was officially declared for its end on 23 May, 2017 under the chair of Ms. Urmila Joshi, Chairperson of ENPHO's executive board. Mr. Prem Krishna Shrestha, Environment Section Chief of Department of Water Supply and Sewerage (DWSS), was resided as chief guest at the ceremony. Mr. Prem Krishna Shrestha, Ms. Urmila Joshi, Mr. Bipin Dangol and Ms. Susmita Sinha were the dignitaries present at the dais. Mr. Ash Kumar Khaitu, Manager, Training Centre of ENPHO, facilitated the program.

10.1.1 Key Closing remarks by the guests

Picture 25: Mr. Gem Tshsering, participant, delivering a closing remarks

Mr. Gem Tshering, Deputy Executive Engineer, Ministry of Human and Urban Settlement

Mr. Gem Tshering express his gratitude for organizer for this fruitful training.

"We are attending such an extensive and hands-on training for the first time. The training has been very useful in terms of designing DEWATS™ and FSTP using locally appropriate technologies. My colleagues and I, have learnt a lot and we are looking forward to implementing our learnings in the field, in our country"

Mr. Shekhar Khanal, Engineer, Ministry of Water Supply and Sanitation

"It was a good learning platform for us on understanding more about wastewater and faecal sludge management. This type of cost effective treatment system has been very necessary for proper management of wastewater. I feel proud to be a part of this training. We have learnt the different perspectives of DEWATS™ and FSM. From the side of Ministry of Water Supply and Sanitation, we would like express our gratitude in organizing this type of training".

Fig-26: Mr. Shekhar Khanal, participant, delivering a closing remarks

Mr. Bipin Dangol, Executive Director, ENPHO

Mr. Bipin Dangol, during his speech, congratulated the training coordinator for managing the training for six days long and thanked all the participants for successful completion of training. Additionally, Mr. Dangol shared the pre-test and post-test results of the training to the participants and share his delights to find out the test result very positive.

Ms. Susmita Sinha, Senior Technical Advisor, BORDA

"The objective of our training was to provide not just to information on technologies but also to build up the abilities. I believe the training was not only the input session but more like a workshop. The learnings and experiences now has been not just limited to one, but for 18 participants"

Fig-27: Ms. Susmita Sinha during her closing remarks

Mr. Prem Krishna Shrestha, Environment Section Chief, DWSS

Mr. Prem Krishna Shrestha underlined the DEWATS™ and FSM as a matter of interest in today's context. He further added, "Because of the high cost technologies, wastewater has not been properly managed. DEWATS™, as a proper and low cost technologies remains as one of the important technology to address the problem of wastewater management. Let us conduct this type of training, scale up the technology and increase the abilities of more engineers around the globe," commented by Mr. Prem Krishna Shrestha.

Fig-27: Mr. Prem Krishna Shrestha, Chief Guest, delivering his closing remarks

Ms. Urmila Joshi, Chairperson, ENPHO

"We are delighted that international resource persons came and share their knowledge. Now the time has come up to scale up the innovation from grass-root level and address the growing problem of wastewater management."

During her closing remarks, Ms. Joshi, congratulated ENPHO team members, and expressed her gratitude towards BORDA and CDD Society and additionally thanked all the participants for the successful completion of training.

Fig-28: Ms. Urmila Joshi, delivering a closing remarks

The closing ceremony also included the distribution of certificates to the participants of the training and token of love to the guests. The ceremony was closed by a session facilitator Mr. Ash Kumar Khaitu wishing all the participants for their better future endeavours.

For Further Information

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