Faecal Sludge Treatment in Nepal

(*An Inventory and Performance Assessment)*

Acknowledgements

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Executive Summary

Faecal Sludge Treatment is a critical aspect for safely managed sanitation especially the country like Nepal where 89% of population relies on on-site sanitation. Nepal had initiated feacal sludge treatment in 1998 with the establishment of its first septage treatment plant in Teku, Kathmandu. Since then, a few municipalities installed Faecal Sludge Treatment Plants (FSTPs) with support from government, I/NGOs, and private sector.

As of 2024, 21 municipalities in Nepal have faecal sludge treatment facilities, including FSTPs, wastewater treatment plants (WWTPs) that also treat faecal sludge, and trenching sites. The total installed capacity of FSTPs is 112 m^3 of FS per day. However, the entire volume of FS being treated is around 57.6 m^3 only. This discrepancy clearly indicates underutilization of existing treatment facilities. There are several factors that contributes to this underutilization including availability of limited mechanical desludging services, the widespread use of leaky containment systems that reduce the frequency of desludging, reluctance among private service providers to use treatment plants, and the haphazard disposal of FS into environment and agriculture land. Additionally, a few treatment plants are currently not in operation.

Operational efficiency remains major challenge in feacal sludge treatment in Nepal. Assessments reveals that only 13 treatment plants are fully functional, while the remaining are either are partially operational or non-functional. Inadequate and proper operation and maintenance practices are common issues across FSTPs in the country.

These issues emphasize the need for improved infrastructure, better management practices, effective regulatory enforcement and enhanced awareness and capacity building.

All FSTPs in Nepal use nature-based technology with treatment processes typically comprising sludge thickening, solid-liquid separation, anaerobic digestion, nutrient management and enhancing dissolved oxygen (DO). While nature-based systems are generally effective and easier to maintain, their performance varies significantly across facilities and fluctuates seasonally.

According to the assessment, the effluent quality parameters such as pH, BOD and COD were generally within permissible limits with a few exceptions observed during the study period.

In conclusion, Nepal has made progress in feacal sludge management and in expanding its treatment infrastructure. However, considerable challenges remain including underutilization of facilities, inconsistent operational performance, and gaps in enforcement of regulatory instruments governing FSM. These challenges underscore the need for increased investment, strengthened institutional capacity, and greater stakeholder engagement. Addressing these issues is critical to achieving safe, sustainable, and effective FSM nationwide, thereby safeguarding public health and promoting environmental sustainability.

Introduction

Background

Nepal, with its diverse geography ranging from the fertile plains of the Terai to the rugged hills and the world's tallest mountain peaks, is bordered by India to the east, south, and west, and China to the north. Administratively, the country is divided into seven provinces namely Koshi, Madhesh, Bagmati, Gandaki, Lumbini, Karnali, and Sudurpaschim comprising 293 municipalities and 460 rural municipalities. With a total population of 26,494,504, Nepal has experienced a significant increase in in urbanization, particularly over the last two decades. This rapid urban growth has created a rising demand for improved urban services, especially in the sanitation sector, including the safe management of wastewater and faecal sludge. In response to these needs and several initiatives have been launched to strengthen FSM in Nepal. These efforts have led to the establishment of FSTPs in a few municipalities. In some cases, existing WWTPs have also been utilized for faecal sludge treatment. However, from an operational perspective, there are still significant gaps that hinder the effective functioning, efficiency and sustainability of these FSM systems. Against, this backdrop, the Environment and Public Health Organization (ENPHO), under the Municipalities Network Advocacy on Sanitation in South Asia – Phase II (MuNASS II) program, assessed existing FSTPs across the country. The assessment, carried out between January and August 2024 serves as a critical reference for identifying the strengths, challenges and opportunities for improving FSM practices in Nepal.

Objective

The primary objective of this assessment was to provide an evidence-based analysis of the operational status and functionality of Feacal Sludge treatment facilities in Nepal. The specific objectives of the assessment were as follows:

- To develop an inventory of treatment plants treating faecal sludge in Nepal including technical approaches and technologies adopted.
- To evaluate and analyze the operational status and performance of these treatment plants.

