REPORT

INDIAN INSTITUTE FOR HUMAN SETTLEMENTS

TN US SP
TAMIL NADU URBAN SANITATION SUPPORT PROGRAMME

QUALITY ASSURANCE SUPPORT FOR IMPLEMENTATION OF FECAL SLUDGE TREATMENT PLANTS IN TAMIL NADU

October 2020

QUALITY ASSURANCE SUPPORT FOR IMPLEMENTATION OF FECAL SLUDGE TREATMENT PLANTS IN TAMIL NADU

October 2020

INDIAN INSTITUTE FOR HUMAN SETTLEMENTS

TAMIL NADU URBAN SANITATION SUPPORT PROGRAMME

Quality Assurance Support for Implementation of Fecal Sludge Treatment Plants in Tamil Nadu

October 2020

For Citation: TNUSSP, 2020. Quality Assurance Support for Implementation of Fecal Sludge Treatment Plants in Tamil Nadu.

This document is produced as part of Tamil Nadu Urban Sanitation Support Programme (TNUSSP). TNUSSP supports the Government of Tamil Nadu (GoTN) and cities in making improvements along the entire urban sanitation chain. The TNUSSP is being implemented by a consortium of organisations led by the Indian Institute for Human Settlements (IIHS), in association with CDD Society, Gramalaya, and Keystone Foundation.

Document Team: Sasikumar Eswaramurthy, Dhanik Narayan, Renukaradhya Somya Sethuraman, Jega Loyal, Sakthi Balasubramani, Fayaz Ahamed, Siva Raj

Editing: Sofia Juliet Rajan, IIHS Word Lab, Bengaluru

Design and Layout: Divya Dhayalan

Production: Shaheena Manoj, Krishnapriyaa P., Govardhan Seshachalam

Team Leader: Santhosh Ragavan

Project Director: Kavita Wankhade

1. CC license terms: This research and data has been published under the Creative Commons Attribution 4.0 license. Under the aforementioned license, you are free to:
Share — copy and redistribute the material in any medium or format
Adapt — remix, transform, and build upon the material for any purpose, even commercially.

This license is acceptable for Free Cultural Works. The licensor cannot revoke these freedoms as long as you follow the license terms.
Under the following terms:
Attribution — you must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.

No additional restrictions — you may not apply legal terms or technological measures that legally restrict others from doing anything the license permits.
Notices:
You do not have to comply with the license for elements of the material in the public domain or where your use is permitted by an applicable exception or limitation. No warranties are given. The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material.

2. BMGF funding acknowledgement: This Research / Work was supported by Bill & Melinda Gates Foundation.

3. Acknowledgement: We thank Consortium for DEWATS Dissemination Society (CDD), Enlit Constructions and all TNUSSP team members for their support in bringing out this document.

4. Logo use: ''The IIHS logo, name and all graphics on the IIHS website are trademarks of IIHS. Use, reproduction, copying or redistribution of trademarks, without the written permission of IIHS is prohibited. All other trademarks marks or service marks appearing on this report are the marks of their respective owners.''

www.tnussp.co.in | www.iihs.co.in

CONTENTS

CONTENTS *(contd..)*

Figures

Figures *(contd...)*

Tables

Abbreviations

CT	Collection Tank
DPC	Damp Proof Course
FRP	Fibre-reinforced plastic
GI sheets	Galvanised Iron sheets
HPGF/PGF	Horizontal Planted Gravel Filter
ISAF	Integrated Settler and Anaerobic Filter
OPC	Ordinary Portland Cement
O&M	Operation & Maintenance
PCB	Pollution Control Board
PCC	Plain Cement Concrete
PP	Polishing Pond
PVC	Polyvinyl chloride
RCC	Reinforced Cement Concrete
RR masonry	Random Rubble masonry
SC	Screen Chamber
SDB	Sludge Dying Beds
SR	Stabilisation Reactor
SRC	Sulphate Resisting Cement
SWM	Solid Waste Management
UPVC	Unplasticised polyvinyl chloride

Executive Summary

Executive Summary

The Government of Tamil Nadu (GoTN) has been a pioneer in the sanitation sector by recognising the importance of full sanitation as core to improved standards of public health. It has prioritised the full cycle of sanitation, including strengthening septage management as an economical and sustainable complement to network-based sewerage systems.

Tamil Nadu Urban Sanitation Support Programme (TNUSSP), launched in November 2015, supports the GoTN in making improvements along the entire urban sanitation chain in cities. TNUSSP aims to scale safe and inclusive sanitation across the state by providing technical support to the state government and working with the private sector, urban local bodies (ULB), sanitation workers, masons, schools, students, urban poor communities, de-sludging operators, and contractors, among others.

TNUSSP functions within the GoTN's Municipal Administration and Water Supply (MAWS) Department. To support the cause, Bill and Melinda Gates Foundation (BMGF) has set up a state-level Technical Support Unit (TSU), with two sub-TSUs each in Coimbatore and Trichy.

In 2018, the MAWS Department, with the support of TNUSSP, prepared a State Investment Plan (SIP)[1] that estimated the investment required by the GoTN to ensure full coverage of sanitation across 663 ULBs in a phased manner.

The SIP was developed on two principles:
1. Optimal utilisation of treatment facilities by clustering ULBs.
2. Co-treatment of fecal sludge (FS) at existing sewage treatment plants (STP).

A cluster approach has been adopted to ensure optimum utilisation of resources. The ULBs have been clustered around existing treatment facilities or proposed facilities within a radius of 12 km. In addition, the phasing plan proposes initial clustering around existing STPs, and then adding new treatment facilities.

The details of the phases are given below:
1. Phase I and Phase II: Provision of decanting stations in STP sites i.e., enabling co-treatment in existing and upcoming STPs respectively.
2. Phase III: Utilising space available in the solid waste management (SWM) sites in municipalities to construct new fecal sludge treatment plants (FSTP).
3. Phase IV: Utilising space available in Resource Recovery Parks (RRP) in town panchayats to construct new FSTPs.
4. Phase V: Treatment facilities catering to stand-alone towns/cities (not covered in clusters).

This document provides details on the quality assurance support provided by the TSU under TNUSSP during the construction of new FSTPs in phase III and phase IV. This document is a work in progress and captures the activities in phase III and partially in phase IV, and will be updated to reflect the latest developments.

The document will also serve the following purposes:
- Understand the **processes involved** and **challenges faced** in providing Quality Assurance (QA) support for the implementation of FSTPs in Tamil Nadu and the factors that influenced them.

[1]Source: State Investment Plan, 2018

- Assess the initiatives undertaken and the **effectiveness of the QA support** in improving construction – quality, time, pace and cost.
- Enable better planning and implementation of QA support based on the **learnings**.
- Highlight the effectiveness of operation and maintenance and cost advantages as a result of quality assurance for the treatment plants.

Introduction

1. Introduction

The American Society for Quality (ASQ) defines quality assurance as "part of *quality management* focused on providing confidence that *quality requirements* will be fulfilled." According to ASQ, “the confidence provided by quality assurance is twofold — internally to management and externally to customers, government agencies, regulators, certifiers, and third parties. ASQ’s alternate definition for quality assurance is "all the planned and systematic activities implemented within the quality system that can be demonstrated to provide confidence that a product or service will fulfil requirements for quality."

In the context of the FSTP construction project, in addition to preparing and reviewing Detailed Project Reports (DPR), the TSU decided to support the GoTN in quality assurance and site inspection for a period of nineteen months – from the tender phase till the completion of the FSTP construction. The decision was taken for the following reasons:

a) **Independent agency**: The TSU would serve as an independent and un-biased agency for providing Quality Assurance supportand ensure greater credibility of inputs and feedback provided at every step of the project.

b) **FSTP - A novel approach/concept**: The technology and operations and maintenance (O&M) for FSTPs are relatively new concepts for the ULB officers and require training sessions, knowledge transfers and handholding.

1.1. The Purposes of Quality Assurance

Quality Assurance for FSTP implementation would serve the following purposes:

a) **Conformance**: Construct the FSTPs as per plan, site drawings, specifications, and standards.

b) **Safe construction practices**: Ensure safety standards are maintained at the site at every stage, right from the procurement of raw materials to trials/commissioning of the FSTP.

c) **Time and cost**: Ensure timely completion of the project within the allocated budget.

d) **Smooth operations and maintenance:** Resolve any issues pertaining to quality until the FSTP is fully operational.

1.2. Key Actors/stakeholders in Quality Assurance Implementation

Table 1.1: Key stakeholders in QA implementation

Stakeholder	Role
Implementing agency: Government of Tamil Nadu	
Municipal Administration and Water Supply Department (MAWS)	Responsible for decision-making, review and approval of plans, strategy, policies and MoUs
Commissionerate of Municipal Administration (CMA)	Responsible for tracking the implementation of 49 FSTPs

Table 1.1: Key stakeholders in QA implementation	
Stakeholder	**Role**
Directorate of Town Panchayats (DTP)	Responsible for tracking the implementation of 11 FSTPs
Tamil Nadu Water Supply and Drainage Board (TWAD)	TWAD engineers to coordinate with ULB staff to check site suitability and carry out inspections
Urban Local Bodies (ULBs) - Municipalities and Town Panchayats	Call for tenders, award work to private contractors, execute the project, make timely payments, and complete the project as per schedule
Other stakeholders	
Private Contractors	Responsible for the construction of the FSTP based on the structural drawing provided by ULBs
De-sludging Operators	Ensure fecal sludge is safely transported from households and other point of generation to designated FSTPs
Technical support agency for implementation	
Technical Support Unit (TSU) - TNUSSP led by IIHS	Provide technical support to the implementing agency from the tender stage to the completion of construction, commissioning, and field trials in addition to quality assurance support
Source: TNUSSP, 2019	

Implementing Quality Assurance

2. Implementing Quality Assurance

2.1. Formation of QA support team

In early 2019, the TSU decided to recruit a private agency for QA support for all FSTPs. However, the CMA requested to explore the possibility of hiring a team of retired government executive/assistant-executive engineers on a short-term basis to work closely with the TSU for QA support and field inspection. However, only a few retired engineers came forward to take up this task. Out of the 15 shortlisted retired engineers, only three expressed interest. The TSU trained them along with other government officers but they later showed reluctance to take up the task due to the nature of the job and the extensive travel involved.

As a result, the TSU formed a QA team, comprising five members from the TSU and the staff of a private agency in May 2019. This team ensured the timely planning and execution of QA activities as per the plan and in close coordination with the ULB staff.

2.2. Site investigation report

The site investigation report was prepared from the data collected on a) site suitability assessment and b) site readiness. The TSU prepared a detailed site investigation report template to enable the engineers at all shortlisted FSTP locations of the CMA, to assess the site conditions and its suitability for construction.

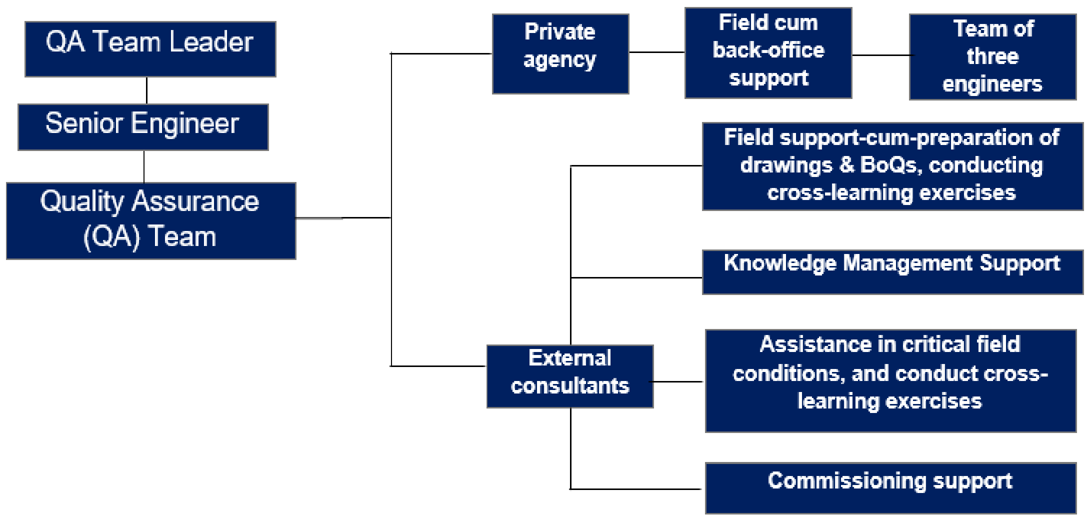
Site suitability assessment: The QA team prepared a checklist to capture details such as compliance with regulations, bio-mining, approach road to site, soil testing, land availability for expansion and groundwater table. Once all shortlisted ULBs completed this part of the checklist, the ease of construction in each of these ULBs became evident.

Site readiness: Parameters such as location and surrounding land use, topography, contour, electricity and water supply arrangements, site dimensions and feasibility of setting out the layout of the FSTP was used to check the site readiness. A few ULBs commenced fieldwork in January 2019 itself, while the remaining ULBs started by June 2019.

2.3. TSU: Organisational framework

The organisational structure for the QA team consists of a team leader, senior engineer and a dedicated QA team working from the field and the back office. This team is supported by consultants and specialists engaged for specific tasks as depicted in figure 2.1.

Figure 2.1: Organisation of the QA team



Source: TNUSSP, 2019

2.4. Finalising the scope and stages of QA

The QA team prepared the scope and stages for QA support required for the ULBs under the CMA and decided that QA support would not cover structural design and review, bill certification, payments, delays and cost escalations, as these aspects came under the direct purview of the CMA. The QA support would essentially cover the following seven elements to be carried out at the site:

Table 2.1: Stages of construction

No.	Stage	Objective
1	Pre-construction stage	Confirmation of site readiness to start construction activities
	a. Site clearances and drawings	Verification of necessary site clearances and drawings
	b. Marking stage	Confirmation of the optimal layout of the modules
2	Excavation, preparing the ground and laying PCC	Excavation, preparation of the ground, including compaction and provision of soling wherever necessary Levels for the PCC and RCC structures
3	Reinforced cement concrete	Review of final PCC/RCC levels, masonry and dimensions of the modules; inspection and confirmation of the excavation of PGF or other tertiary treatment at this stage
4	Pipe fixing and floor levels	Proper fixing of inlet, outlet, and baffles; all pipes; marking for laying filter material and material inspection

Table 2.1: Stages of construction		
No.	**Stage**	**Objective**
5	Finishing works	Plastering works, painting and placing filter materials as per drawings, placing perforated slabs and manholes by number and position as per design
6	Testing and trial run	Inspection of water flows, plantation quality, plastering and water tightness for all water-retaining civil structures
7	Commissioning	Review of commissioning process, guidance on performance assessment and testing
Source: Quality Assurance Procedures for Site Work (Annexure), TNUSSP, 2019		

2.5. State-level orientation for executing quality assurance

To facilitate QA systematically for all the planned FSTPs, the TSU held a state-level workshop on "**Implementation: Quality Assurance of FSTPs"** on March 22, 2019. CMA officers, ULB engineers, and private contractors from across the state, and TNUSSP participated in the workshop. The session included a detailed presentation on the type designs of FSTP and stages of QA support, followed by an in-depth discussion with the participants on various issues related to the FSTP construction. The key topics covered in the workshop were as follows:

1. Overview of fecal sludge management and Tamil Nadu state plan for 49 FSTPs.
2. FSTP type design: Overview and unit-wise description.
3. Quality assurance for FSTP: Each element under QA, starting from site-readiness, checks during pre-construction phase, running tests and trials after completion.
4. A review of site-specific drawings with suggestions to revise drawings based on discussions.
5. A review of each site's progress and clarification of site-specific queries and challenges through one-on-one discussions with municipal officers and private contractors.

As FSTPs were in different stages of construction, field-level inputs for both FSTP design and QA measures were discussed. The TSU emphasised the **need for material testing** with a renewed focus on using **high quality materials from trusted brands**. **ULBs were requested to document every stage of progress and keep an updated report ready at the site** during inspections by the QA team. The **dos and don'ts of construction** and avoiding errors in the field were discussed. The TSU experts emphasised the importance of site safety measures.

The TSU created a **common email ID** and a **WhatsApp group** to provide day-to-day field support to the ULB engineers working on site. A working methodology, timelines to track periodic progress, conduct review meetings and report meeting minutes with the CMA was shared.

During the meeting, a majority of the ULBs reported that they had not applied to the Tamil Nadu Pollution Control Board (TNPCB) for Consent to Establish (CTE) FSTPs. The ULBs were requested to immediately submit the applications. The QA team also shared a sample filled form for ULBs' reference.

This first workshop helped in underscoring the importance of quality assurance for the construction of FSTPs. Technical details, especially on site-specific queries from ULBs were clarified. ULBs lagging behind in construction were encouraged to speed up their processes.

2.6. Approach for quality assurance in FSTP implementation

The quality assurance framework consists of the following:

a) **Planning and organising orientation sessions:** Orientation workshops and training sessions during the various stages of FSTP implementation to familiarise ULB staff, contractors, and other relevant stakeholders with QA.

b) **Periodical visits to the FSTP construction sites by the QA team:** Regular visits as well as expert visits by the QA team to resolve specific issues at the site.

c) **Reporting and monitoring:** A dedicated helpline number to resolve site-related issues in addition to remote support through weekly calls and a dedicated WhatsApp group to share daily progress reports and quickly resolve issues. Visual and written documentation of the progress of the construction with up-to-date information to serve as a handy guide for the inspection team.

d) **Exposure/cross-learning visits:** Visits for state government officers including ULB staff to the FSTPs to reinforce the need for and the importance of quality assurance during the construction of FSTPs.

Stage-wise Quality Assurance Support

3. Stage-wise Quality Assurance Support

The TSU encountered different problems and situations at each stage. The QA team assisted the ULB and offered best possible solutions in every situation.