Methodology

The methodology for this study was carefully designed to enable a comprehensive assessment of the operational status, treatment technologies, and overall efficiency of faecal sludge treatment plants in Nepal. A mixed-methods approach, incorporating both qualitative and quantitative data collection and analysis, was employed to ensure a robust and evidence-based evaluation.

Review of relevant documents

As part of the study, a comprehensive review of relevant documents was conducted to gather background information and contextual insights into FSM in Nepal. This review included national policies, guidelines, reports, project documents and previous assessments related to FSM and wastewater treatment. The served to identify existing treatment infrastructure, regulatory frameworks and institutional arrangements, best practices and gaps in current systems. Additionally, it provided understanding of the historical development and implementation challenges of FSM initiatives across the country. The findings from this document review informed both the design of field assessments and the overall analytical framework.

Key Informant Interviews (KIIs):

A structured checklist was developed to guide the data collection process. The study team conducted in-depth interviews with key informants, including treatment plant operators and representatives from relevant stakeholder organizations. These interviews were aimed at gathering detailed information on the design specifications, operational procedures, and overall functionality of faecal sludge treatment plants across various locations.

Field Observation:

Field visits were conducted to assess the physical and functional status of faecal sludge treatment plants on site. During these visits, the study team engaged directly with plant caretakers and operators to gather firsthand information on day-to-day operations. Observations and interactions were systematically documented. Based on the field data collected, the team analyzed the operational procedures and assessed the functionality and performance of each treatment plant.

Lab Testing of Effluents:

To quantify treatment efficiency, laboratory analysis of effluent samples was conducted. Key water quality parameters including Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Total Suspended Solids (TSS) were measured to evaluate the performance of the treatment plants. The results provided critical insights into the effectiveness of the treatment processes and the degree of compliance with national environmental standards.

Findings

Chronology of Faecal Sludge Treatment in Nepal

Nepal's early initiative in FSM began with the establishment of a septage treatment facility in Teku, Kathmandu in 1998. The facility was designed to treat faecal sludge generated withing the Kathmandu valley and operated by the Urban Environment Section of the Kathmandu Metropolitan City until 2004. However, due to technical and managerial shortcomings, the facility was shut down in 2005 (HPCIDBC, 2011). In 2000, the second Septage Treatment Plant was established in Pokhara with a treatment capacity of 115 m^3 per day under the Pokhara Environment Improvement Project, funded by the Asian Development Bank (ADB). The plant, integrated with the Pokhara landfill site, was designed to co-treat faecal sludge along with landfill leachate. Unfortunately, this facility is no longer operational, as it is now located within the buffer zone of the newly built Pokhara International Airport.

During the 2000s, toilet coverage in the country was approximately 30%. As a result, fecal sludge production was not yet considered a priority concern. Consequently, the replication of FSTPs was not observed for nearly a decade following initial efforts.

A significant shift observed with the implementation of the Sanitation and Hygiene Master Plan in 2011, which accelerated the Open Defecation Free (ODF) campaign and led to a rapid increase in toilet coverage. As coverage expanded, FSM emerged as a critical issue. In response, several FSM initiatives were undertaken. These included the construction of a fecal sludge drying bed under the Asian Development Bank (ADB) supported Second Small Towns Water Supply and Sanitation Sector Project (STWSSSP Phase II) during 2014/15. In 2015, a dedicated FSTP was established in Gulariya Municipality in 2015 with technical assistance from ENPHO, implemented under SAFA and SWASTHA Gulariya project, supported by Practical Action Nepal and UK Aid. That same year, another FSTP was constructed in Lubhu, Mahalaxmi Municipality, Lalitpur by ENPHO with support from BORDA.These early interventions played a pivotal role in shaping subsequent FSM strategies and infrastructure development. Since then, government, non-government, and private sector organizations have contributed at various levels to establishing FSTPs using a range of technologies from basic(trenching) methods to advanced systems that enable the reuse of by-products such as biogas, compost and treated water. Additionally, a few wastewater treatment plants are now being designed and implemented with facilities for the co-treatment of fecal sludge and wastewater.

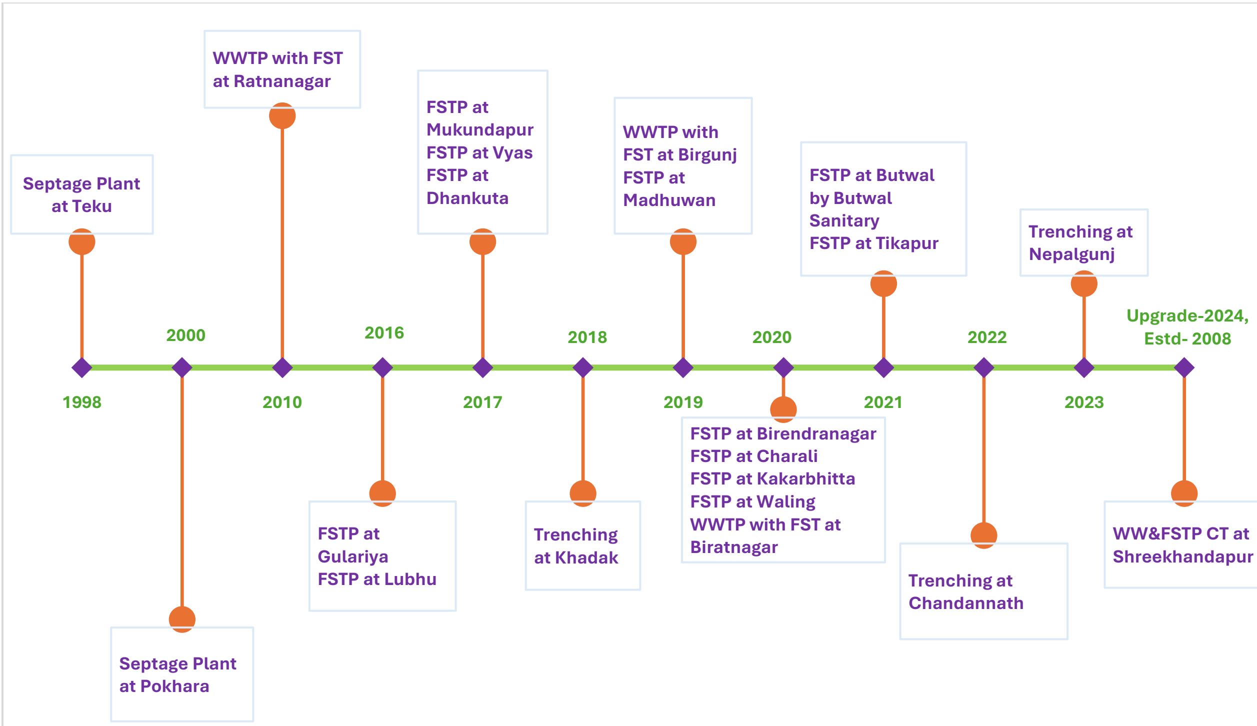

Figure 1 Chronological order of the establishments of treatment plants to treat faecal sludge in Nepal

Operational Status

Currently, 21 municipalities across Nepal, including metropolitan and sub-metropolitan cities, are equipped with liquid wastewater treatment facilities. Notably, all seven provinces have at least one treatment facility within their respective jurisdictions. Present status of feacal sludge treatment in Nepal -

- The Septage Treatment Plants (SPTs) in Teku and Pokhara have been decommissioned
- 13 FSTPs are fully operational and functional.
- 3 facilities (FSTPs/WWTPs with faecal sludge treatment or trenching capabilities) are partially functional
- 3 FSTPs remain non-functional and incomplete.