3.1. Stage I: Pre-construction stage

Site clearances and drawings:

Figure 3.1: Detailing of the type design

Source: TNUSSP, 2019

The TSU provided the type design(s) for the FSTP and were finalised in consultation with the CMA and DTP. Typeset drawings for 20 KLD, 30 KLD AND 40 KLD FSTPs were shared with the ULBs to obtain technical and administrative sanctions to commence work. Three significant revisions were made to the typeset drawings based on inputs from experts and learnings from implementing the designs in the field. Technical experts of regional engineering colleges prepared structural drawings by referring to the typeset drawings to customise the design based on land availability and field characteristics of the respective FSTPs. All ULBs were given assistance to fix the hydraulic profile of the treatment plant.
The TSU also shared a format to obtain PCB clearances so that ULBs could apply for the CTE certificate.

Marking stage:

After verifying the necessary site clearances and drawings, the field engineer marked the site. Marking stage is one of the most critical stages, which involves fixing the layouts and completing the contour survey/site profiling. The following activities were conducted in this stage:

a. Ensuring the layout is optimal for both construction and operations.
b. Checking the temporary benchmark by referring to the permanent benchmark.
c. Marking the boundaries for excavation.
d. Checking the alignment/orientation of each module.

Figure 3.2: Marking of Screen Chamber

Source: TNUSSP, 2019

3.1.1. Challenges in stage I and their solutions

The scenarios and challenges were unique in almost every ULB. Some of the challenges and solutions are presented below:

Table 3.1: Challenges in stage I			
Sl. No.	**Challenges in stage I: Pre-construction**	**Site-specific examples**	**Solutions**
1	Land availability: Land identified by the ULB is inadequate or unsuitable for the construction of FSTP **Figure 3.3: FSTP site with inadequate area**  Source: TNUSSP, 2019	*Srivilliputhur*: A portion of the selected land belonged to the National Highways *Manapparai:* This ULB felt that the available land was more than adequate for the construction of FSTP. However, being uncertain, the QA team visited the site and conducted a land survey. The survey found that the identified land was not a single continuous land parcel; It was two different portions covering a total area of 2,850 sq.m. and was not sufficient enough to construct an FSTP.	QA team visited each of these sites for a detailed investigation and once the land was found unsuitable after survey, site profiling and observations, held a review meeting. The CMA requested the ULBs to look for alternative land.
2	Waterlogged site **Figure 3.4: A wetland identified as FSTP site**  Source: TNUSSP, 2019	*Colachel:* Identified land was previously used as salt pan for many years. Hence, soil condition was unsuitable for an FSTP as waterlogging issues were observed at the site.	Two options – (option 1: Soil filling and pile foundation) and (option 2: Mechanised FSTP) – were provided by the QA team, and the ULB decided to go with (option 1).

Table 3.1: Challenges in stage I

Sl. No.	Challenges in stage I: Pre-construction	Site-specific examples	Solutions
3	Hilly terrain **Figure 3.5: FSTP site with difficult terrain and unstable soil**  Source: TNUSSP, 2020	*Padmanabhapuram:* The land identified by the ULB was on a hilly terrain. Solid waste was dumped on one part of the site which had consolidated with the soil over several years. Therefore, it was not possible to proceed with the typeset design. The QA team found that construction of all the Sludge Drying Beds side by side was not possible.	The QA team provided a site-specific customised design, where it requested the ULB engineers to construct a bigger single bed, instead of two beds. The QA team also instructed the ULB to lay Wet Mix Macadam and then lay footings with grade beam connection to enhance stability. Similarly for Stabilisation Reactor (SR), it was observed that having two SR for a 20-KLD plant next to each other with a gap of 2 m was not possible due to space constraints. Hence, the QA team requested the ULB to combine the two SRs and have one big SR.
4	Inappropriate soil conditions **Figure 3.6: FSTP site with an existing structure**  Source: TNUSSP, 2019	Several sites	In such cases, alternative locations were suggested with suitable soil conditions. Or in some cases, an appropriate structural drawing was suggested based on the soil test reports.

Table 3.1: Challenges in stage I			
Sl. No.	**Challenges in stage I: Pre-construction**	**Site-specific examples**	**Solutions**
5	Soil characteristics **Figure 3.7: FSTP site with instable soil**  Source: TNUSSP, 2019	In some sites, the soil had large volumes of solid waste which threatened the stability of the soil.	In such cases, ULBs were requested to refill soil.
6	Slope related issues **Figure 3.8: FSTP located in a hilly terrain**  Source: TNUSSP, 2019	ULBs with hilly terrain.	Appropriate structural drawings were suggested based on the challenges. For instance, additional retaining wall was suggested in hilly areas.
7	Solid waste dumped at site **Figure 3.9: FSTP site covered with municipal solid waste**  Source: TNUSSP, 2019	In many ULBs, solid waste was found to be more than 4-5 feet deep. It took five to six months to clear it which led to severe delays in the construction of the FSTP.	The QA team requested ULBs to not wait until all the waste was removed. Instead, they were requested to remove waste from one portion of the site and commence excavation work or any related work in the other portions. Though it was initially hard to convince the ULBs to carry out this task, they eventually understood and commenced work.

Table 3.1: Challenges in stage I			
Sl. No.	Challenges in stage I: Pre-construction	Site-specific examples	Solutions
Source: TNUSSP, 2019-20			

In a few cases, when the QA team visited a site identified as suitable by the ULB engineers, they found it unsuitable for construction for various reasons such as an undocumented structure at the site, excessive legacy waste and difficult terrain. After a thorough inspection of the site profile, certain locations were declared unsuitable for FSTP construction and ULBs were requested to look for alternate sites and restart the process. Some ULBs did not obtain proper drawings for executing the work making it difficult to do the markings or verify if the markings were accurate. Benchmarking was not done properly in many sites making it difficult to move to the next stage. In certain ULBs, after fixing the layouts, the engineers started earthwork without confirming the levels and excavated too much soil.

3.1.2. Key lessons for QA team from stage I

Site profiling, marking stage and hydraulic profiling of the site are the most critical tasks to ensure quality in the subsequent stages of construction. The QA team realised that it was fair to spend two to three days at each site to orient ULB engineers and contractors about proper execution of Stage I, including corrective measures to overcome challenges. Pictures were taken at the site and whenever necessary, the CMA was requested to hold a review meeting to take corrective measures. The experience of implementing Stage I also helped the QA team understand that these errors in the pre-construction stage resulted in significant losses in terms of money, resources, and time. These errors could have been avoided if ULB engineers had acquired proper drawings and fixed optimal layouts with support from the QA team. The QA team ensured that the following tasks were completed in the initial stages:

Site suitability and compliance with regulations

- Sample filled template form was provided to obtain Pollution Control Board (PCB) approval for CTE.
- A thorough study was conducted to assess groundwater level.
- Identification of waterbodies in and around the site.

Site-specific construction planning

- The site was cleared (bio-mining completed) and levelled.
- Soil test was conducted to aid structural design.
- Topographic survey, contour mapping and construction of compound wall.
- Approach road was planned.
- Ensured drawings of layout and each module (including levels) were available with the construction and supervision teams for each site.
- Site profiling, hydraulic profile and benchmarking.
- Ensured site-specific structural design of the modules took into consideration the soil conditions (based on Soil Bearing Capacity), groundwater table and other factors as found necessary.
- The effluent flow drain/other provisions were identified.
- Infrastructure surrounding the site were identified and located in maps. Human habitations with the least distance from the facility were marked.
- Ensured availability of electricity connection and potable water supply.
- Ensured that no potential hindrance to effective treatment existed.

Material testing and procurement

After the marking stage, the ULB engineers were expected to procure sample materials and send it to regional engineering colleges for material testing. Based on the results of the test, a test certificate was obtained for each material used at the site to ascertain its quality. The QA team, during field visits, inspected the certificates and verified the quality of materials.

Initially, most ULBs did not fully understand the importance of material testing. Only upon emphasising its importance during field visit(s) by the QA team, ULBs began to conduct material tests at their respective sites. The importance of material testing was also explained during review meetings at the CMA. Despite several reminders, some ULBs delayed sending materials for testing to the concerned REC. Even those who did send their materials for testing sometimes failed to send all necessary samples for testing.

The QA team had specified to the ULB engineers that Sulphate Resistant Cement (SRC) be used wherever septage came in contact with the cement. Despite this request, many ULBs used Ordinary Portland Cement (OPC).

During informal discussions with the field engineers, the QA team noted that SRC was expensive and difficult to procure. Moreover, the dealers supplying to the ULBs did not have SRC. The issue was raised during the review meeting and the CMA insisted on using SRC wherever necessary. The CMA also helped in identifying suppliers.

3.2. Stage II: Excavation, preparing ground and laying PCC

The following activities were carried out in stage II.

1) Excavated according to the plan.
2) Verified the excavated ground level with the plan.
3) Verified and confirmed the alignment/orientation of the modules as per the master plan.
4) Laid PCC once the excavation level was achieved.

3.2.1. Challenges in stage II and their solutions

Some of the challenges in stage II and their solutions are listed below.

Table 3.2: Challenges in stage II

S. No.	Challenges in stage II	Site-specific examples	Solutions
1	Presence of rocks during excavation **Figure 3.10: FSTP site with rocky soil**  *Source:* TNUSSP, 2019	Workers encountered rocks during excavation in many sites, stalling the digging process. Due to these rocks, the site-specific levels that the QA team initially provided could not be achieved.	If the level changes for one of the components in the FSTP, then the levels must be changed for the successive components. The QA team helped change the levels of all the components so work could commence on time.

Table 3.2: Challenges in stage II			
S. No.	**Challenges in stage II**	**Site-specific examples**	**Solutions**
2	Difficulties in maintaining the standard levels during excavation **Figure 3.11: Improper excavation**  *Source:* TNUSSP, 2019	After the QA team provided the standard levels, several ULBs started the excavation process without paying due attention to these levels. This resulted in the excavator either digging too much or too less.	The QA team advised the ULB to dig more at sites where less than optimum levels of digging had taken place. However, in sites where too much digging had taken place, the QA team requested the ULBs to increase the thickness of the PCC layer and the base slab. ULBs were also requested to not refill with soil, leading to structural weakness.
3	Space constraints **Figure 3.12: Insufficient working space**  *Source:* TNUSSP, 2020	In many ULBs, excavation work commenced for both sides of the Sludge Drying Beds simultaneously which restricted space for worker movement as well as for trucks to reach the end of the site and unload raw materials.	After observing these challenges at several sites, the QA team requested the new ULBs to first start work on one SDB and use the rest of the space to unload materials and have unrestricted working space.

Table 3.2: Challenges in stage II			
S. No.	**Challenges in stage II**	**Site-specific examples**	**Solutions**
4	Barricading **Figure 3.13: Unsafe/Open excavation**  *Source:* TNUSSP, 2019	Deeper excavation requires barricading for safety and protection. However, most ULBs did not put-up barricades or warning signs at the construction sites.	The QA team continuously emphasised the importance of barricades for the safety of the workers. They were also requested to place signboards at appropriate locations.
5	Compaction **Figure 3.14: FSTP site spotted with insufficient compaction**  *Source:* TNUSSP, 2019	Many ULBs laid the PCC right after excavation, skipping compaction, a crucial process.	The QA team visited the sites to check for compaction before the ULBs laid the PCC. ULBs were also mandated to inform the QA team before laying the PCC.
Source: TNUSSP, 2019-20			

3.2.2. Key lessons for QA team from stage II

Since the topographical survey reports/contour maps shared by the ULBs were not the latest or precise, the QA engineers conducted a special study to understand the field conditions and decide how and where earthwork excavation could be made.

The QA team realised that adhering to the exact levels as per the hydraulic profile provided was sometimes difficult for the ULB for various reasons such as presence of municipal solid waste, rocks or other hurdles below the ground. The QA engineers sought alternative solutions in such cases to ensure the process flow was unaffected.

The QA engineers understood that frequent cross-checking at this stage had a huge impact on the overall cost of the project. Excavating too deep or too shallow would affect the depth of the successive treatment modules, resulting in more cutting and filling, and requiring more manpower, time, and cost.

Amidst all such barriers, the QA team also had to try and go with a completely gravity-based system and avoid installation of many pumping facilities as far as possible.

3.3. Stage III: Reinforced cement concrete

The following activities were carried out in stage III:

- Checked the PCC top level against the construction drawing.
- Checked the alignment/orientation of module.
- Marked the RCC base slab.
- Checked the bar-bending schedule.
- Re-checked bar-bending works against the structural drawing.
- Checked the base slab reinforcement and shuttering.
- After the base slab was cast, checked the starters cast around the RCC walls to fix the internal dimensions and the position of reinforcement.
- Checked the reinforcement, plumb and shuttering of RCC walls.
- Checked the height against the drawings after the construction of RCC walls.

3.3.1. Challenges in stage III and their solutions

Some of the challenges in stage III and their solutions are listed below.

Table 3.3: Challenges in stage III

S. No.	Challenges in stage III	Site-specific examples	Solutions
1	Problems in reinforcement: Thickness, quality & spacing **Figure 3.15: Insufficient reinforcement**  *Source:* TNUSSP, 2019	Although specifications for (quality, thickness and spacing of rods) reinforcement were provided to the ULBs, many tended to minimise costs by reducing the thickness and increasing the spacing of rods.	During field inspection, the QA team emphasised the importance of material testing and adhering to specifications for structural strength of the FSTP. In many cases, ULBs were asked to change and place additional rods as per the required design.

Table 3.3: Challenges in stage III

S. No.	Challenges in stage III	Site-specific examples	Solutions
2	Shuttering **Figure 3.16: Improper shuttering**  *Source:* TNUSSP, 2020	In some sites, ULBs skipped wooden shuttering and directly poured the concrete. In Padmanabhapuram, proper support was not provided while shuttering. When concrete was laid, the entire structure gave away, creating a hollow space on the surface.	The QA team oriented the ULB engineers about the importance of shuttering and explained that improper shuttering could result in issues such as formation of honeycombs and concrete bulging. The structure could also collapse while laying concrete, posing serious challenges.
3	Cover blocks **Figure 3.17: Absence of cover blocks**  *Source:* TNUSSP, 2019	Some ULBs did not give importance to placement of cover blocks.	The QA team explained to the ULB engineers the importance of following standard procedures. They were made aware that in the absence of these blocks, the reinforcement would be exposed when shuttering was removed, leading to corrosion.
4	Laying concrete **Figure 3.18: Concrete vibration**  *Source:* TNUSSP, 2020	In some sites, concrete was poured without the use of the vibrator, required for equal distribution of the concrete.	The QA team explained that the use of the vibrator was critical as it prevented the formation of honeycombs and could affect the stability of the structure.

Table 3.3: Challenges in stage III			
S. No.	**Challenges in stage III**	**Site-specific examples**	**Solutions**
5	Improper material ratio **Figure 3.19: Material mixing**  *Source:* TNUSSP, 2019	Material mixing ratio: ULBs were requested to use M30 concrete (cement + fine aggregate + coarse aggregate). Many ULBs did not follow this ratio.	The QA team repeatedly explained the importance of following the ratio sto not compromise on the quality.
6	Hurdles at site	*Pattukottai:* Due to the presence of a retaining wall (SWM site), the ULB reduced the size of one of the chambers in the Stabilisation Reactor.	When the QA team visited and observed this error, it requested the ULB to adjust the size, so that the chamber held the required quantity of wastewater.
7	Curing **Figure 3.20: Curing of base slab**  *Source:* TNUSSP, 2019	After concreting, ULBs are requested to cure it for one week. However, many ULBs did not allow the curing of concrete.	The QA team explained to the ULBs and their contractors that curing increased the compressive strength and decreased the permeability of hardened concrete.

Source: TNUSSP, 2019-20

3.3.2. Key lessons for QA team from stage III

The QA team found that some municipalities did not own proper site-specific structural drawings, and did not follow the specifications in the drawings. The ULBs were inclined towards reducing the cost in various ways such as using poor quality and low-cost materials, inappropriate mix ratio, improper compaction, not using cover blocks, avoiding cube tests and plinth projection of base slab, among others, which resulted in defects such as formation of honeycombs and cracks and exposure of reinforcements.

The QA team visited the FSTP sites frequently and monitored the RCC works during different stages of construction.

3.4. Stage IV: Pipe fixing and floor levels

The following activities were carried out in stage IV:

a. Ensured height of the block masonry was constructed up to the pipe bottom.
b. Ensured the inlet and outlet pipes were fixed as per the drawing prior to the casting of concrete.
c. Checked whether the pipe diameter and pressure were same as in the construction drawing and specifications.
d. Checked the PCC top level inside the modules to ensure proper flow of the percolate or the secondary treated wastewater.
e. Ensured the make and the diameter of the pipe were as per standard specifications.
f. Ensured the perforations in the pipes were same as in the drawing.

Two methods for pipe fixing

The methods recommended by the QA team and followed by the ULBs were:

1. Fixing the holes while shuttering itself and fixing the pipes after concreting.
2. Cutting out/creating spaces for pipes after concreting by core-cutting method.

3.4.1. Challenges in stage IV and their solutions

Some of the challenges in stage IV and their solutions are listed below.

Table 3.4: Challenges in stage IV

S. No.	Challenges in stage IV	Site-specific examples	Solutions
1	Core-cutting method not followed properly and challenges in fixing pipe levels **Figure 3.21: TSU assisting in fixing pipe levels**  *Source:* TNUSSP, 2020	During each site visit, the QA team provided the levels for each of the components to fix the pipes. However, it during follow-up visits the team observed that several ULBs misplaced the levels and did not cut properly. In most ULBs, the QA team repeatedly encountered errors in the pipe levels. Despite fixing the pipe levels, ULBs made mistakes during the cutting process.	In such cases, they were advised to fill the holes and redo the cutting. However, re-cutting is not ideal because, during the cutting process, the steel rods also get cut and too many cuts could impact the strength and stability of the modules in the long term.