The treatment infrastructure includes various types of facilities such as Faecal Sludge Treatment Plants (FSTPs), Wastewater Treatment Plants (WWTPs) with capabilities of FS treatment, and trenching facilities. Table 1 summarizes the operational status of FSTPs across all provinces.

Table 1: Status of Treatment Plants Treating Faecal Sludge across Nepal

Province	Demolished	Functional	Operational Status Partially functional	Non-functional & incomplete	Grand Total
Bagmati	1	2	1		4
Gandaki	1	1		2	4
Karnali		2			2
Koshi		3	1		4
Lumbini		3		1	4
Madhesh		1	1		2
Sudurpaschim		1			1
Grand Total	2	13	3	3	21

Figure 2 shows the location map of the Treatment Plants Treating Faecal Sludge across Nepal.

Annex Spatial Distribution and

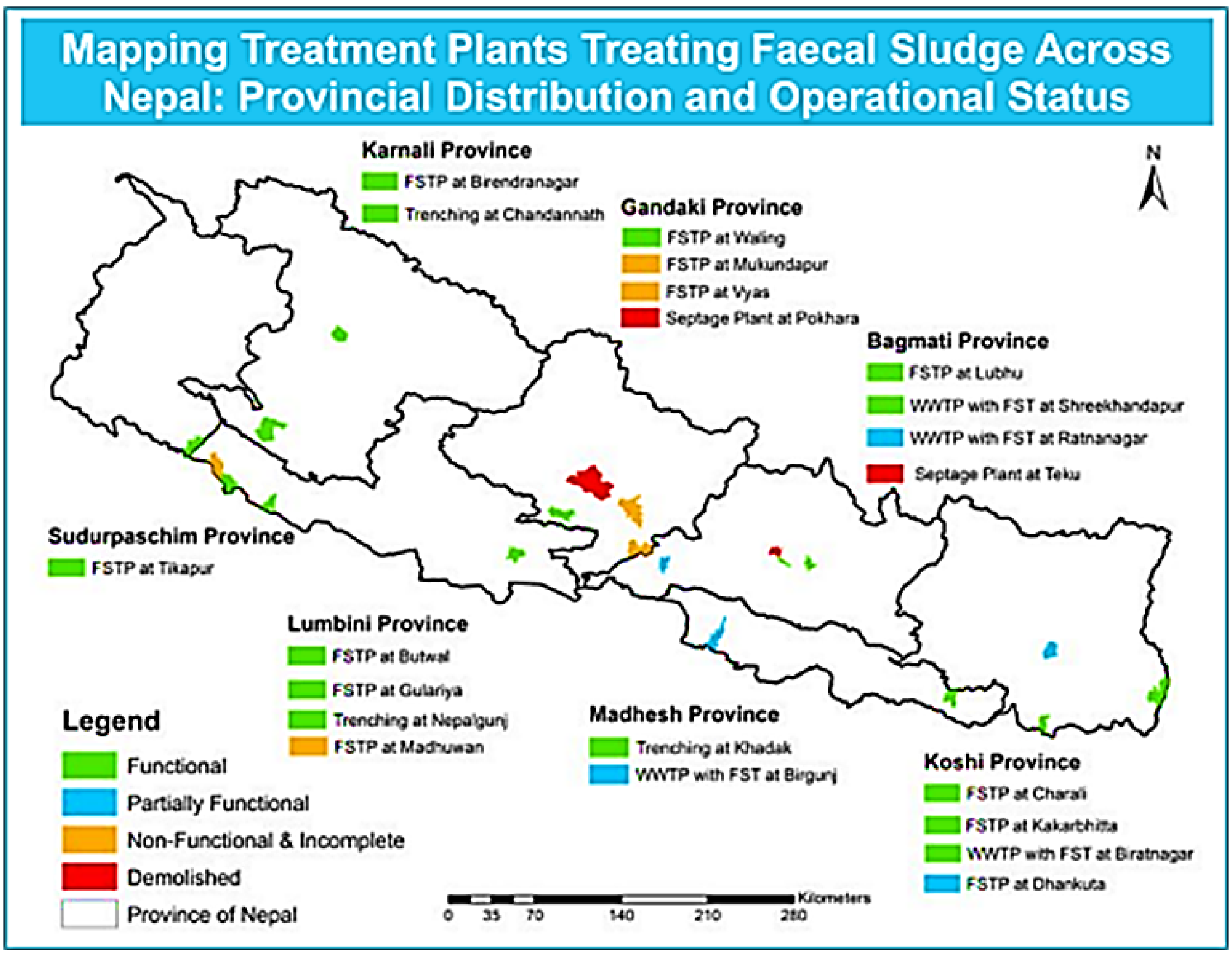

Figure 2 Map of Treatment Plants Treating Faecal Sludge across Nepal

Capacity of the TPs treating FS

Currently, the total designed capacity of all existing functional and partially functional FSTPs excluding trenching facilities is calculated as 112 m^3 per day. However, only an average of 57.6 m^3 of faecal sludge is being treated daily indicating that most of the FSTPs are operating below their design capacity. The major key factors contributing to underutilization are:

i. Prevalence of manual emptying due to limited availability of mechanical desludging services.
ii. Leakage in containment structures which allows sludge to infiltrate into the ground thereby reducing frequency of emptying.
iii. Disposal of FS outside the treatment facilities by desludgers mainly due to longer haulage distance and widespread practice of directly applying untreated faecal sludge to agricultural land etc.

The WWTPs in Biratnagar Metropolitan City, Birgunj Metropolitan City and Ratnanagar Municipality have integrated faecal sludge treatment facilities and are treating substantial volumes of sludge.

Technologies adopted

Most FS treatment plants (FSTPs) in the country comprise nature-based treatment technologies. These systems typically include stages of solid-liquid separation (dewatering) and effluent treatment. Common components include:

- Anaerobic digesters and thickening tanks for pre-dewatering.
- Sludge drying beds for dewatering and
- Anaerobic baffle reactor and constructed wetlands for effluent treatment

In addition, deep row trenching is being used in a few municipalities for disposal of faecal sludge. In addition, deep row trenching is used in a few municipalities for the disposal of faecal sludge. The figure below illustrates the typical configuration of treatment technologies.

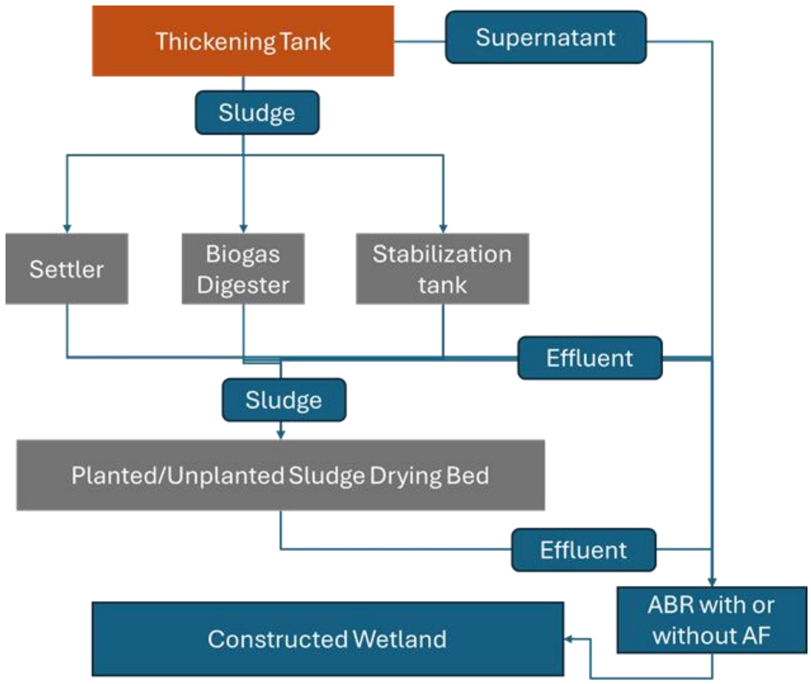

Figure 3: General composition of technological units in FSTP's of Nepal

Treatment Efficiency

Out of the 13, seven were assessed for performance based on key effluent quality parameters, including pH, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Total Suspended Solids (TSS). The results were compared against the national effluent discharge standards for water bodies and public lands set by the Government of Nepal. Specific details on sampling dates and collection locations for each FSTP are provided in the table below.