Table 3.4: Challenges in stage IV			
S. No.	**Challenges in stage IV**	**Site-specific examples**	**Solutions**
2	Quality of pipes **Figure 3.22: TSU inspecting quality of pipes**  *Source:* TNUSSP, 2020	Proper specifications for pipe quality were given to the ULBs. ULBs were supposed to procure UPVC pipes of a certain quality and thickness for piping. However, many ULBs were found using inferior quality PVC pipes for construction. Such PVC pipes lacked strength and became brittle or broke over time.	In such instances, the QA team explained the importance of adhering to the specifications without compromising on quality. In some cases, like Kangeyam, superior quality pipes were used which exceeded the standards prescribed in the specifications. The QA team explained that this too was unnecessary.
3	T-pipes not used as recommended **Figure 3.23: TSU inspecting pipe connections**  *Source:* TNUSSP, 2020	The QA team had specified the usage of T-pipes in the revised structural drawings for ease of O&M in the different modules. However, during field visits, the QA team observed the usage of elbow/bend pipes. Once fixed, it was very difficult to replace these elbow/bend pipes. T-pipes were useful in clearing blockages unlike elbow/bend pipes.	The QA team insisted on using T-pipes to avoid irreversible O&M issues in the long run.

Table 3.4: Challenges in stage IV			
S. No.	**Challenges in stage IV**	**Site-specific examples**	**Solutions**
4	Absence of UPVC clamps **Figure 3.24: Pipes supported with SS clamps**  *Source:* TNUSSP, 2020	In the Stabilisation Reactor, the length of the chamber was almost 10 m and the pipe connections were very long. In such cases, the pipes needed to be supported well with the help of UPVC clamps that held the pipes to the walls. While UPVC clamps were recommended for use, in most places the QA team observed the usage of steel clamps. Steel clamps corroded easily.	As and when the QA team observed the usage of steel clamps, they advised the ULBs to replace them with UPVC clamps. However, in certain places where the steel clamps were already fixed, it was challenging to remove and replace them with UPVC clamps.
5	Angular cuts in pipes recommended but not followed **Figure 3.25: Angular cuts in T-pipes**  *Source:* TNUSSP, 2020	The QA team had recommended an angular cut at the base of the T-pipes to achieve a larger diameter so that septage could flow easily through the pipes. However, most ULBs failed to understand its importance.	After proper orientation, most ULBs understood the relevance of angular cuts and started implementing it.

Table 3.4: Challenges in stage IV			
S. No.	**Challenges in stage IV**	**Site-specific examples**	**Solutions**
6	Vent pipes for anaerobic modules **Figure 3.26: Vent pipes in treatment modules**  *Source:* TNUSSP, 2020	While vent pipes were to be fixed in all the anaerobic modules like Stabilisation Reactor and Integrated Settler-Anaerobic Filter, some ULBs did not provide this despite orientation.	The QA team insisted on the usage of vent pipes in all anaerobic modules.
7	Pipe exposure **Figure 3.27: Exposed drainpipes**  *Source:* TNUSSP, 2020	When the distance between the two modules is very long, there is a threat of pipes getting exposed. In Tirumangalam, the distance between IS-AF and PGF was more than 2 m. Hence, the pipes were completely exposed and visible above the ground level.	The QA team noticed this during their fortnightly visits and requested the ULB to conceal the pipes by filling it up with soil till the level of the pipes.
8	Swivel pipes: Improper installation	The ULBs were instructed to provide movable swivel pipes at the outlet of the PGF chamber. However, most ULBs did not understand the relevance of swivel pipes and failed to install them.	After the QA support team explained how the swivel pipes helped in maintaining the water levels in the PGF and ensured adequate retention time for treatment in PGF, the ULBs immediately installed the pipes.
		The swivel pipes should be bent at a certain to maintain	The QA support team requested the ULBs

<table>
<tr><th colspan="4">Table 3.4: Challenges in stage IV</th></tr>
<tr><th>S. No.</th><th>Challenges in stage IV</th><th>Site-specific examples</th><th>Solutions</th></tr>
<tr><td></td><td>Figure 3.28: Swivel pipe installation

Source: TNUSSP, 2020</td><td>the water level in the HPGF, which could be confusing for the ULBs to understand during routine O&M.</td><td>to provide a ‘paint mark’ on the wall adjacent to the pipe. Similarly, in SDBs too, the QA team requested ULBs to provide paint markings to indicate the maximum level of sludge that each SDB could receive.</td></tr>
<tr><td rowspan="2">9</td><td rowspan="2">Perforations in the pipe: Not cleaned and level drops not maintained
Figure 3.29: Improper perforations

Source: TNUSSP, 2020</td><td>Perforated pipes were fixed within the Sludge Drying Beds. After the perforations were made in the pipes, they needed to be cleaned to clear all the clogged particles.</td><td>The QA support team requested all ULBs to carry out this cleaning exercise.</td></tr>
<tr><td>The level drops in the pipes connecting the drainage must be maintained. For instance, in Kovilpatti, it was noted that the level drops for one 10 KLD unit were not maintained resulting in a backflow. In the future, this could result in water stagnation and reduced efficiency of the plant.</td><td>The QA team requested that corrections be made in the future construction in the 40 KLD plant in Kovilpatti.</td></tr>
<tr><td colspan="4">Source: TNUSSP, 2019-20</td></tr>
</table>

3.4.2. Key lessons for QA team from stage IV

The QA team found it challenging to make the ULBs understand the importance of using appropriate piping at different modules. The ULBs’ lack of awareness was evident as the QA team witnessed misplaced pipes, inaccurate levels and wrongly fixed pipes.

Therefore, the QA team decided to make the stakeholders understand all the module-specific usage of pipes, the importance of maintaining accurate levels and slopes, procedure to make templates for perforations, and adhering to pipe specifications.

3.5. Stage V: Finishing works

The following activities were carried out in stage V:

a. Ensured the internal and external plastering thickness was as per the construction drawing.
b. Checked whether the plumbing works were as per the standard drawings.
c. Ensured the base slab was clean before commissioning.
d. Ensured perforated precast slab was cast based on the construction drawing and the spacing of the perforations were maintained as per the standard drawing.
e. Ensured filter materials were laid as per the standard specifications and construction drawing.
f. Checked the depths and sizes of various filter materials filled into the structures and levels have been marked on the adjacent wall of the structures.
g. Ensured the filter materials were sieved based on the sizes.
h. Ensured proper cut-outs of manholes were maintained during the top slab concreting.

3.5.1. Challenges in stage V and their solutions

Some of the challenges in stage V and their solutions are listed below:

Table 3.5: Challenges in stage V

S. No.	Challenges in stage V	Site-specific examples	Solutions
1	Plastering: Waterproofing chemicals not added **Figure 3.30: Wall plastered without using waterproofing chemicals**  *Source:* TNUSSP, 2020	After concreting and curing is complete, plastering work must be undertaken for all the modules. During plastering, waterproofing chemical must be added in addition to the plastering mix. The QA team found that many ULBs did not add waterproofing chemicals while plastering.	Proper orientation was given to the ULBs regarding the importance of using waterproofing chemicals to protect the structure from damage when it came in contact with sludge/ moisture.

<table>
<tr><th colspan="4">Table 3.5: Challenges in stage V</th></tr>
<tr><th>S. No.</th><th>Challenges in stage V</th><th>Site-specific examples</th><th>Solutions</th></tr>
<tr><td>2</td><td>Plastering: Improper and not thorough

Figure 3.31: Partially plastered wall of SR

Source: TNUSSP, 2019</td><td>It was observed that ULBs plastered portions of the modules that were visible on the surface and left out the parts concealed/below the surface.</td><td>The QA team requested the ULBs to make corrections and plaster both the inner and outer surfaces thoroughly.</td></tr>
<tr><td>3</td><td>Plastering of irregular surfaces</td><td>Any irregularities/ depressions in the internal and external surfaces of the modules, due to improper concreting/ shuttering, must be filled with concrete before plastering. However, ULBs plastered over the irregular surface leading to hollow/empty spaces between the module surface and plaster.</td><td>This was difficult to correct once plastering was done. The QA team advised the ULBs to follow protocols and ensure plastering was done properly.</td></tr>
<tr><td>4</td><td>Filter media: Not laid over perforated pipes

Figure 3.32: TSU assisting in perforating pipes

Source: TNUSSP, 2019</td><td>Filter media must be laid over perforated blocks after thorough washing. However, in certain ULBs like Kovilpatti, ULBs misunderstood the process and left the perforated blocks uncovered as they thought water would drain through the perforations.</td><td>The QA team clarified that filter media must be laid over the perforated pipes and instructed the ULBs to increase the size of the filter media closer to the perforations.</td></tr>
</table>

Table 3.5: Challenges in stage V

S. No.	Challenges in stage V	Site-specific examples	Solutions
5	Perforated blocks in SDB **Figure 3.33: Perforated blocks placed in the SDB**  *Source:* TNUSSP, 2020	Perforated blocks must be placed on top of the filter media and the perforations filled with sand. In Kangeyam, the ULB engineer had procured a sample of a perforated block from the local market to check with the QA team, if it could be used on the SDBs.	The QA team found the blocks unsuitable and requested the ULB engineer to procure from an alternate source.
6	No nets to be used for cinder material in ISAF **Figure 3.34: Placing of cinder materials in the ISAF**  *Source:* TNUSSP, 2020	Cinder material must be placed in IS-AF to act as filter media as well as a place for bacteria to thrive. The QA team initially advised the ULBs to place the cinder material inside nets to enable periodical replacement and ease of removal. In Kangeyam it was noted that nets could get disintegrated and clog the filter media.	The QA team requested against the use of nets in the future.
7	Manholes misplaced **Figure 3.35: Misplaced manholes**  *Source:* TNUSSP, 2019	Manholes should be ideally placed right on top of the pipes. However, in many cases, ULBs misplaced the manholes and did not follow the prescribed measurements.	The QA team requested the ULBs to close and reconstruct the manholes. This was challenging since reconstructing the manholes could cause structural weakness.

Table 3.5: Challenges in stage V

S. No.	Challenges in stage V	Site-specific examples	Solutions
8	Revision in total no. of manholes	Initially, 25 manholes were planned for each Stabilisation Reactor (10 kld). The ULBs felt this was excessive.	After the ULBs faced challenges in placing so many manholes, the sizes of a few manholes were reduced to be compact only to serve O&M of pipes beneath, and sampling.
9	Change from cast iron to FRP manhole covers **Figure 3.36: FRP manhole covers**  *Source:* TNUSSP, 2019	Initially, manhole covers made of cast iron were planned to be used. Experts advised against the use of cast iron due to the risk of corrosion.	ULBs were advised to use FRP manhole covers.
10	Roofing: Polycarbonate sheets not used as recommended **Figure 3.37: Polycarbonate-GI sheet roofing in SDB**  *Source:* TNUSSP, 2019	ULBs were requested to use polycarbonate sheets for roofing for maximum penetration of sunlight. However, many ULBs chose GI sheets to save costs.	The QA team requested ULBs to use polycarbonate sheets in alternate rows while roofing.

Source: TNUSSP, 2019-20

3.5.2. Key lessons for QA team from stage V

As the time required for completing this stage was short, the QA team was present at site, whenever activities were taken up. Also, the QA team underlined the most important factors in such projects, such as using waterproofing chemicals in the plastering mix, washing the filter materials before laying them, and positioning manholes and so on, to avoid negligence.

3.6. Stage VI: Testing and trial run

The following activities were carried out in stage VI:

a. Inspection of water flows in each module.
b. Check for quality of plantation in the Horizontal Planted Gravel Filter.
c. Check for quality of plastering and performing hydraulic test to examine water tightness in all water retaining civil structures.

At present, trial run is under way in the FSTPs at Kangeyam, Dharapuram, Kovilpatti and Tirumangalam.

3.7. Stage VII: Commissioning

The following activities would be carried out in stage VII:

a. Ensure the completeness and correctness of levels, dimensions, and hydraulic profile of the components in the FSTP.
b. Ensure that the consent to operate has been obtained by the ULB.
c. Ensure that testing kits and all necessary documents like the O&M protocol & checklist are available on the premises.
d. Ensure the availability of all constituents such as landscaping, non-treatment units and electro-mechanical items at site.
e. Verify and document that the facility and all its systems and assemblies are installed, tested, operated as per plan and design, and maintained to meet the project requirements.

4

QA Monitoring Systems

4. QA monitoring systems

To strengthen the field implementation and ensure smooth O&M of the FSTP, TNUSSP developed several support documents and tools leveraging information technology, in close coordination with the CMA and DTP. These tools are listed below:

1. **FAQs**
   During field visits, the QA team received similar queries from several ULBs which prompted the compilation of frequently asked questions (FAQs) regarding the design and construction aspects of an FSTP.

2. **Checklists**
   - **Field QA checklist:** To ensure all important aspects regarding the construction of an FSTP were covered during the site visits.
   - **Commissioning checklist:** To help in the final verification of all aspects of an FSTP after implementation.
   - **O&M checklist:** To record the O&M activities to be performed at site once the plant is operational.

3. **Assistance in preparation of documents for ULBs**
   - **PCB CTE/CTO templates:** The QA team provided the ULBs a sample filled template to fill the PCB form to obtain CTE. The team is also supporting the ULBs in preparing the CTO application to be submitted to the PCB.
   - Sample documents for soil test reports, material test reports, and structural drawings, among others were verified, and filled-in copies were obtained from each ULB involved in FSTP construction.

4. **Routine collection, collation and review of field data**
   - Updates received from the field engineers on their site visits are scrutinised and records are being maintained.
   - Photographs collected from the QA support field team is being compiled on a regular basis and shared with the ULBs.
   - Progress reports in a specified format with Gantt chart representation, PPTs and spreadsheets are prepared fortnightly and submitted to the CMA and internal team for Phase I (23 FSTPs), Phase II (26 FSTPs) and DTP (11 FSTPs).

5. **Virtual reality video**
   A virtual reality video showcasing the FSTPs in Dhenkanal, Odisha as well as Karunguzhi and Kangeyam in Tamil Nadu was prepared to enable in-depth understanding of the design and constructional aspects of an FSTP. This video is intended for government officers and provides a realistic, 360-degree view of the FSTP.

6. **IT dashboard**
   A mobile application-based IT Dashboard was created to facilitate efficient monitoring of progress in all the 60 FSTPs. The dashboard was specifically designed for government officers to review the updates on the construction of FSTPs in their respective ULBs. The Application makes it easier to monitor and evaluate the quality of construction and speed of the 60 FSTPs.

7. **Review meetings**
   Three different review meetings were regularly organised.

a. General review meeting organised by the CMA every two months involving all the ULB members, FSTP stakeholders and QA team.
b. Monthly progress review meeting involving select team members from the TSU and the office of the CMA.
c. Brief review meeting by the QA team members as and when they visited a FSTP site.

8. Cross-learning orientation programme

TNUSSP launched a series of cross-learning programmes at FSTP sites. Other ULBs were invited for this orientation programme, where the QA team along with FSTP experts were present at a particular FSTP site. The QA team evaluated the progress in the construction of the FSTP and also explained the process of construction of each of the FSTP modules, dos and don'ts and how to avoid mistakes on site.

5

Lessons Learnt

5. Lessons learnt

Few FSTPs are still under various stages of construction and many have been fully commissioned. The findings/challenges/lessons learnt from the construction activities so far are summarised below:

- **Time constraints:** ULB staff were occupied with routine tasks, which prevented them from sparing time to focus on new/novel projects such as FSTPs.
- **Need of awareness/knowledge/clarity:** Since FSTPs are a relatively new concept in Tamil Nadu, the ULB engineers or other staff overseeing their construction need adequate training and knowledge on the various aspects of FSTP construction.
- **Transfer of ULB engineers:** In some ULBs, the engineers or staff overseeing the construction were transferred to other locations which necessitated trainings all over again to the new engineers or staff.
- **Cost-cutting tendency at contractor's level:** Though material testing was made compulsory, most contractors continued to deploy low-cost materials to cut costs.
- **Low enthusiasm in some ULBs:** Although many ULBs were interested in establishing FSTPs, some of them were reluctant because they believed the long-term solution was in extending sewerage networks across all ULBs to enable treatment in STPs.
- **Payment related issues:** ULBs that had a good relationship with the contractor and continued to make timely payments made faster progress.

Despite these challenges, the QA team, through regular field visits and participation in review meetings managed to overcome many of them. The positive impact brought about by the QA team is summarised below:

- Timely rectification of errors on site, which saved both time and cost.
- Better technical clarity for field engineers.
- Specialised knowledge and resource support to the field engineers.
- Resolving issues in a timely manner that prevented unwanted delays.
- Reduced operational issues after the implementation.

The monthly investment made to the QA team was INR 2,85,000. The team has significantly reduced the time, effort, and expense of the construction. The prompt correction of construction problems by the QA team would help in the effective O&M of the plant. There are certain cost advantages that are listed in Annexure 4.

Bibliography

1. Quality Assurance vs Control, The American Society for Quality (ASQ). Retrieved from https://asq.org/quality-resources/quality-assurance-vs-control

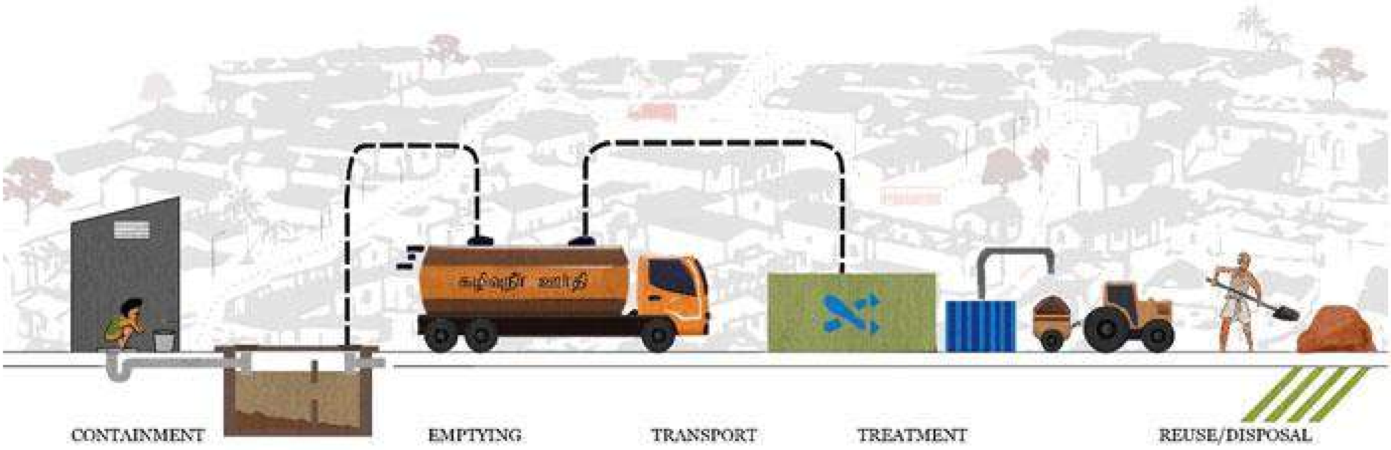
2. CII. (2022). Construction Industry Institute. Retrieved from https://www.construction-institute.org/resources/knowledgebase/knowledge-areas/commissioning-startup-handover

Annexures

Annexure 1: Quality assurance checklist for implementation

SITE NAME

SITE VISIT - INVESTIGATION



INDIA INDIAN INSTITUTE FOR HUMAN SETTLEMENTS

YEAR: 2019-2020

SITE NAME:

A1.1. Introduction

To facilitate the QA engineers in tracking the quality of work at sites at different stages of construction and to record site-specific information, a detailed checklist has been prepared, against which the QA engineers are to tick yes/no with remarks, after checking the work executed for quality during each of their site visits.

A1.2. General Information

Table A1.1: General details of the FSTP site	
FSTP Location	
Capacity of Plant	
Name of the ULB	
Region	
Limit under which the FSTP is located (Municipality/TP Limit)	
Responsible Person from IIHS & Contact details (Name, Mobile No, E-mail address)	
Contractor Details (Name, Mobile No, E-mail address)	
Municipality In charge Details (Name, Designation, Mobile No, E-mail address)	
Google Maps Location	
Communication Address	
Last updated date/Date of site visits	
Source: TNUSSP	

A1.3. Location Map

Map to be attached, highlighting the following:

- Details of neighbouring lands in all directions and their land use
- Nearby water bodies and distance from site

A1.4. Topography Details

Topography drawing to be attached

- Details of neighbouring lands in all directions and their land use at least for a 100-m distance
- Nearby water bodies, distance from site and maximum water level

Note: Reference Benchmark to be clearly mentioned in the drawing with the value. The same number to be used for preparation of hydraulic profile, Finished Ground Level and all respective drawings.

A1.5. Site-Specific Layout

Drawing to be attached

A1.6. Hydraulic Profile

Drawing to be attached

A1.7. Checklist

The checklist is divided into different portions based on the modules.

The site engineer must check the correctness and completeness of the work against each of the items mentioned in the checklist according to the progress of work. The site engineer should note down all the observations made at site and give their suggestions to the contractor and the municipal authorities in addition to noting them on the checklist and signing them off along with all the parties present during the site visit. A separate sheet is defined for the sign off.

The site engineer, during his next visit, should verify and record if the recommended measures were taken and provide details.

A1.7.1.1. Rules for filling the checklist

1. The checking must be made and updated at the site in the presence of the contractor/municipal authority.
2. The updated checklist must be sent to the office, the same day of the site visit.
3. It is mandatory for all the parties present during the site visit to sign off the checklist.

A1.7.2. Clearances & Drawings

A brief note about this section. If the answer to each activity is “NO” then provide brief reason/status and when it will be completed.

Table A1.2: Checklist on clearances & drawings				
S. No.	**Particulars**	**Yes /No**	**Remarks**	**Date of Rectification**
A	**Site suitability and Compliance with regulations**			
1	Is CTE obtained from Tamil Nadu Pollution Control Board (TNPCB)?			
B	**Site specific construction planning**			
1	Are the Site-specific Layout and construction drawings and structural drawings available with ULB & Contractor? Drawings provided by whom?			
2	Is the Biomining completed?			
3	Is the site cleared and levelled?			
4	Is Permanent Benchmark established? Please provide value of BM			
5	Is compound wall constructed?			
6	Is approach road to site laid? What is the Width of approach road?			
7	Are soil tests conducted? Reported SBC value? Attach copy of the SBC test report			
8	Is soil test report considered for structural design?			
9	Effluent disposal arrangement: availability of drain or other ways?			
10	Is co-composting/ waste management allocated near FSTP?			

Table A1.2: Checklist on clearances & drawings				
S. No.	**Particulars**	**Yes /No**	**Remarks**	**Date of Rectification**
11	Is Electricity connection available at site?			
12	Is Potable water supply available at site?			
13	Is clearance ensured from the potential hindrances to treatment and civil structures (e.g., trees/compound walls near SDB or PP)?			
14	Proper arrangement made for disposal of dewatering from excavated trenches/pits?			
15	Adequate land availability for expansion?			
C	**Drawings**			
1	Optimum utilisation of space ensured?			
2	Is site layout efficiently designed as per the contour map?			
3	Are modules placed such that pumping distance is minimal?			
4	Is minimum 1 to 2 m space provided between modules & 4 to 5 m between the drying beds?			
5	What is the groundwater table? (Mention in remarks) If it is high, has it been considered for structural design?			
6	Adequate space for vehicle/truck movement within the plants is provided?			
7	Adequate space/Provision for greeneries is provided?			
Source: TNUSSP				

A1.7.3. General Particulars

A1.7.3.1. Construction material

Table A1.3: General checklist				
S. No.	**Particulars**	**Yes/No**	**Remarks**	**Date of Rectification**
A	**Construction Materials**			
1	Whether Sulphate Resisting Cement is used for the construction of the modules?			
2	Is M30 grade concrete is used?			
3	W/C ratio maintained while concreting?			
	Are test reports for all materials available: a. Steel b. Cement c. Fine aggregate d. Coarse aggregate e. if any other, specify [Note: Tests should be done as per IS 456 specifications]			
B	**General Construction activities**			
1	Is marking for stormwater drain, ramp, road and compound wall done?			
2	Type of levelling instrument used?			
3	Is plantation done as per drawings?			
4	Is the waterproofing chemical used for concreting and plastering? Specify the brand used			
5	Is appropriate material used for manhole covers and frames? Mention the type of manhole material used			
6	Are UPVC pipes are ISI-manufactured?			
7	Whether UPVC pipes of 6 kg/cm2 used for the pipe fittings and pipelines?			
8	Of what material the pipe fixing clamps are made of?			
Source: TNUSSP				

A1.7.3.2. Construction specifications

Table A1.4: Checklist on construction specification										
S. No.	**Checklist\Module**	**SC (Y/N/NA)**	**SR (Y/N/NA)**	**SDB (Y/N/NA)**	**ISAF (Y/N/NA)**	**CT 1 (Y/N/NA)**	**PGF (Y/N/NA)**	**PP (Y/N/NA)**	**CT 2 (Y/N/NA)**	**Remarks**
C	**Excavation**									
1	Alignment/ orientation and marking is as per drawings									
2	Is working space provided for excavations?									
3	Is excavated soil dumped with proper lead?									
4	Is safe space available for movement around the dug pit?									
5	Is barricading provided for deep structures?									
6	Is sheet pile provided for collapsible soil?									
7	Is dewatering done properly?									
D	**PCC**									
1	Is grade of PCC as per drawing?									
2	Is size of coarse aggregate as per specification									
3	Is PCC laid over sand layer? Mention thickness									
4	Is PCC compaction done?									
5	Is sufficient offset provided for RCC?									

Table A 1.4: Checklist on construction specification																	
S. No.	**Checklist\Module**	**SC**			**SR**			**SDB**	**ISAF**			**CT1**	**PGF**	**PP**	**CT2**	**Remarks**
	[Note: F - Footing/Foundation, W/C – Wall/Column, CS – Cover Slab]	**F/ BS**	**W/ C**	**CS**	**F/ BS**	**W/ C**	**CS**		**F/ BS**	**W/C**	**CS**					
E	**REINFORCEMENT**															
1	Is reinforcement free from rust?															
2	Is BBS as per drawing?															
3	Is proper binding done?															
4	Has standard gauge (min 18 swg) been used?															
5	Are sufficient lap lengths provided?															
6	Is cover block provided as per drawings?															
7	Are adequate chairs provided for seating of reinforcement?															
F	**RCC**															
1	Is Centre line as per drawing?															
2	Are Formwork & Staging as per drawing and in exact plumb?															
3	Is thickness of the structure provided as per drawing?															

Table A 1.4: Checklist on construction specification																
S. No.	**Checklist\Module**	**SC**			**SR**			**SDB**	**ISAF**			**CT1**	**PGF**	**PP**	**CT2**	**Remarks**
	[Note: F - Footing/Foundation, W/C – Wall/Column, CS – Cover Slab]	**F/ BS**	**W/ C**	**CS**	**F/ BS**	**W/ C**	**CS**		**F/ BS**	**W/C**	**CS**					
4	Is shuttering aligned as per drawing and in plumb?															
5	Is shuttering properly supported?															
6	Are temporary spacers and ties removed?															
7	Water tightness of shuttering, if required															
8	Is Water cement ratio as per specification?															
9	Is slump test done? Mention test result															
10	Is Adequate vibration done															
11	Number of cubes taken for testing with proper date. 3 No's for RCC > 6 cum. 3 No's for every 5 cum															
12	Are any honeycombs observed?															
13	Are cracks and air bubbles present?															
14	Is curing being done?															
Source: TNUSSP																

A1.7.4. Module wise detailed specification

A1.7.4.1. Screen Chamber

Insert drawing of the module with the actual site-specific dimensions.

Table A1.5: SC- Checklist on specifications				
S. No.	**Description**	**Yes/No**	**Remarks**	**Date of rectification**
1	Is the layout fixed as per the drawing?			
2	Is the height of the module as per drawing? Mention the height of the Screen Chamber from the top of access road. Is the height designed considering the local sewage trucks?			
3	Are footings provided for the chamber? If yes, mention size of the footings.			
4	Is slope at base slab provided as per the drawing?			
5	Is the inlet pipe fixed in the side wall?			
6	Are vitreous tiles laid in the inner sides and floor?			
7	Is Size of coarse screen as per drawing?			
8	Is Size of fine screen as per drawing?			
9	Is screen fabricated with stainless steel material?			
10	Whether the coarse and fine screens are placed in correct inclination, parallel to each other?			
11	Are handles provided for easier removal of the bar screens during O&M?			
12	Is the screen bottom bar obstructing the smooth flow? (To prevent clogging of particles at the screen)			
13	Is the Size and position of the manhole as per drawing?			
14	Base slab and interior of pipes are cleaned from construction debris and other waste?			
15	Is the module constructed at least 300 mm above ground level?			
16	Is a freeboard of minimum 300 mm is provided to all water retaining structures?			

Table A1.5: SC- Checklist on specifications				
S. No.	**Description**	**Yes/No**	**Remarks**	**Date of rectification**
17	Whether a slot is provided for manholes? How is the manhole slot provided? Cutting/Casting?			
18	Are manhole frames provided for manholes?			
19	Are pipe inverts provided?			
20	Are clamps provided to hold the pipes in position?			
21	Base slab and interior of pipes are cleaned from construction debris and other waste?			
22	Is painting done as per specifications?			
Source: TNUSSP				

Table A1.6: SC- Checklist for levels					
S. No.	**Description**	**Level as per drawing**	**Levels as per site**	**Actual level at site**	**Remarks**
	Benchmark-+100.000 m				
1	Inlet level (top)				
2	Inlet level (side)				
3	Base slab level near the inlet				
4	Base slab level near the outlet				
5	Outlet of screen chamber				
6	Bottom level of the top slab				
7	Top level of the top slab				
8	Top level of the base slab				
9	Distance b/w SC and SR in meter				
Source: TNUSSP					

Table A1. 7: SC-Checklist for dimension				
S. No.	**Description**	**Dimension as per drawing in meter**	**Actual dimension at site in meter**	**Remarks**
1	Finished Width of the tank			
2	Finished Length of the tank			
3	Length between the inlet side wall and coarse screen			
4	Length between the coarse screen and fine screen			
5	Length between the fine screen and outlet side wall			
Source: TNUSSP				

A1.7.4.2. Stabilisation Reactor

Insert drawing of the module with the actual site dimensions.

Table A1.8: SR-checklist on specifications				
S. No.	**Description**	**Yes/No**	**Remarks**	**Date of rectification**
1	Is the layout fixed as per the drawing?			
2	Is the height of the module as per drawing?			
3	Is the slope provided in base slab as per the drawing?			
4	Is an offset provided at the base slab? If yes, mention the offset distance			
5	Are all the Inlet and Outlet pipes and fixed in position?			
6	Is a vent pipe provided in the chamber?			
7	Is the vent pipe provided in the partition wall?			
8	Mention the slope provided at the base at each chamber of the SR.			
	a) Chamber 1			
	b) Chamber 2			

Table A1.8: SR-checklist on specifications				
S. No.	**Description**	**Yes/No**	**Remarks**	**Date of rectification**
	c) Chamber 3			
9	Are 4" pipes used for all pipelines in the Stabilisation Reactor?			
10	Are the inlet distribution pipes provided as per the drawings (number and spacing) in the first chamber (inlet to SR)?			
11	Are the inlet distribution/baffle pipes provided as per the drawings (number and spacing) in the second chamber (inlet of CH2)?			
12	Are the inlet distribution/baffle pipes provided as per the drawings (number and spacing) in the third chamber (Inlet to CH3)?			
13	Whether an angular cut (45 degree) is provided at the bottom of all the vertical inlet pipes?			
14	Is sufficient distance provided between the baffle wall and base slab in the second chamber?			
15	Is proper bedding slope and sump provided at the base of the collection well (pump sump)?			
16	Is a 'T' pipe provided at all the inlets & outlets?			
17	Is the pump provided in the collection well as per specification? Please provide specification.			
18	Is the size and position of the manhole as per drawing?			
19	Is plastering slope provided on top of the slab for rainwater discharge?			
20	Is the finished top slab level being at least 30 cm above FGL?			
21	Base slab and interior of pipes are clear of construction debris and other waste?			
22	Is the module constructed at least 300 mm above ground level?			
23	Is a freeboard of minimum 300 mm provided to all water retaining structures?			

Table A1.8: SR-checklist on specifications				
S. No.	**Description**	**Yes/No**	**Remarks**	**Date of rectification**
24	Whether a slot is provided for manholes? How is the manhole slot provided? Cutting/Casting?			
25	Are manhole frames provided for manholes?			
26	Are pipe inverts provided?			
27	Are clamps provided to hold the pipes in position?			
28	Base slab and interior of pipes are clear of construction debris and other waste?			
29	Is painting done as per specifications?			
Source: TNUSSP				

Table A1.9: SR-checklist for levels					
S. No.	**Description**	**Level as per drawing**	**Levels as per site**	**Actual level at site**	**Remarks**
	Benchmark-+100.000m				
1	Inlet of SR				
2	Outlet of CH1				
3	Outlet of CH2				
4	Outlet of CH3 (supernatant O/L)				
5	Base slab concrete level of SR				
6	Difference in levels b/w CH1 I/L to CH1 O/L				
7	Difference in levels b/w CH2 I/L to CH2 O/L				
8	Height of PCC upper side slope from base slab				
9	Height of PCC lower side slope from base slab				
10	2" dia pipe pump outlet level				

Table A1.9: SR-checklist for levels					
S. No.	**Description**	**Level as per drawing**	**Levels as per site**	**Actual level at site**	**Remarks**
11	Projection above the top slab level				
12	Top level of top slab (excluding plastering)				
13	Top level of top slab (including 50 mm plastering at the top for draining rainwater)				
14	Thickness of top slab (excluding plastering)				
14	Bottom level of top slab				
15	Freeboard at CH1				
16	Freeboard at CH2				
17	Freeboard at CH3				
18	Distance b/w SR and SDB in meter				
Source: TNUSSP					

Table A1.10: SR-checklist for dimension				
S. No.	**Description**	**Dimension as per drawing in meter**	**Actual dimension at site in meter**	**Remarks**
1	Finished Width of the tank – First chamber			
2	Finished Length of the tank – First chamber			
3	Finished Width of the tank – Second chamber			
4	Finished Length of the tank – Second chamber			

Table A1.10: SR-checklist for dimension				
S. No.	**Description**	**Dimension as per drawing in meter**	**Actual dimension at site in meter**	**Remarks**
5	Opening dimension below the partition wall and base slab in the second chamber			
6	Finished Width of the tank – Third chamber			
7	Finished Length of the tank – Third chamber			
8	Size of the sump at the base of third chamber			
Source: TNUSSP				

A1.7.4.3. Sludge Drying Beds

Insert drawing of the module with the actual site-specific dimensions.

Table A1.11: SDB-checklist on specifications				
S. No.	**Sludge Drying Bed:**	**Yes/No**	**Remarks**	**Date of rectification**
1	Is the layout fixed as per the drawing?			
2	Is the overall height of the module as per drawing?			
3	Is the number of beds provided as per drawings and specifications?			
4	Is adequate slope provided at the base? Please specify			
5	Is the side wall and partition wall height provided as per drawing?			
6	Are the inlet and outlet levels fixed as per the drawings?			
7	Is sufficient bedding provided at the base of all the registers collecting the wastewater from the beds?			
8	Are the SBM walls properly bonded?			