Table 2: Description on sample collected date and sampling point

SN	FSTP	Sample collection Date	Collection point
1	Birendranagar FSTP	21st April 2024	Polishing pond
2	Butwal Sanitary	17th April 2024	Polishing pond
3	Charali FSTP	30th April 2024	Polishing pond
4	Gulariya FSTP	18th April 2024	Outlet of constructed wetland
5	Kakarbhitta FSTP	30th April 2024	Polishing Pond
6	Lubhu FSTP	21st May 2024	Polishing Pond
7	Tikapur FSTP	19th April 2024	Polishing Pond

pH

According to the national wastewater discharge standards set by the Government of Nepal, the permissible pH range for effluent discharged into nearby water bodies and public lands is between 6.0 and 9.0. This parameter is critical for ensuring environmental safety and regulation compliance across treatment facilities.

Effluent samples from all operational FSTPs were found to be within this permissible pH range. Among the tested facilities, Birendranagar FSTP recorded the lowest pH value at 7.67, while Charali FSTP recorded the highest at 8.8. Figure 4 illustrates the pH values of effluents from various FSTPs in comparison with the national standard.

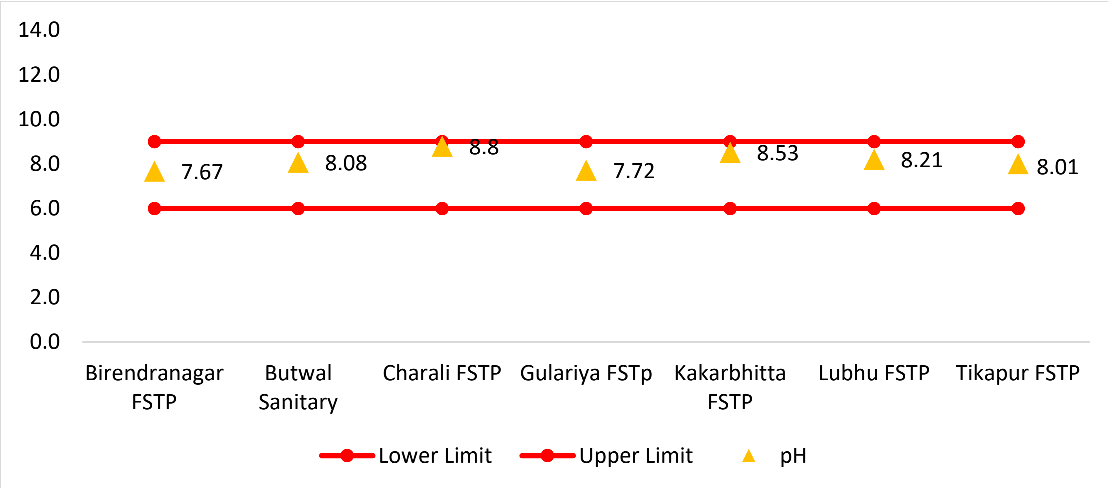

Figure 4: pH values of effluent from FSTPs

Biological Oxygen Demand (BOD)

According to the national standards set by the Government of Nepal, the maximum permissible limit of the biological oxygen demand (BOD) in the effluents of wastewater treatment plants is 50 mg/l. All FSTPs complied with this standard except the FSTP in Birendranagar. The BOD of the effluent from Birendranagar FSTP was recorded at 265 mg/l exceeding the permissible limit. This indicates a potential risk of environmental pollution and harm to aquatic life in the receiving water body. Figure 5 illustrates the BOD levels of effluents from FSTPs.