Table A1.11: SDB-checklist on specifications				
S. No.	**Sludge Drying Bed:**	**Yes/No**	**Remarks**	**Date of rectification**
9	Are the 6" perforated drainage pipes placed in a slope? Mention the slope provided.			
10	Are the perforated pipes placed in all the beds at the same level?			
11	Is a vent/maintenance pipe with a cowl provided at both the ends of the perforated drainage pipes?			
12	Is the slope provided at the beds towards the perforated drainage pipes as per drawing?			
13	Are perforations provided in the correct size, coverage and spacing throughout the length of the drainage pipe as per the drawing?			
14	Are the perforated drainage outlet pipes from the Sludge Drying Beds to the Registers placed above the drainpipes from Register to Register?			
15	Is required number of Registers provided at outlet of each drying beds?			
16	Are the registers provided with manhole for easy access?			
17	Is sufficient level drop provided from Register to Register?			
18	Is damp proof course-50 mm thick provided above the RR masonry?			
19	Are the filter materials washed before laying?			
20	Are the filter materials placed in order as per the drawings?			
	a) 40mm gravel-200mm thk			
	b) 16-20mm gravel-150mm thk			
	c) 6-8mm gravel-100mm thk			
	d) 1-2mm sand-50mm thk			
21	Is the Porotherm brick/grass paver/terracotta jali-100mm thk filled with sieved sand and 1-2mm is placed in all the beds?			

Table A1.11: SDB-checklist on specifications				
S. No.	**Sludge Drying Bed:**	**Yes/No**	**Remarks**	**Date of rectification**
22	Is a splash plate (cuddapah stone slab) laid at the inlet point of the beds?			
23	Are steps provided to access the drying beds if found necessary?			
24	Is the pedestrian platform on finished floor level as per specification?			
25	Are the structural steel members of roof structure fabricated as per the drawings?			
26	Is polycarbonate sheet used for roofing alternatively?			
27	Are corrugated sheets provided for roofing?			
28	Is wind stay provided over the roof?			
29	Is rainwater gutter provided in the roof?			
30	Is the finished side wall top level at least 30 cm above FGL?			
31	Base slab and interior of pipes are clear of construction debris and other waste?			
32	Is the module constructed at least 300 mm above ground level?			
33	Is a freeboard of minimum 300 mm is provided to all water retaining structures?			
34	Whether a slot is provided for manholes? How is the manhole slot provided? Cutting/Casting?			
35	Are manhole frames provided for manholes?			
36	Are pipe inverts provided?			
37	Are clamps provided to hold the pipes in position?			
38	Is painting done as per specifications?			

Source: TNUSSP

Table A1.12: SDB-checklist for levels					
S. No.	**Description**	**Level as per drawing**	**Levels as per site**	**Actual level at site**	**Remarks**
	Benchmark-+100.000m				
1	Inlet level of the SDB at the beginning of the pedestrian platform				
2	Finished floor level of the pedestrian platform at the start point				
3	Finished floor level of the pedestrian platform at the centre				
4	Finished floor level of the pedestrian platform at the end				
	Level details of one bed				
5	Inlet pipe level at the Inlet Distribution Channel				
6	Inlet pipe level to the drying bed				
7	Outlet pipe levels of the Distribution Chamber				
8	L' bottom outlet pipe levels of the Distribution Chamber				
9	Base slab top finished level of the Distribution Chamber				
10	Perforated drainage pipe bottom level at the upstream side				
11	Perforated drainage pipe outlet level at the downstream side toward the registers (R1 to R6)				
	Register R1				
12	R1-I/L				
13	R1-O/L				

Table A1.12: SDB-checklist for levels					
S. No.	**Description**	**Level as per drawing**	**Levels as per site**	**Actual level at site**	**Remarks**
14	Difference in levels between R1 I/L & O/L				
	Register R2				
15	R2-I/L				
16	R2-O/L				
17	Difference in levels between R2 I/L & O/L				
	Register R3				
18	R3-I/L				
19	R3-O/L				
20	Difference in levels between R3 I/L & O/L				
	Register R4				
21	R4-I/L				
22	R4-O/L				
23	Difference in levels between R4 I/L & O/L				
	Register R5				
24	R5-I/L				
25	R5-O/L				
26	Difference in levels between R5 I/L & O/L				
	Register R6				
27	R6-I/L				
28	R6-O/L				
29	Difference in levels between R6 I/L & O/L				
30	Top level of base slab				

Table A1.12: SDB-checklist for levels					
S. No.	**Description**	**Level as per drawing**	**Levels as per site**	**Actual level at site**	**Remarks**
31	Height of base slab slope at the upper side (upstream)				
32	Height of base slab slope at the lower side (upstream)				
33	Height of base slab slope at the upper side (downstream)				
34	Height of base slab slope at the lower side (downstream)				
35	Top level of 40 mm thk gravel layer				
36	Top level of 16-20 mm thk gravel layer				
37	Top level of 6-8 mm thk gravel layer				
38	Top level of 1-2 mm thk sand layer				
30	Top level of porotherm brick layer				
40	Distance b/w SDB and CT1 in meter				
Source: TNUSSP					

Table A1.13: SDB-checklist for dimension				
S. No.	**Description**	**Dimension as per drawing in meter**	**Actual dimension at site in meter**	**Remarks**
1	Total number of drying beds			
2	Total (finished) Width of the tank including pedestrian platform			

Table A1.13: SDB-checklist for dimension				
S. No.	**Description**	**Dimension as per drawing in meter**	**Actual dimension at site in meter**	**Remarks**
3	Total (finished) Length of the tank			
4	Finished Width of each bed			
5	Finished Length of each bed			
6	Width of inlet distribution channel			
7	Finished Size of inlet distribution chamber			
8	Finished width of Pedestrian platform			
9	Distance between registers			
Source: TNUSSP				

A1.7.4.4. Integrated Settler Anaerobic Filter

Insert the drawing of the module

Insert the hand sketch of the module with the actual site-specific dimensions

Table A1.14: ISAF-checklist for specifications				
S. No.	**Description**	**Yes/No**	**Remarks**	**Date of rectification**
1	Is the layout fixed as per the drawing?			
2	Is there a slope provided at the base slab?			
3	Is the height of the module as per drawing?			
4	Are openings provided at the partition wall of the settler as per the drawings?			
5	Are the Inlet and Outlet pipes fixed in position with the specified number and spacing in the settler?			
6	Is a vent pipe with cowl provided in the chamber?			
7	Is the distribution channel at the outlet of settler and inlet of AF as per drawings?			

Table A1.14: ISAF-checklist for specifications				
S. No.	**Description**	**Yes/No**	**Remarks**	**Date of rectification**
9	Are the baffle pipes at the inlet, partition wall and at the outlet fixed in position with specified number, location and spacing as mentioned in the drawings in the AF?			
10	Is sufficient offset provided at the AF chamber walls to rest the precast perforated slab?			
11	Are perforations in the perforated slab as per drawings (hole dia and spacing?			
12	Are de-sludging pipes provided and placed at the right location?			
13	Is 4” dia hole provided at the bottom of de-sludging pipes?			
14	Is the brickbat layer placed 50 mm below the pipe level?			
15	Is the distribution channel base slab finished smoothly and 50 mm below the AF inlet pipe level?			
16	Are the Size and position of the manhole as per drawing?			
17	Are the cinder materials packed in nets and placed on top of the perforated slab?			
18	Is adequate slope provided at the outlet distribution channel as per the drawing?			
19	Is the finished top slab level at least 30 cm above FGL?			
20	Base slab and interior of pipes are clear of construction debris and other waste?			
21	Is the module constructed at least 300 mm above ground level?			
22	Is a freeboard of minimum 300 mm provided to all water retaining structures?			
23	Whether a slot is provided for manholes? How is the manhole slot provided? Cutting/Casting?			
24	Are manhole frames provided for manholes?			
25	Are pipe inverts provided?			
26	Are clamps provided to hold the pipes in position?			
27	Base slab and interior of pipes are clear of construction debris and other waste?			
28	Is painting done as per specifications?			

Source: TNUSSP

Table A1.15: ISAF-checklist for levels					
S. No.	**Description**	**Level as per drawing**	**Levels as per site**	**Actual level at site**	**Remarks**
	Benchmark-+100.000m				
1	Top level of the top slab				
2	Bottom level of top slab				
3	Inlet pipe level at the inlet chamber				
4	Inlet pipe level at the settler				
5	Minimum Freeboard at the settler				
6	Bottom level of partition wall opening at settler				
7	Inlet level of distribution channel chamber (Outlet of Settler)				
8	Outlet level of the distribution channel (inlet to AF)				
9	Base slab level of distribution channel				
10	Outlet of first chamber of AF				
11	Outlet of second chamber of AF				
12	Outlet of third chamber of AF				
13	Outlet of the distribution channel				
14	Bottom level of precast perforated slab				
15	Top level of the base slab				
16	Top level of cinder material				
Source: TNUSSP					

Table A1.16: ISAF-checklist for dimension				
S. No.	**Description**	**Dimension as per drawing in meter**	**Actual dimension at site in meter**	**Remarks**
1	Finished length of first chamber in settler			
2	Finished width of first chamber in settler			
3	Finished length of second chamber in settler			
4	Finished width of second chamber in settler			
5	Finished length of Inlet Distribution channel of AF			
6	Finished length of first chamber in AF			
7	Finished width of first chamber in AF			
8	Finished length of second chamber in AF			
9	Finished width of second chamber in AF			
10	Finished length of third chamber in AF			
11	Finished width of third chamber in AF			
12	Finished length of outlet Distribution channel of AF			
Source: TNUSSP				

A1.7.4.5. Horizontal Planted Gravel Filter

Insert drawing of the module

Insert hand sketch of the module with actual site dimensions

Table A1.17: HPGF-checklist on specifications				
S. No.	**Description**	**Yes/No**	**Remarks**	**Date of rectification**
1	Is the layout fixed as per the drawing?			
2	Is the height of the module as per drawing?			

Table A1.17: HPGF-checklist on specifications				
S. No.	**Description**	**Yes/No**	**Remarks**	**Date of rectification**
3	Is the slope provided at the base slab as per the drawing?			
4	Are all the Inlet and Outlet pipes fixed in position as per the drawings?			
5	Is the inlet distribution chamber placed as per drawings (distance and location)?			
6	Are all the inlet pipes to the distribution channel (DC) placed at the same level?			
7	Is the distribution channel base slab finished smoothly and 50 mm below the PGF inlet pipe level?			
8	Are all the pipes at the inlet to PGF (Outlet of DC) placed uniformly as per drawings – number and spacing?			
9	Is the register placed in the middle of the module near the inlet?			
10	Are the pipelines from the register to the PGF given sufficient slope?			
11	Are the filter materials properly sieved, washed and then laid?			
12	Are the perforated drainage pipes at the outlet placed in position with sufficient perforations?			
13	Is a vent pipe with cowl provided at the end of the perforated drainage pipes?			
14	Are sampling pipes with perforations provided at the filter chamber?			
15	Are cowls provided at the top of the sampling pipes?			
16	Are swivel pipes provided at the outlet register in the required inclination? (20 cm below the filter material top level on the outlet side)			
17	Are the Size and position of the manhole as per drawing?			
18	Is the finished side wall top level at least 30 cm above FGL?			

Table A1.17: HPGF-checklist on specifications				
S. No.	**Description**	**Yes/No**	**Remarks**	**Date of rectification**
19	Base slab and interior of pipes are clear of construction debris and other waste?			
20	Is the module constructed at least 300 mm above ground level?			
21	Is a freeboard of minimum 300 mm provided to all water retaining structures?			
22	Whether a slot is provided for manholes? How is the manhole slot provided? Cutting/Casting?			
23	Are manhole frames provided for manholes?			
24	Are pipe inverts provided?			
25	Are clamps provided to hold the pipes in position?			
26	Base slab and interior of pipes are clear of construction debris and other waste?			
27	Is painting done as per specifications?			
Source: TNUSSP				

Table A1.18: HPGF-checklist for levels					
S. No.	**Description**	**Level as per drawing**	**Levels as per site**	**Actual level at site**	**Remarks**
	Benchmark-+100.000m				
	Inlet Register R1				
1	Inlet pipe level				
2	Outlet pipe level at the register				
	Inlet Distribution channel				
3	Inlet pipe level to the distribution channel				
4	Finished base slab level				

Table A1.18: HPGF-checklist for levels					
S. No.	**Description**	**Level as per drawing**	**Levels as per site**	**Actual level at site**	**Remarks**
	PGF				
5	Outlet pipe level of the distribution channel (Inlet to PGF)				
6	Top level of distribution pipe wall				
7	Top level of base slab near the inlet				
8	Top level of base slab near the outlet				
9	Perforated drainage pipe level at the up stream				
10	Perforated drainage pipe level at the down-stream				
11	Top level of base at the outlet chamber (swivel pipe chamber)				
12	Outlet pipe level at the outlet chamber				
	Outlet Register R2, R3				
13	Inlet level of R2				
14	Outlet level of R2				
15	Inlet level of R3				
16	Outlet level of R3				
Source: TNUSSP					

Table A1.19: HPGF-checklist for dimension				
S. No.	**Description**	**Dimension as per drawing in meter**	**Actual dimension at site in meter**	**Remarks**
1	Size of the Inlet Distribution chamber R1			
2	Distance between the Distribution chamber and Channel			

Table A1.19: HPGF-checklist for dimension				
S. No.	**Description**	**Dimension as per drawing in meter**	**Actual dimension at site in meter**	**Remarks**
3	Finished length of Distribution channel (flow direction)			
4	Finished length of each PGF bed			
5	Finished width of each PGF bed			
6	Outlet chamber size (single PGF)			
5	Outlet chamber size (twin PGF)			
6	Size of the Register R2			
7	Size of the Register R3			
Source: TNUSSP				

A1.7.4.6. Polishing Pond/ Maturation Pond

Insert drawing of the module. Insert hand sketch of the module with the actual site-specific dimensions

Table A1.20: PP-checklist on specifications				
S. No.	**Description**	**Yes/No**	**Remarks**	**Date of rectification**
1	Is the layout fixed as per the drawing?			
2	Is the dimension of tie beam at the bottom as per the drawing?			
3	Is the dimension of tie beam at the top as per the drawing?			
4	Are steps provided for the accessibility of the pond?			
5	Is proper stone soling provided at the bottom and the sides of the pond?			
6	Is a clay layer laid at the bottom of the pond?			
7	Is precast RCC slab provided at the sides?			
8	Are all the Inlet and Outlet pipes fixed in position as per the drawing?			
9	Is the finished side bund level at least 30 cm above FGL?			

Table A1.20: PP-checklist on specifications				
S. No.	**Description**	**Yes/No**	**Remarks**	**Date of rectification**
10	Base slab and interior of pipes are clear of construction debris and other waste?			
11	Is the module constructed at least 300 mm above ground level?			
12	Is a freeboard of minimum 300 mm provided to all water retaining structures?			
13	Are pipe inverts provided?			
14	Are clamps provided to hold the pipes in position?			
15	Is painting done as per specifications?			
Source: TNUSSP				

Table A1.21: PP-checklist for levels					
S. No.	**Description**	**Level as per drawing**	**Levels as per site**	**Actual level at site**	**Remarks**
	Benchmark-+100.000m				
1	Inlet pipe level				
2	Outlet pipe level				
3	Base slab top level				
Source: TNUSSP					

Table A1.22: PP-checklist for dimension				
S. No.	**Description**	**Dimension as per drawing in meter**	**Actual dimension at site in meter**	**Remarks**
1	Finished Length of the pond			
2	Finished Width of the pond			
Source: TNUSSP				

A1.7.4.7. Collection tank 1 & 2

Insert drawing of the module

Insert hand sketch of the module with the actual site-specific dimensions

Table A1.23: CT 1 & 2-checklist on specifications				
S. No.	**Description**	**Yes/No**	**Remarks**	**Date of rectification**
1	Is the layout fixed as per the drawing?			
2	Is the height of the module as per drawing?			
3	Are all the Inlet and Outlet pipes fixed in position?			
4	What is the slope provided at the base slab?			
5	Is a vent pipe with cowl provided in the chamber?			
6	Is an overflow pipe provided just above the outlet pipe?			
7	Is the provision given for the pump and its fixing?			
8	What is the capacity of the pump provided in the tank?			
9	Are the Size and position of the manhole as per drawing?			
10	Is the finished top slab level at least 30 cm above FGL?			
11	Base slab and interior of pipes are clear of construction debris and other waste?			
12	Is the module constructed at least 300 mm above ground level?			
13	Is a freeboard of minimum 300 mm provided to all water retaining structures?			
14	Whether a slot is provided for manholes? How is the manhole slot provided? Cutting/Casting?			
15	Are manhole frames provided for manholes?			
16	Are pipe inverts provided?			
17	Are clamps provided to hold the pipes in position?			
18	Is painting done as per specifications?			
Source: TNUSSP				

Table A1. 24: CT 1 & 2-checklist for levels					
S. No.	**Description**	**Level as per drawing**	**Levels as per site**	**Actual level at site**	**Remarks**
	Benchmark-+100.000m				
I	**Collection Tank 1**				
1	Inlet level				
2	Pump outlet				
3	Top level of top slab (including plastering)				
4	Thickness of top slab (excluding plastering)				
5	Bottom level of top slab				
6	Top level of base slab				
7	Freeboard				
II	**Collection Tank 2**				
1	Inlet level				
2	Pump outlet				
3	Top level of top slab (including plastering)				
4	Thickness of top slab (excluding plastering)				
5	Bottom level of top slab				
6	Top level of base slab				
7	Freeboard				
Source: TNUSSP					

Table A1.25: CT 1 & 2-checklist for dimension				
S. No.	**Description**	**Dimension as per drawing in meter**	**Actual dimension at site in meter**	**Remarks**
I	**Collection Tank 1**			
1	Finished Length of the Tank			

Table A1.25: CT 1 & 2-checklist for dimension				
S. No.	**Description**	**Dimension as per drawing in meter**	**Actual dimension at site in meter**	**Remarks**
2	Finished Width of the Tank			
II	**Collection Tank 2**			
1	Finished Length of the Tank			
2	Finished Width of the Tank			
Source: TNUSSP				

A1.7.5. Commissioning

Table A1.26: Checklist on commissioning				
S. No.	**Description**	**Yes/No**	**Remarks**	**Date of rectification**
1	Are the constructed modules watertight? If No, mention the defective modules with inferences			
2	Do the interconnection sewer systems have required slope?			
3	The positions and levels of inlet, outlet and distribution pipes are as per design?			
Source: TNUSSP				

A1.7.6. Testing and Trial Run

Table A1.27: Checklist on testing and trial run				
S. No.	**Description**	**Yes/ No**	**Remarks**	**Date of rectification**
1	Continuous and uninterrupted flow achieved in all modules in the presence of the TSU?			
2	The effluent standards are within PCB limits			
Source: TNUSSP				

A1.7.7. Observations

(Shall have 10 pages with this format for filling up)
Date of Visit:
People present:

Urban Local Body	:	(Name and Designation)
Contractor	:	(Name and Designation)
TNUSSP	:	(Name and Designation)

Table A1.28: Field observation

S. No.	Observations and suggestions
Enter checklist item number and observation/suggestion/progress of work:	
Source: TNUSSP	

Checked and Noted:

TNUSSP Engineer **Contractor** **ULB**

Completion Note:
The status of each observation should be checked and detailed during the next site visit until its status becomes 'rectified'. The status of each item can only be any of the following possibilities:
1. Rectified 2. Rectified with approved changes, 3. Highlighted to top management, 4. Carried forward

Table A1.29: Status of observation

S. No.	Status	Remarks
Source: TNUSSP		

Checked and Noted:

TNUSSP Engineer **Contractor** **ULB**

A1.8. Status of construction during site visits

(Shall have 10 pages with this format for filling up)

Table A1.30: Status update during site visits									
S. No.	**Date**	**Status of work**							
		SC	**SR**	**SDB**	**CT1**	**CT2**	**ISAF**	**PGF**	**PP**

Table A1.30: Status update during site visits									
S. No.	**Date**	**Status of work**							
		SC	**SR**	**SDB**	**CT1**	**CT2**	**ISAF**	**PGF**	**PP**

Source: TNUSSP

Annexure 2: Quality assurance checklist for commissioning

Commissioning and Startup is the transitional phase between plant construction completion and its operations. (CII, 2022) The overall objective of the commissioning stage of the treatment project is to ensure that the components of the treatment plant are complete, operational, and meet the design requirements.
The objectives of commissioning will be achieved through the following tasks:

- Completion of construction confirming that all civil structures, electromechanical components and any other related items related to treatment plant have been checked for its correctness and completeness.
- Conduct Pre-commissioning to confirm each module and its accessories (if any) are fit for the purpose.
- Conduct Process commissioning by starting up the treatment plant with the feed sludge.
- Manage the operation and treatment performance testing of the plant to achieve commissioning completion.

Overall commissioning will be complete when

- The functionality of the treatment plant is as per the project design brief.
- The treatment plant demonstrates the capability to meet the performance standards set out in the project design brief.
- All the project-related documents and O&M guidelines are handed over to the client with required training for plant O&M.

Commissioning of the treatment plant is carried out in different stages as mentioned below:

- Pre-Commissioning of individual components (dry and wet commissioning)
- Process Commissioning and Performance tests
- Commissioning Completion and Handover

Pre-Commissioning:
The pre-commissioning checks mainly include on-site inspections and tests. *Refer to Annexure 2.1 for the checklist and Reporting*. During this stage, each module of the treatment plant will be systematically inspected for its correct installation and all the observations noted down for any correction/modifications to be carried out before putting the system to operation. This mainly includes:

- Checking for correctness and completeness of construction, which includes a) checking the finished sizes and levels of each module, b) checking for all the components within the treatment modules and its specification – Annexure 2.1
- Hydraulic Testing of civil structures and pipes (leakage, flow) – Annexure 2
- Checking and testing Electrical and mechanical equipment and Control equipment for optimum performance – Annexure 3

Process Commissioning:
Process Commissioning is the process of introducing sludge/sewage into the treatment plant, establishing the biological treatment and testing the operation of overall treatment plant process.

Process Commissioning of the Plant includes the following:

- Establishment and stabilisation of the treatment process, which includes sludge stabilisation, sludge dewatering and drying and percolate treatment

- The operation of electrical, mechanical and control systems under working conditions that represent the anticipated operating conditions
- Operation of all auxiliaries / standby equipment
- Final adjustment of valves, equipment, and control settings
- Performance testing to establish that the operation of the plant conforms with the specified requirements and the design intent
- Final training of operators and demonstration of maintenance activities

Process Performance Test shall be conducted at the end of process commissioning (45 to 60 days) to demonstrate that the plant meets the output specification set out in the project design brief. A Process Performance Test Report shall be prepared on the completion of the test, outlining the results of all testing.

Commissioning completion and Handover:
Final commissioning completion and handover will occur after successful completion of the Process Performance Test and all commissioning completion criteria as mentioned in the above sections, have been satisfied.

The handover of the treatment plant includes the following documentation and deliverables which consists of documentation, including

- Document introducing the Plant and a Process Overview
- Construction drawings (preferably as built drawings)
- Operations and Maintenance Manuals
- Operator training on O&M
- Asset Registration sheets
- Any reports related to design and construction phases of the project
- Vendor manual (Equipment O&M Manuals) and contacts
- Final commissioning report

Commissioning check of treatment plant is one of the key activities to be carried out before operationalising the plant. It is the process of ensuring that all components of a treatment plant are constructed/installed, tested according to the operational requirements of the treatment process/plant. The checklist below provides the overall observations of the pre-commissioning checks and understandings of correctness and completeness of each of modules. Please refer table A2.1 for the detailed checklist for carrying out the pre-commissioning checks and A2.2 for each module.

Annexure 2.1- Pre-commissioning Checklist
Checklist for pre-commissioning checks

Table A2.1: Checklist for pre-commissioning checks					
S. No.	**Parameters/Description**	**Pass Yes/No**	**Comments/ Correction note**	**Assigned Person**	**Date**
I	**Screen Chamber**				
1	Confirm that the civil structural-internal dimension are as per design				
2	Confirm that quality of finishing is adequate				
3	Confirm that leakage test has been carried out				
4	Confirm that the Screen is as per design & placed in the position & operational conditions				
5	Confirm plumbing arrangement is in place				
6	Confirm levels as per drawing				
7	Confirm painting work is done				
8	Confirm truck access & ease of disposal into tank				
9	Confirm manhole cover has been placed as per drawing				
II	**Stabilisation Reactor**				
1	Confirm that the civil structural-internal dimension are as per design				
2	Confirm that quality of finishing is adequate				
3	Confirm that leakage test has been carried out				
4	Confirm that sludge is flowing equally in both the chamber				
5	Confirm plumbing arrangement is in place				
6	Confirm levels as per drawing				

Table A2.1: Checklist for pre-commissioning checks					
S. No.	**Parameters/Description**	**Pass Yes/No**	**Comments/ Correction note**	**Assigned Person**	**Date**
7	Confirm painting work is done				
8	Confirm that pump is able to pump the sludge (trial run)				
9	Confirm that vent pipe arrangement is provided				
10	Confirm that there is no blockage in the pipe				
11	Confirm that flow rate is as per design				
12	Confirm i hose pipe is available				
13	Confirm manhole cover has been placed as per drawing				
III	**Sludge drying bed**				
1	Confirm that the civil structural-internal dimension are as per design				
2	Confirm that quality of finishing is adequate				
3	Confirm that leakage test has been carried out				
4	Confirm that vent pipe arrangement is provided				
5	Confirm that there is no blockage in the perforated pipe				
6	Confirm that sludge is spread evenly throughout the bed				
7	Confirm that plumbing arrangement is in place				
8	Calculate the volume of percolate water				
9	Confirm that sludge height is as per design				
10	Confirm if painting work is done				

Table A2.1: Checklist for pre-commissioning checks					
S. No.	**Parameters/Description**	**Pass Yes/No**	**Comments/ Correction note**	**Assigned Person**	**Date**
IV	**Collection tank 1**				
1	Confirm that the civil structural-internal dimension are as per design				
2	Confirm that quality of finishing is adequate				
3	Confirm that leakage test has been carried out				
4	Confirm that all the percolate is reaching to the tank				
5	Confirm that plumbing arrangement is in place				
6	Confirm pump and valve arrangement are in place				
7	Confirm that overflow pipe arrangement is provided				
8	Confirm if painting work is done				
9	Confirm if manhole cover has been placed as per drawing				
V	**Integrated Settler Anaerobic Filter (ISAF)**				
1	Confirm that the civil structural-internal dimension are as per design				
2	Confirm that quality of finishing is adequate				
3	Confirm that leakage test has been carried out				
4	Confirm that plumbing arrangement is in place				
5	Confirm that vent pipe arrangement is provided				
6	Confirm that there is no blockage in the pipe				
7	Confirm that flow rate is as per design				

Table A2.1: Checklist for pre-commissioning checks					
S. No.	**Parameters/Description**	**Pass Yes/No**	**Comments/ Correction note**	**Assigned Person**	**Date**
8	Confirm if painting work is done				
9	Confirm if manhole cover has been placed as per drawing				
10	Confirm the orientation of inlet outlet t-pipe as per the construction drawing				
VI	**Horizontal Planted Gravel Filter (HPGF)**				
1	Confirm that the civil structural-internal dimension are as per design				
2	Confirm that quality of finishing is adequate				
3	Confirm that leakage test has been carried out				
4	Confirm that plumbing arrangement is in place				
5	Confirm that distribution of water is equal in the bed				
6	Confirm that sampling pipe is provided				
7	Confirm that swivel pipe is fixed properly				
8	Confirm if painting work is done				
9	Confirm if the plantation is carried out				
10	Confirm if manhole cover has been placed as per drawing				
VII	**Polishing Pond**				
1	Confirm that the civil structural-internal dimension are as per design				
2	Confirm that quality of finishing is adequate				
3	Confirm that leakage test has been carried out				

Table A2.1: Checklist for pre-commissioning checks					
S. No.	**Parameters/Description**	**Pass Yes/No**	**Comments/ Correction note**	**Assigned Person**	**Date**
4	Calculate the total volume of treated water				
5	Confirm that plumbing arrangement is in place				
VIII	**Collection Tank 2**				
1	Confirm that the civil structural-internal dimension are as per design				
2	Confirm that quality of finishing is adequate				
3	Confirm that leakage test has been carried out				
4	Calculate the total volume of treated water				
5	Confirm that plumbing arrangement is in place				
6	Confirm if painting work is done				
7	Confirm that manhole cover has been placed as per drawing				
IX	**Sludge Storage House**				
1	Confirm that the civil structural-internal dimension are as per design				
2	Confirm that quality of finishing is adequate				
3	Confirm truck access & ease of disposal dry sludge				
4	Confirm if painting work is done				
X	**Operator Room**				
1	Confirm that the civil structural-internal dimension are as per design				
2	Confirm that quality of finishing is adequate				
3	Confirm if all the electrical fittings are working				

Table A2.1: Checklist for pre-commissioning checks					
S. No.	**Parameters/Description**	**Pass Yes/No**	**Comments/ Correction note**	**Assigned Person**	**Date**
4	Confirm that toilet facilities are provided				
5	Confirm if painting work is done				
XI	**Store Room**				
1	Confirm that the civil structural-internal dimension are as per design				
2	Confirm that quality of finishing is adequate				
3	Confirm if all the electrical fitting are working				
4	Confirm if painting work is done				
XI	**Additional works**				
1	Confirm if there is a O&M manual available				
2	Confirm if all construction debris removed				
3	Confirm the training of Operator on O&M				
4	Confirm is the boundary wall/ gate work is completed				
5	Confirm if water supply provision is made or is available				
6	Confirm if First aid box is available				
7	Confirm if Treatment plant details are available on the board				
8	Confirm if emergency contact details are provided for public information				
9	Confirm if Fire safety installation is provided				
10	Confirm electricity connection at site				

Table A2.1: Checklist for pre-commissioning checks					
S. No.	**Parameters/Description**	**Pass Yes/No**	**Comments/ Correction note**	**Assigned Person**	**Date**
11	Confirm working of solar power system				
12	Confirm if control panel board is working				
13	Confirm if all the streetlights are working				
14	Confirm installation of DG				
15	Confirm inter-module plumbing work				
16	Confirm the availability of required PPE and O&M tools				
17	Confirm potable water supply at site				
18	Confirm if landscape work is complete				
Source: TNUSSP					

Checklist for different treatment modules

Table A2.2: Checklist for different treatment modules					
S. No.	**Parameters/Description**	**Pass Yes/No**	**Comments/ Correction note**	**Assigned Person**	**Date**
I	**Screen chamber**				
1	Is the inlet pipe fixed in the side wall?				
2	Are the inlet and outlet pipe levels provided as per design?				
3	Are vitreous tiles laid in the inner sides and floor?				
4	Are sufficient openings provided in the coarse and the fine screen?				
5	Is Size of coarse and fine screens as per design?				

Table A2.2: Checklist for different treatment modules					
S. No.	**Parameters/Description**	**Pass Yes/No**	**Comments/ Correction note**	**Assigned Person**	**Date**
6	Is screen fabricated with stainless steel material?				
7	Are the coarse and fine screens placed in s 60-degree inclination with the base slab, and parallel to each other?				
8	Are handles provided for easier removal of the bar screens during O&M?				
9	Is the bottom bar at the screen removed? (To prevent clogging of solid particles at the screen)				
10	Is the slope in base slab provided as per the design?				
11	Is the module constructed at least 300 mm above ground level?				
12	Is a freeboard of minimum 300 mm provided to all water retaining structures?				
13	Are manhole frames provided for manholes?				
14	Is the module watertight? If No, mention the defects with inferences				
	Dimension:				
15	Finished Width of the tank				
16	Finished Length of the tank				
17	Length between the inlet side wall and coarse screen				
18	Length between the coarse screen and fine screen				
19	Length between the fine screen and outlet side wall				
20	Depth of the chamber				
	Levels:				
	Benchmark-+100.000m				

Table A2.2: Checklist for different treatment modules					
S. No.	**Parameters/Description**	**Pass Yes/No**	**Comments/ Correction note**	**Assigned Person**	**Date**
1	Inlet level (side)				
2	Base slab level near the inlet				
3	Base slab level near the outlet				
4	Outlet of Screen chamber				
5	Bottom level of top slab				
6	Top level of the top slab				
7	Top level of the base slab				
8	Distance b/w SC and SR in meter				
II	**Stabilisation Reactor**				
1	Are 4" pipes used for all pipelines in the Stabilisation Reactor?				
2	Are the inlet and outlet pipe levels provided as per design?				
3	Is the inlet distribution/baffle wall provided in the second chamber as per the design?				
4	Whether an angular cut (45 degree) is provided at the bottom of all the vertical inlet pipes?				
5	Is sufficient slope provided at each chamber of the SR?				
6	Is proper bedding slope and sump provided at the base of the collection well of the SR (pump sump)?				
7	Are 'T' pipes provided at all the inlets & outlets?				
8	Is the pump provided in the collection well as per specification? Mention capacity of pump				
9	Is the module constructed at least 300 mm above ground level?				
10	Is a freeboard of minimum 300 mm provided to all water retaining structures?				

Table A2.2: Checklist for different treatment modules					
S. No.	**Parameters/Description**	**Pass Yes/No**	**Comments/ Correction note**	**Assigned Person**	**Date**
11	Are manhole frames provided for manholes?				
12	Is the module watertight? If No, mention the defects with inferences				
13	Is a flexible hose connected from the SR outlet to the Sludge Drying Bed?				
14	Is plastering slope provided on top of cover slab for rainwater discharge?				
	Dimension:				
1	Finished Width of the tank – First chamber				
2	Finished Length of the tank – First chamber				
3	Finished Width of the tank – Second chamber				
4	Finished Length of the tank – Second chamber				
5	Dimension of the opening below the partition wall and base slab in the second chamber				
6	Finished Width of the tank – Third chamber				
7	Finished Length of the tank – Third chamber				
8	Size of the sump at the base of third chamber				
	Levels:				
1	Inlet of SR				
2	Outlet of CH1				
3	Outlet of CH2				
4	Outlet of CH3 (supernatant O/L)				
5	Base slab concrete level of SR				
6	Difference in levels b/w CH1 I/L to CH1 O/L				

Table A2.2: Checklist for different treatment modules					
S. No.	**Parameters/Description**	**Pass Yes/No**	**Comments/ Correction note**	**Assigned Person**	**Date**
7	Difference in levels b/w CH2 I/L to CH2 O/L				
8	2" dia pipe pump outlet level				
9	Projection above the top slab level				
10	Top level of top slab (including 50 mm plastering at the top for draining of rainwater)				
11	Freeboard at CH1				
12	Freeboard at CH2				
13	Freeboard at CH3				
14	Distance b/w SR and SDB in meter				
III	**Sludge Drying Beds**				
1	Is sufficient slope provided at the base of the drying bed?				
2	Is a vent/maintenance pipe with a cowl provided at one end of the perforated drainage pipes?				
2	Are manholes provided in the registers for easy access?				
3	Is sufficient level drop provided from Register to Register?				
4	Is sufficient slope provided for the perforated drainage pipe?				
5	Are the filter materials placed in order as per the drawings?				
	a) 40 mm gravel-200 mm thk				
	b) 16-20 mm gravel-150 mm thk				
	c) 6-8 mm gravel-100 mm thk				
	d) 1-2 mm sand-50 mm thk				
6	Is the Porotherm brick/grass paver/terracotta jali-100 mm thk filled with sieved sand 1-2 mm placed in all the beds?				