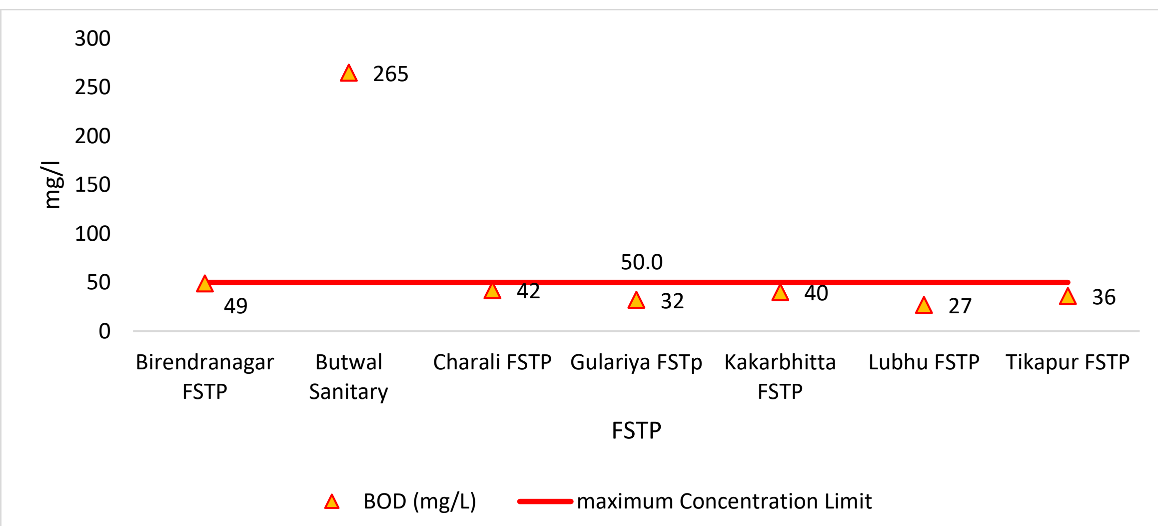

Figure 5: Concentration of BOD in effluent from FSTPs

Chemical Oxygen Demand (COD)

According to Nepal's national standards for wastewater discharge into water bodies and public lands, the permissible limit for Chemical Oxygen Demand (COD) in effluent from treatment plants is 250 mg/l.

However, three FSTPs located at Birendranagar, Butwal and Kakarbhitta exceeded this limit. The highest COD concentration was observed at Butwal Sanitary FSTP with 1290 mg/l which is more than five times the permissible limit. This finding raises significant concern about the effectiveness of treatment efficiency of the treatment facility and the potential environmental impacts of the discharged effluents. Figure 6 presents the COD concentrations in effluents from FSTPs.