Table A2.2: Checklist for different treatment modules					
S. No.	**Parameters/Description**	**Pass Yes/No**	**Comments/ Correction note**	**Assigned Person**	**Date**
7	Is a splash plate (cuddapah stone slab) laid at the inlet point of the beds?				
8	Are steps provided to access the drying beds if found necessary?				
9	Is the pedestrian platform and finished floor level as per specification?				
10	Are the structural steel members of roof structure fabricated as per the drawings?				
11	Is polycarbonate sheet used for roofing alternatively?				
12	Aew corrugated sheets provided for roofing?				
13	Is wind stay provided over the roof?				
14	Is rainwater gutter provided in the roof?				
15	Is the module constructed at least 300 mm above ground level?				
16	Is a freeboard of minimum 300 mm provided to all water retaining structures?				
17	Are manhole frames provided for manholes?				
18	Is the module watertight? If No, mention the defects with inferences				
19	Is slope at base slab provided as per the drawing?				
20	Is plastering slope provided on top of cover slab for rainwater discharge?				
21	Is painting done as per specifications?				
22	Total number of drying beds				
	Dimension:				

Table A2.2: Checklist for different treatment modules					
S. No.	**Parameters/Description**	**Pass Yes/No**	**Comments/ Correction note**	**Assigned Person**	**Date**
1	Total (finished) size-B x W of the module including pedestrian platform				
2	Finished Width of each bed				
3	Finished Length of each bed				
4	Depth of each drying bed				
5	Finished Size of inlet distribution chamber				
6	Finished width of Pedestrian platform				
7	Finished size and depth of the registers				
i)	R1				
ii)	R2				
iii)	R3				
iv)	R4				
v)	R5				
vi)	R6				
vii)	R7				
8	Finished size and depth of the collecting register R7				
9	Distance between each register from R1 to R6				
	Levels:				
1	Inlet level of the SDB at the beginning of the pedestrian platform				
2	Finished floor level of the pedestrian platform at the start point				
3	Finished floor level of the pedestrian platform at the centre				
4	Finished floor level of the pedestrian platform at the end				
	Level details of one bed				

Table A2.2: Checklist for different treatment modules					
S. No.	**Parameters/Description**	**Pass Yes/No**	**Comments/ Correction note**	**Assigned Person**	**Date**
1	Inlet pipe level at the Inlet Distribution Channel				
2	Inlet pipe level to the drying bed				
3	Outlet pipe levels of the Distribution Chamber				
4	L' bottom outlet pipe levels of the Distribution Chamber				
5	Perforated drainage pipe outlet level at the downstream side toward the registers (R1 to R6)				
	Interconnecting Registers				
	Register R1				
1	R1-I/L				
2	R1-O/L				
3	Difference in levels between R1 I/L & O/L				
	Register R2				
4	R2-I/L				
5	R2-O/L				
6	Difference in levels between R2 I/L & O/L				
	Register R3				
7	R3-I/L				
8	R3-O/L				
9	Difference in levels between R3 I/L & O/L				
	Register R4				
10	R4-I/L				
11	R4-O/L				
12	Difference in levels between R4 I/L & O/L				

Table A2.2: Checklist for different treatment modules					
S. No.	**Parameters/Description**	**Pass Yes/No**	**Comments/ Correction note**	**Assigned Person**	**Date**
	Register R5				
13	R5-I/L				
14	R5-O/L				
15	Difference in levels between R5 I/L & O/L				
	Register R6				
16	R6-I/L				
17	R6-O/L				
18	Difference in levels between R6 I/L & O/L				
19	Top level of porotherm brick layer				
20	Distance b/w SDB and CT1 in meter				
IV	**Collection Tank 1**				
1	Is an overflow pipe provided just above the outlet pipe?				
2	Is pump of the required capacity provided? Mention brand name and its capacity				
3	Is base slab and interior of pipes clear of construction debris and other waste?				
4	Are the size and position of the manhole as per drawing?				
5	Are the positions and levels of inlet, outlet and distribution pipes as per design?				
6	Is the module watertight? If No, mention the defects with inferences				
7	Is slope at base slab provided as per the drawing?				
8	Is plastering slope provided on top of cover slab for rainwater discharge?				
9	Is painting done as per specifications?				

Table A2.2: Checklist for different treatment modules					
S. No.	**Parameters/Description**	**Pass Yes/No**	**Comments/ Correction note**	**Assigned Person**	**Date**
10	Is the module constructed at least 300 mm above ground level?				
11	Is a freeboard of minimum 300 mm provided to all water retaining structures?				
12	Are manhole frames provided for manholes?				
	Dimensions:				
1	Finished Length of the Tank				
2	Finished Width of the Tank				
3	Depth of the tank				
	Levels:				
1	Inlet level				
2	Pump outlet				
3	Top level of top slab (including plastering)				
4	Thickness of top slab (excluding plastering)				
5	Bottom level of top slab				
6	Top level of base slab				
7	Freeboard				
V	**Integrated Settler Anaerobic Filter (ISAF)**				
1	Are the Inlet and Outlet pipes fixed in position with the specified number and spacing in the settler?				
2	Are openings provided at the partition wall of the settler as per the drawings?				
3	Is a vent pipe with cowl provided in the chamber?				
4	Are the baffle pipes at the inlet, partition wall and at the outlet fixed in position with specified number,				

Table A2.2: Checklist for different treatment modules					
S. No.	**Parameters/Description**	**Pass Yes/No**	**Comments/ Correction note**	**Assigned Person**	**Date**
	location and spacing as mentioned in the drawings in the AF?				
5	Are de-sludging pipes provided and placed at the right location?				
6	Is the brickbat layer placed 50 mm below the pipe level?				
7	Is the distribution channel base slab finished smoothly and 50 mm below the AF inlet pipe level?				
8	Are the cinder materials packed in nets and placed on top of the perforated slab?				
9	Is adequate slope provided at the outlet distribution channel as per the drawing?				
10	Is the module constructed at least 300 mm above ground level?				
11	Is a freeboard of minimum 300 mm provided to all water retaining structures?				
12	Are manhole frames provided for manholes?				
13	Is the module watertight? If No, mention the defects with inferences				
14	Is slope at base slab provided as per the drawing?				
15	Is plastering slope provided on top of cover slab for rainwater discharge?				
16	Is painting done as per specifications?				
	Dimension:				
1	Finished size of first chamber in settler				
2	Finished size of second chamber in settler				
3	Finished size of Inlet Distribution channel of AF				

Table A2.2: Checklist for different treatment modules					
S. No.	**Parameters/Description**	**Pass Yes/No**	**Comments/ Correction note**	**Assigned Person**	**Date**
4	Finished size of first chamber in AF				
5	Finished size of second chamber in AF				
6	Finished size of third chamber in AF				
7	Finished size of outlet Distribution channel of AF				
	Levels:				
1	Top level of the top slab				
2	Bottom level of top slab				
3	Inlet pipe level at the inlet chamber				
4	Inlet pipe level at the settler				
5	Minimum Freeboard at the settler				
6	Bottom level of partition wall opening at settler				
7	Inlet level of distribution channel chamber (Outlet of Settler)				
8	Outlet level of the distribution channel (inlet to AF)				
9	Base slab level of distribution channel				
10	Outlet of first chamber of AF				
11	Outlet of second chamber of AF				
13	Outlet of third chamber of AF				
14	Outlet of the distribution channel				
15	Bottom level of precast perforated slab				
16	Top level of the base slab				
17	Top level of cinder material				
VI	**Horizontal Planted Gravel Filter**				
1	Are all the Inlet and Outlet pipes fixed in position as per the drawings?				

Table A2.2: Checklist for different treatment modules					
S. No.	**Parameters/Description**	**Pass Yes/No**	**Comments/ Correction note**	**Assigned Person**	**Date**
2	Are all the inlet pipes to the distribution channel (DC) placed at the same level?				
3	Is the distribution channel base slab finished smoothly and 50 mm below the PGF inlet pipe level?				
4	Is the register placed in the middle of the module near the inlet?				
5	Are the pipelines from the register to the PGF given sufficient slope?				
6	Are the filter materials properly sieved, washed and then laid?				
7	Are the perforated drainage pipes at the outlet placed in position with sufficient perforations?				
8	Is a vent pipe with cowl provided at the end of the perforated drainage pipes?				
9	Are sampling pipes with perforations provided at the filter chamber?				
10	Are cowls provided at the top of the sampling pipes?				
11	Are swivel pipes provided at the outlet register in the required inclination? (20 cm below the filter material, top level on the outlet side)				
12	Is the module constructed at least 300 mm above ground level?				
13	Is a freeboard of minimum 300 mm provided to all water retaining structures?				
14	Are manhole frames provided for manholes?				
15	Are the specified plants planted in the PGF?				
16	Are the plants planted in the PGF with sufficient spacing?				

Table A2.2: Checklist for different treatment modules					
S. No.	**Parameters/Description**	**Pass Yes/No**	**Comments/ Correction note**	**Assigned Person**	**Date**
17	Is the module watertight? If No, mention the defects with inferences				
18	Is slope at base slab provided as per the drawing?				
19	Is plastering slope provided on top of cover slab for rainwater discharge?				
20	Is painting done as per specifications?				
	Dimensions:				
1	Size of the Inlet Distribution chamber R1				
2	Finished width of Distribution channel				
3	Finished length of Distribution channel (flow direction)				
4	Finished internal dimension of each PGF bed				
5	Outlet chamber size (single PGF)				
6	Outlet chamber size (twin PGF)				
7	Size of the Register R2				
8	Size of the Register R3				
	Levels:				
	Inlet Register R1				
1	Inlet pipe level				
2	Outlet pipe level at the register				
	Inlet Distribution channel				
3	Inlet pipe level to the distribution channel				
4	Finished base slab level				
	PGF				
5	Outlet pipe level of the distribution channel (Inlet to PGF)				

Table A2.2: Checklist for different treatment modules					
S. No.	**Parameters/Description**	**Pass Yes/No**	**Comments/ Correction note**	**Assigned Person**	**Date**
6	Top level of distribution pipe wall				
7	Top level of base slab near the inlet				
8	Top level of base slab near the outlet				
9	Top level of base at the outlet chamber (swivel pipe chamber)				
10	Outlet pipe level at the outlet chamber				
	Outlet Register R2, R3				
13	Inlet level of R2				
14	Outlet level of R2				
15	Inlet level of R3				
16	Outlet level of R3				
VII	**Polishing Pond**				
1	Are steps provided for the accessibility of the pond?				
2	Is proper stone soling provided at the bottom and the sides of the pond?				
3	Is a clay layer laid at the bottom of the pond?				
4	Is precast RCC slab provided at the sides?				
5	Are all the Inlet and Outlet pipes fixed in position as per the drawing?				
	Dimensions:				
1	Finished Length of the pond				
2	Finished Width of the pond				
3	Designed depth of wastewater in the pond?				
	Levels:				
1	Inlet pipe level				
2	Outlet pipe level				

Table A2.2: Checklist for different treatment modules					
S. No.	**Parameters/Description**	**Pass Yes/No**	**Comments/ Correction note**	**Assigned Person**	**Date**
3	Base slab top level				
VIII	**Collection Tank 2**				
1	Is an overflow pipe provided just above the outlet pipe?				
2	Is pump of the required capacity provided? Mention brand name and its capacity				
3	Is base slab and interior of pipes cleaned from construction debris and other waste?				
4	Is the size and position of the manhole as per drawing?				
5	Are the positions and levels of inlet, outlet and distribution pipes as per design?				
6	Is the module watertight? If No, mention the defects with inferences				
7	Is slope at base slab provided as per the drawing?				
8	Is plastering slope provided on top of cover slab for rainwater discharge?				
9	Is painting done as per specifications?				
10	Is the module constructed at least 300 mm above ground level?				
11	Is a freeboard of minimum 300 mm provided to all water retaining structures?				
12	Are manhole frames provided for manholes?				
	Dimensions:				
1	Finished Length of the Tank				
2	Finished Width of the Tank				
3	Depth of the tank				
	Levels:				

Table A2.2: Checklist for different treatment modules					
S. No.	**Parameters/Description**	**Pass Yes/No**	**Comments/ Correction note**	**Assigned Person**	**Date**
1	Inlet level				
2	Pump outlet				
3	Top level of top slab (including plastering)				
4	Thickness of top slab (excluding plastering)				
5	Bottom level of top slab				
6	Top level of base slab				
7	Freeboard				
IX	**Sludge Storage House**				
X	**Operator Room**				
XI	**Store Room**				
I	**Additional Items**				

Table A2.2: Checklist for different treatment modules					
S. No.	**Parameters/Description**	**Pass Yes/No**	**Comments/ Correction note**	**Assigned Person**	**Date**
1	Is a boundary wall constructed as per the master plan?				
2	Is an approach road provided? Mention width of approach road.				
3	Is a ramp provided near the Screen Chamber to facilitate emptying of the septage from the truck?				
4	Is sufficient ramp height provided? Specify height of the ramp				
5	Does the height of the truck outlet match the inlet of the Screen Chamber?				
6	Is adequate space for vehicle/truck movement within the plants is provided?				
7	Is a spillage collection drain provided to carry away the septage that spills from the truck outlet while unloading?				
8	Are stormwater drains provided at site?				
9	Is proper backfilling done and all debris moved out of site?				
10	Is solar panel installed? Specify capacity of the panel				
11	Is the solar power generated sufficient for the pump operation?				
12	Is clearance ensured from the potential hindrances to treatment and civil structures (e.g., trees/compound walls near SDB or PP)				
13	Effluent disposal arrangement: availability of drain or other ways?				

Source: TNUSSP TSU, 2019

Annexure 2.2- Hydraulic test

Water tightness and flow test for each module:

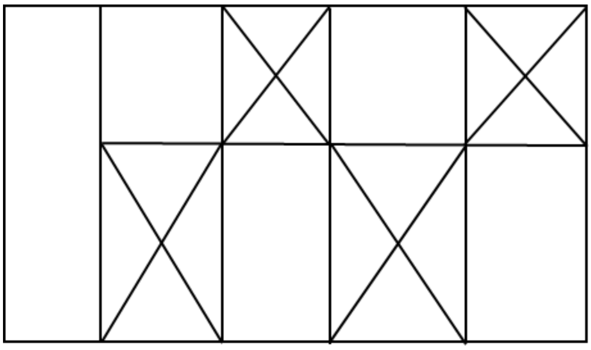
After pre-commissioning checks, all the tanks should be tested for smooth water flow and water tightness.

Water tightness (leakage) test:

Procedures for conducting the test are as follows:

a. Empty and clean all the chamber/s.
b. Fill the chamber/s, if more than one chamber or row of chambers, then fill alternative tanks (as specified in the drawing below) and take all the levels of water with reference to the base slab/top slab.
c. Leave the water for 24 hours and check the levels in each chamber.
d. If the leakage is not found, then pump the water to the other set of empty chambers and take all the levels of water with reference to the base slab or distribution pipes.
e. Once the above-mentioned procedures are completed then flood all the chambers and check the flow direction and smoothness.

Figure A2. 1: Water tightness test



Source: TNUSSP TSU, 2019

Table A2. 3: Hydraulic Test Reporting Format

S. No.	Particulars	Water filled in	Water level readings with respect to outlet level / top level of Swivel pipe		
			1st Day	2nd Day	3rd Day
1	**Stabilisation Reactor**	All the chambers up to Outlet level			
		1st Chamber			
		2nd Chamber			
		3rd Chamber			

Table A2. 3: Hydraulic Test Reporting Format					
S. No.	**Particulars**	**Water filled in**	**Water level readings with respect to outlet level / top level of Swivel pipe**		
			1st Day	2nd Day	3rd Day
2	**Settler**	All the chambers up to Outlet level			
3	**Anaerobic Filter**	All the alternate chambers up to Outlet level			
		1st Channel: 1st Chamber			
		2nd Chamber			
		2nd Channel: 1st Chamber			
		2nd Chamber			
		3rd Channel: 1st Chamber			
		2nd Chamber			
4	**Sludge drying beds**	Close the outlet pipe with end cap and fill water in SDB up to the top level of Swivel pipe			
		1st SDB			
		2nd SDB			
		3rd SDB			
		4th SDB			
5	**Planted Gravel Filter**	Close the outlet pipe with end cap and fill water in PGF up to the top level of Swivel pipe			
		1st PGF			
		2nd PGF			

Table A2. 3: Hydraulic Test Reporting Format					
S. No.	Particulars	Water filled in	Water level readings with respect to outlet level / top level of Swivel pipe		
			1st Day	2nd Day	3rd Day
		3rd PGF			
		4th PGF			
6	**Collection Tank**	Up to the Outlet level			
		1st Tank			
		2nd Tank			
Any other (Please specify)					
Source: TNUSSP TSU, 2019					

Hydraulic Test has been carried out successfully without any leakage in the above mentioned FSTP Modules.

Date, Name and Signature

Annexure 2.3 – Electromechanical equipment test

Refer to manufacturer manual and check its efficient functioning. If any differences are found in comparison to the specification, contact the supplier/manufacturer.

All the electromechanical equipment and control equipment checked for its functioning and confirmed its working as per the manufacturer specification.

Date, Name and Signature

Annexure 3: Quality assurance checklist for O&M

Name of the Facility: Name of the Operator: Signature: Date: Time:

Table A3. 1: O&M Checklist					
S. No.	**Tasks**	**Frequency**	**Primary Responsibility**	**Yes/No**	**Observations (If any)**
REGULAR O&M CHECKLIST					
1	**Screen Chamber**				
	Cleaning of screens/ Removal of solids accumulated in the screens	Daily/When blockage found	Helper		
	Grit removal	Daily/When blockage found	Helper		
	Clean spillage, if any, after every de-sludging truck leaves the facility	Daily/After every de-sludging activity	Helper		
2	**Stabilisation Reactor**				
	Pumping of sludge from SR to SDB	Daily – Before the start of operations	Operator		
	Check level of sludge and supernatant in the last chamber of the stabilisation reactor	Daily	Operator		
	Cleaning of flexible de-sludging pipe	Weekly once/When blockage found	Helper		
3	**Sludge Drying Bed**				
	Removal of dried sludge (only when sludge bed is dry and underlying sand is visible)	Once in 2 weeks	Operator		

Table A3. 1: O&M Checklist					
S. No.	**Tasks**	**Frequency**	**Primary Responsibility**	**Yes/No**	**Observations (If any)**
4	**Integrated Settler & Anaerobic Filter**				
	Ensure/Observe free flow of water at the outlet	Once in 2 weeks	Operator		
	Cleaning of inlet distribution channel	Monthly once	Helper		
	Observe free flow of water at the outlet	Once in 2 weeks			
	Cleaning of vent pipes	Once in 3 months			
	Check sludge level in the settler	Once in 6 months (if found more than 1 m, then de-sludge)			
	Check sludge level in the anaerobic filter	Once in 6 months (if found more than 0.3 m, then de-sludge)			
5	**Horizontal Planted Gravel Filter**				
	Weed removal	Daily	Helper		
	Cleaning of inlet distribution channel	Monthly once	Helper		
	Swivel pipe level checking Check for following: • The water level is observed above the upper surface of the filter material (coarse aggregates) • There is dampness observed at the	Monthly once	Operator		

Table A3. 1: O&M Checklist					
S. No.	**Tasks**	**Frequency**	**Primary Responsibility**	**Yes/No**	**Observations (If any)**
	surface of the filter material • There is no plant growth • There is excess mosquito growth				
6	**Sludge Storage Shed**				
	Emptying dried sludge	As and when required	Helper		
7	**Sewer Systems**				
	Cleaning registers & check for flow	Monthly once			
8	**General Maintenance/ Housekeeping**				
	Ensure that the manhole covers are not damaged and cover the manholes properly	Daily	Helper		
	Clean up litter and dead leaves around the surroundings	Daily	Helper		
	Disposal of unused hoses, extension cords and ropes	Monthly once	Helper		
	If observed, clean up accumulated scum/garbage	Monthly once	Helper		
	Gardening/watering plants	Daily	Helper/ Gardener		
	Landscaping/sweeping-cleaning facility	Daily	Helper/ Housekeeping		
	Check sludge level in all systems	Daily			
		Daily			Report problem here:

Table A3. 1: O&M Checklist					
S. No.	**Tasks**	**Frequency**	**Primary Responsibility**	**Yes/No**	**Observations (If any)**
	Ensure all lights are in working condition at the site				
1	**Stabilisation Reactor**				
	Scum removal	Once in 3 months	Helper		
	Pumping sludge from the first two chambers	Once in 6 months	Helper		
	Cleaning of 'T' pipes	Once in 6 months	Helper		
2	**Sludge Drying Bed**				
	Periodical re-filling of sand	Once in 6 months/ as and when required	Operator		
	Cleaning of perforated drainage pipes	Once in 6 months	Helper		
3	**Collection Tank**				
	Emptying and cleaning of collection tank	Once in 6 months/ as and when required	Helper		
4	**Integrated Settler and Anaerobic Filter**				
	Removal of scum	Once in 3 months	Helper		
	De-sludging of the settler and anaerobic filter	Once in 6 months/ as and when required	Helper		
	Cleaning of inlet and outlet pipes	Once in 6 months	Helper		
5	**Horizontal Planted Gravel Filter**				

Table A3. 1: O&M Checklist					
S. No.	Tasks	Frequency	Primary Responsibility	Yes/No	Observations (If any)
	Trimming of plants	Once in 3 months/when overgrowth observed	Helper		
	Cleaning of perforated drainage pipes	Once in 6 months	Helper		
6	**Polishing Pond**				
	Removal of weeds and excess algae	Once in 3 months	Helper/ Gardener		
	De-sludging	Once in 6 months	Helper		
7	**Pump And Level Controller Maintenance**	Once a month/as and when required			
	Sewer System				
	Cleaning of pipes between registers	Once in 6 months	Helper		
PERIODIC O&M CHECKLIST (1-6 YEARLY)					
1	**Screen Chamber**				
	Maintenance of screens-Repaint/replacement of screens	Yearly Once	Operator		
2	**Sludge Drying Bed**				
	Washing and replacing filter material	Once in 3 years/ when clogging is observed/drying is slower than 20 days	Operator		
3	**Integrated Settler and Anaerobic Filter**				

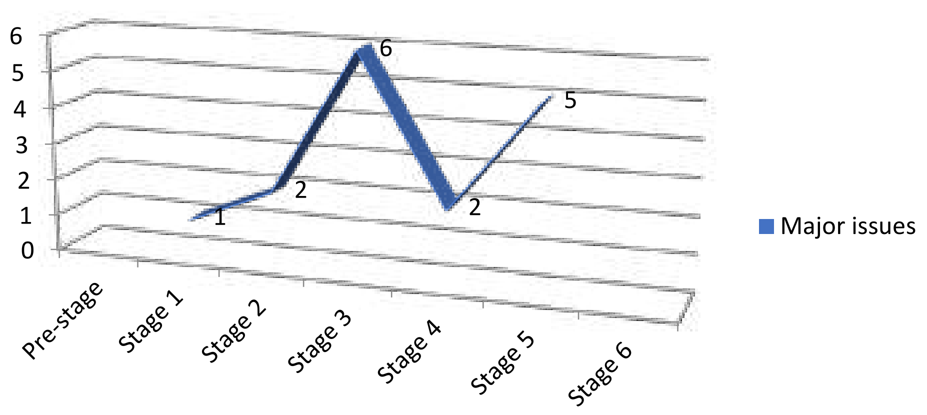
Table A3. 1: O&M Checklist					
S. No.	**Tasks**	**Frequency**	**Primary Responsibility**	**Yes/No**	**Observations (If any)**
	Cleaning/replacement of filter media in anaerobic filter	Once in 3 years	Operator		
4	**Horizontal Planted Gravel Filter**				
	Cleaning/replacement of filter media	Once in 6 years	Operator		
Source: TNUSSP, 2019					

Annexure 4: Facts & Figures

Table A4.1: Occurrences of major issues across ULBs at different stages			
Major issues	**ULBs**	**Occurrence stage**	**Number of occurrences**
Improper levels	Kovilpatti	Stage IV	3
Pumps not as per specification		Stage V	1
Baffle wall at the SR dislocated	Tirumangalam	Stage III	4
Larger area consumed	Paramakudi	Stage I	1
OPC cement used initially	Melur	Stage III	1
Manholes misplaced in one of the SRs	Kulithalai	Stage III	1
Insufficient reinforcement at base slab of SR	Pattukottai	Stage III	1
Bulging of concrete	Mannargudi	Stage III	2
Difficulty in excavation due to rocky features	Chengalpattu	Stage II	2
Negative slopes and levels	Kovilpatti	Stage III, IV	3
	Kadayanallur	Stage II	1
Polycarbonate sheets not provided	Kovilpatti	Stage V	1
	Paramakudi	Stage V	1
	Kulithalai	Stage V	1
	Mannargudi	Stage V	1

Source: TNUSSP Analysis, 2020

Figure A4.1: Stage-wise major issues trends



Source: TNUSSP Analysis, 2020

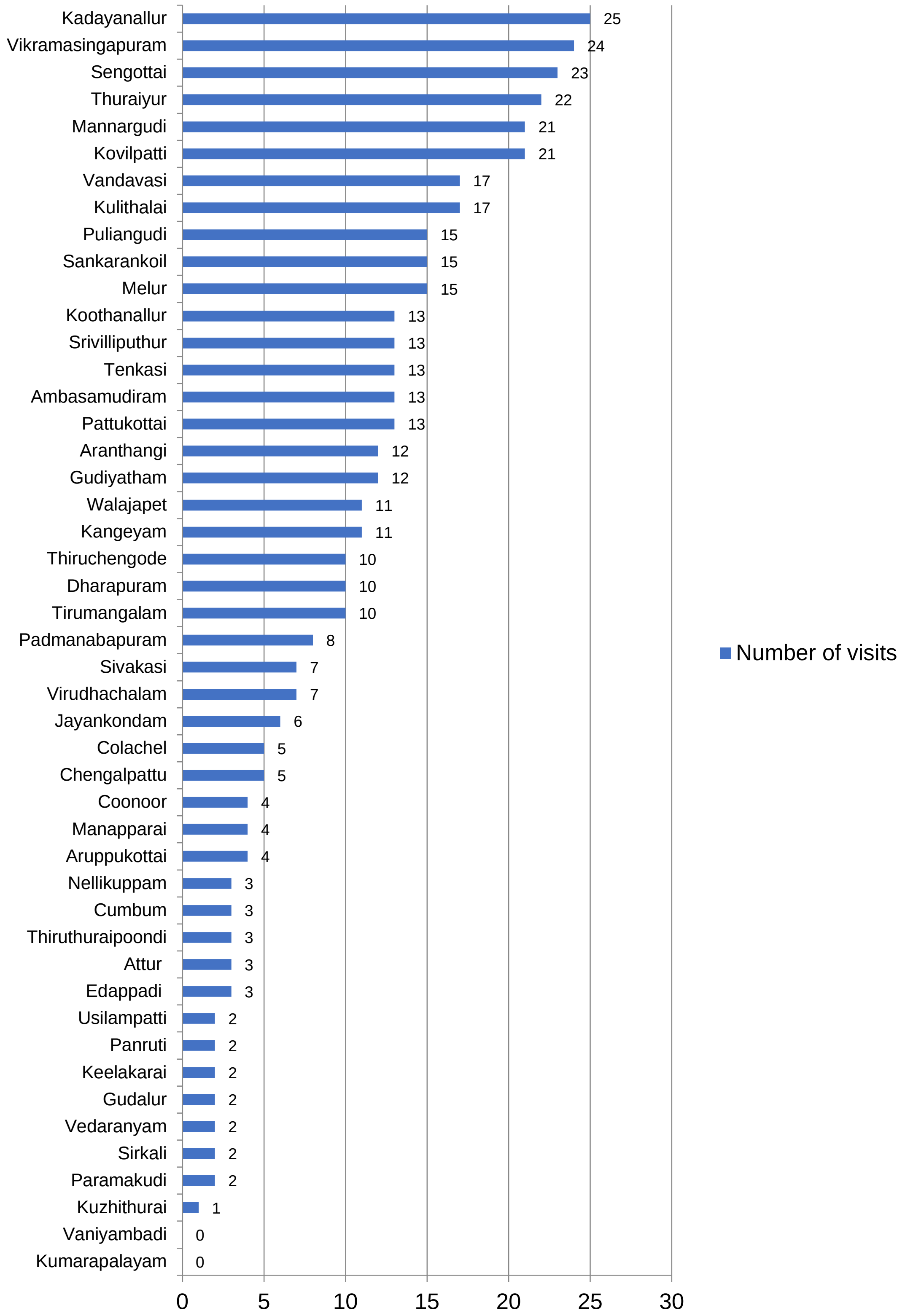
As and when the QA team observed errors during site visits at different stages of construction, they alerted the ULBs immediately. The team explained about the potential loss of money if the work continued as such and provided technical guidance. After learning from mistakes from a site, the QA team informed the other ULBs against making such errors. The QA team conducted frequent cross-learning sessions to the ULBs to share best practices and avoid any O&M errors.

Table A4.2: Cost saved due to timely intervention by QA team

ULBs	Number of errors rectified	Cost saved (INR)
Kovilpatti	12	1,23,000
Sengottai	6	69,000
Vickramasingapuram	5	45,000
Melur	8	1,55,000
Thuraiyur	8	1,40,000
Kadayanallur	10	2,70,000
Kulithalai	9	1,00,000
Pattukottai	5	1,36,000
Mannargudi	8	85,000
Sankarankoil	5	3,45,000
Ambasamudiram	3	65,000
Virudhachalam	4	57,000
Tenkasi	4	27,000
Vandavasi	10	25,76,000
Padmanabhapuram	4	1,00,000
Walajapet	3	45,000
Srivilliputhur	4	77,000
Koothanallur	4	55,000
Gudiyatham	5	60,000
Aranthangi	3	50,000
Puliangudi	3	75,000
Chengalpattu	3	70,000
Sivakasi	2	12,000
Total		**47,37,000**

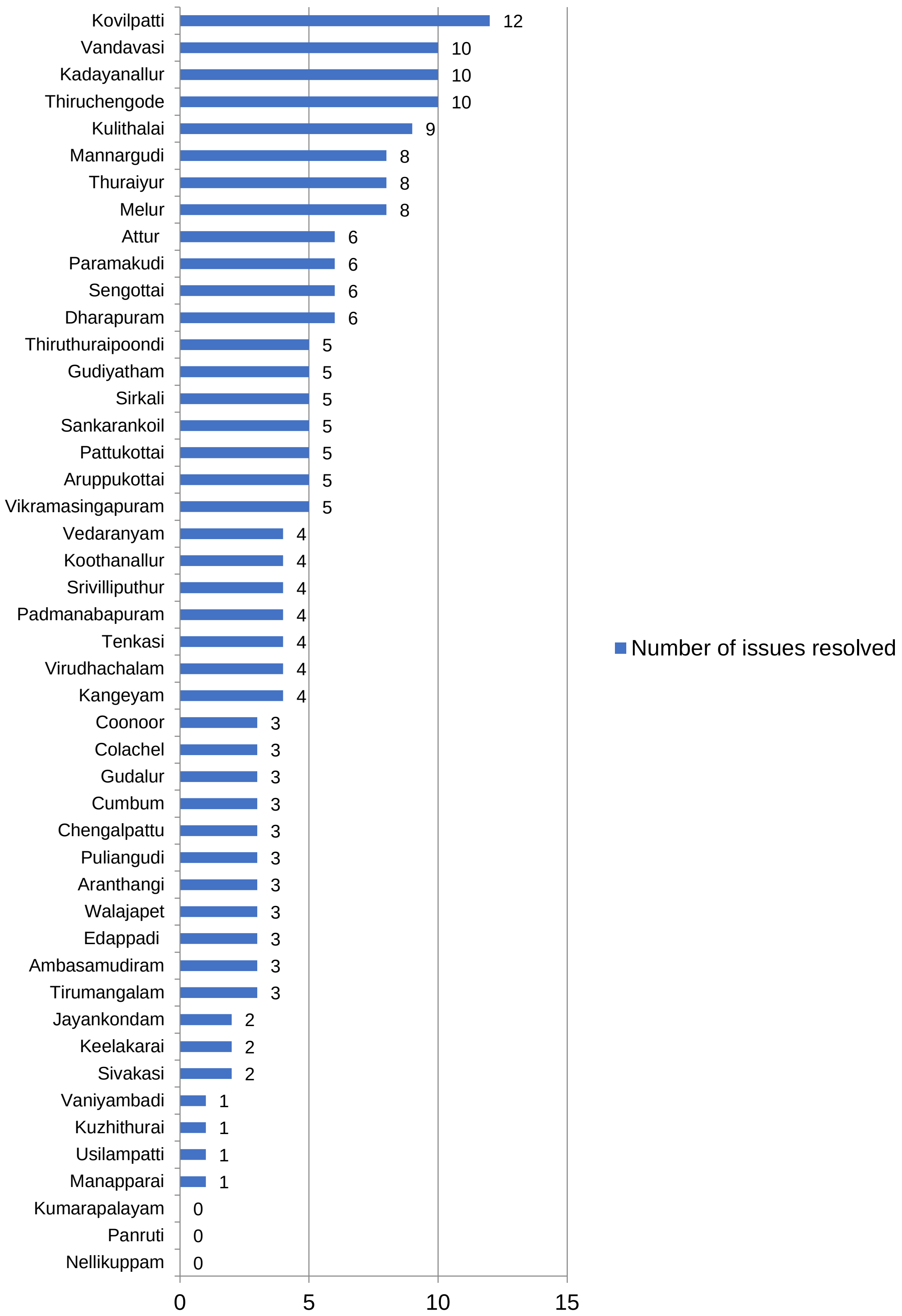
Source: TNUSSP Analysis, 2020

Figure A4.2: QA team visits across ULBs



Source: TNUSSP Analysis, 2020

Figure A4. 3: Total number of issues resolved



Source: TNUSSP Analysis, 2020

Table A4.3: Capacity building initiatives from QA team		
Capacity building sessions	**No. of participants**	**ULB participants**
Workshop on Implementation of Quality Assurance for FSTPs, March 22, 2019	**49** (Phase I - 21 ULB engineers + 21 Contractors+7 Regional Engineers)	Kangeyam, Kovilpatti, Tiruchengode, Pattukkottai, Sengottai, Walajapet, Dharapuram, Virudhachalam, Keelakarai, Melur, Paramakudi, Tirumangalam, Kulithalai, Mannargudi, Jayamkondan, Thuraiyur, Kadayanallur, Vikramasingapuram, Aruppukkottai, Srivilliputhur, Vandavasi
Workshop on Implementation of Quality Assurance for FSTPs, January 8 & 9, 2019	**33** (Phase II - 26 ULB engineers+7 Regional Engineers)	Chengalpattu, Nellikuppam, Panruti, Manapparai, Coonoor, Thiruthuraipoondi, Vedaranyam, Koothanallur, Aranthangi, Ambasamudiram, Puliangudi, Sankarankoil, Padmanabapuram, Cumbum, Gudalur, Attur, Panruti, Sirkali, Kuzhithurai, Edappadi, Arcot, Ranipet, Pazhani, Tindivanam, Usilampatti, Tenkasi
Cross-learning session at Kovilpatti and Tirumangalam FSTPs, January 28 & 29, 2020	**40** (Commisioners-20+ULB engineers-20)	Kovilpatti, Sankarankoil, Kadayanallur, Puliangudi, Tenkasi, Sengottai, Vikramasingapuram, Ambasamudiram, Sivakasi, Aruppukottai, Colachel, Padmanabapuram, Kuzhithurai, Tirumangalam, Cumbum, Gudalur, Paramakudi, Usilampatti, Keelakarai, Melur
Pre-commissioning session, February 02, 2020	**6** (**Kangeyam:** Commissioner, Municipal Engineer, Working Inspector, Contractor **Dharapuram:** Assistant Engineer, Contractor)	Kangeyam, Dharapuram
Source: TNUSSP, 2019 & 2020		

TN US SP
TAMIL NADU URBAN SANITATION SUPPORT PROGRAMME

Tamil Nadu Urban Sanitation Support Programme (TNUSSP) supports the Government of Tamil Nadu and cities in making improvements along the entire urban sanitation chain.
The TNUSSP is implemented by a consortium of organisations led by the Indian Institute for Human Settlements (IIHS), in association with CDD Society, Gramalaya and Keystone Foundation.

iihs®
INDIAN INSTITUTE FOR HUMAN SETTLEMENTS

IIHS CHENNAI: Floor 7A, Chaitanya Exotica, 24/51, Venkatnarayana Road, T.Nagar, Chennai-600017.
044-6630 5500 tnussp@iihs.ac.in www.tnussp.co.in www.facebook.com/TNUSSP