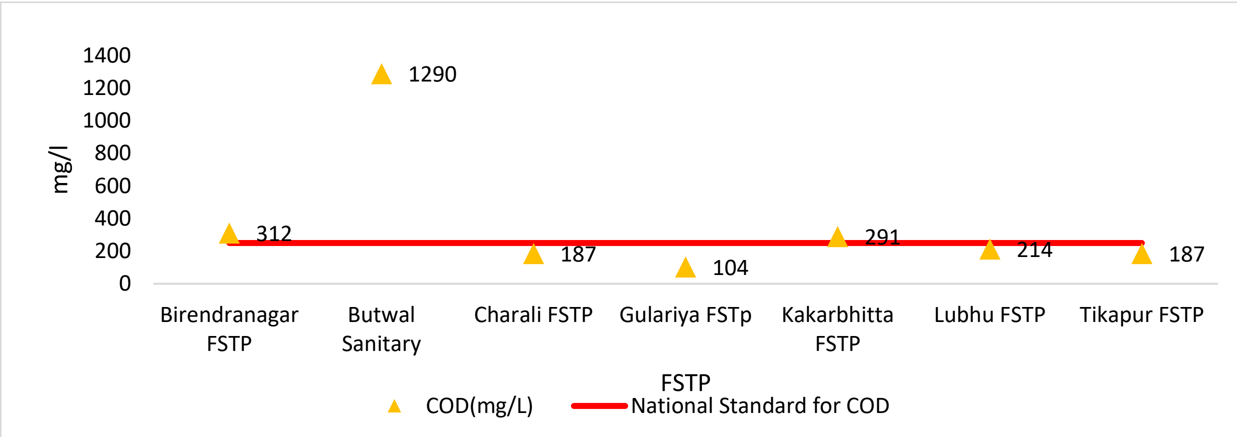

Figure 6 Concentration of COD in effluents from FSTPs

Total Suspended Solids (TSS)

According to Nepal's national standard for wastewater discharge into water bodies and public lands, the maximum permissible concentration of Total Suspended Solids (TSS) in effluents from treatment plants is 60 mg/l. Among all the FSTPs evaluated, only the effluents from Charali FSTP, Gulariya FSTP, Kakarbhitta FSTP complied with the standard. The remaining FSTPs discharged effluents with TSS concentrations exceeding the allowable limit indicating potential shortcomings in the treatment efficiency Figure 7 illustrates the TSS levels in effluents from FSTP in comparison to the national standard.

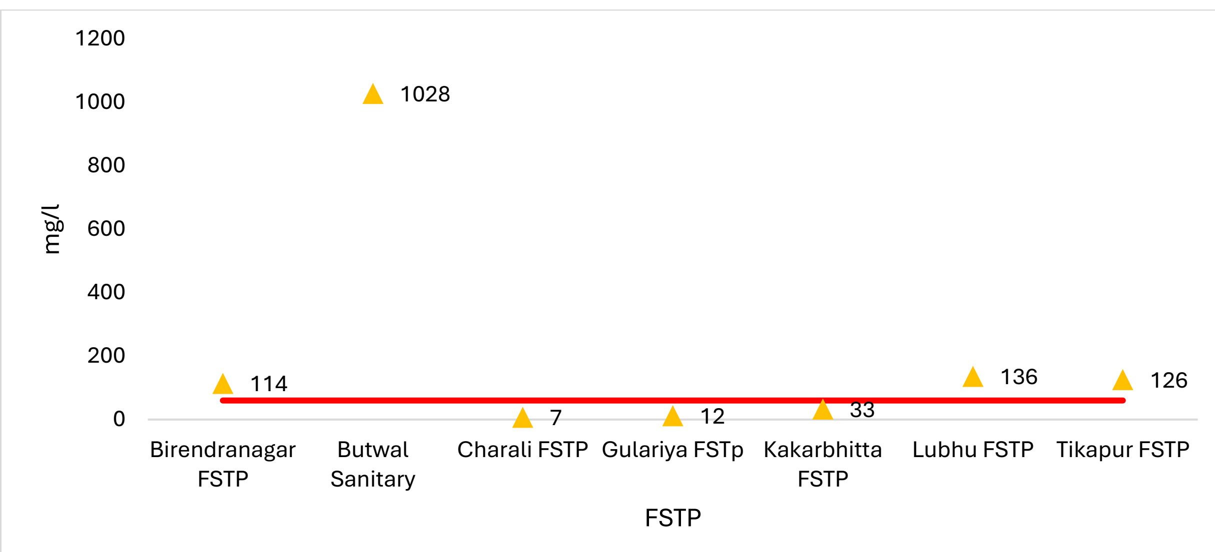

Figure 7 Concentration of TSS in effluents from FSTPs

Overview of FSTPs

Birendranagar FSTP

The FSTP was established in 2020 by Birendranagar Municipality, with support from SNV under WASH SDG Programme. It is located at the western edge of city attached to boundary of Barahatal Rural Municipality in Surkhet district. The plant is an integral component of the Integrated Solid Waste and Fecal Sludge Processing Site. It plays a vital role in managing feacal sludge and promotes sustainable sanitation practices in the region. Municipality operates the facility and has appointed a caretaker to oversee its day-to-day operation.

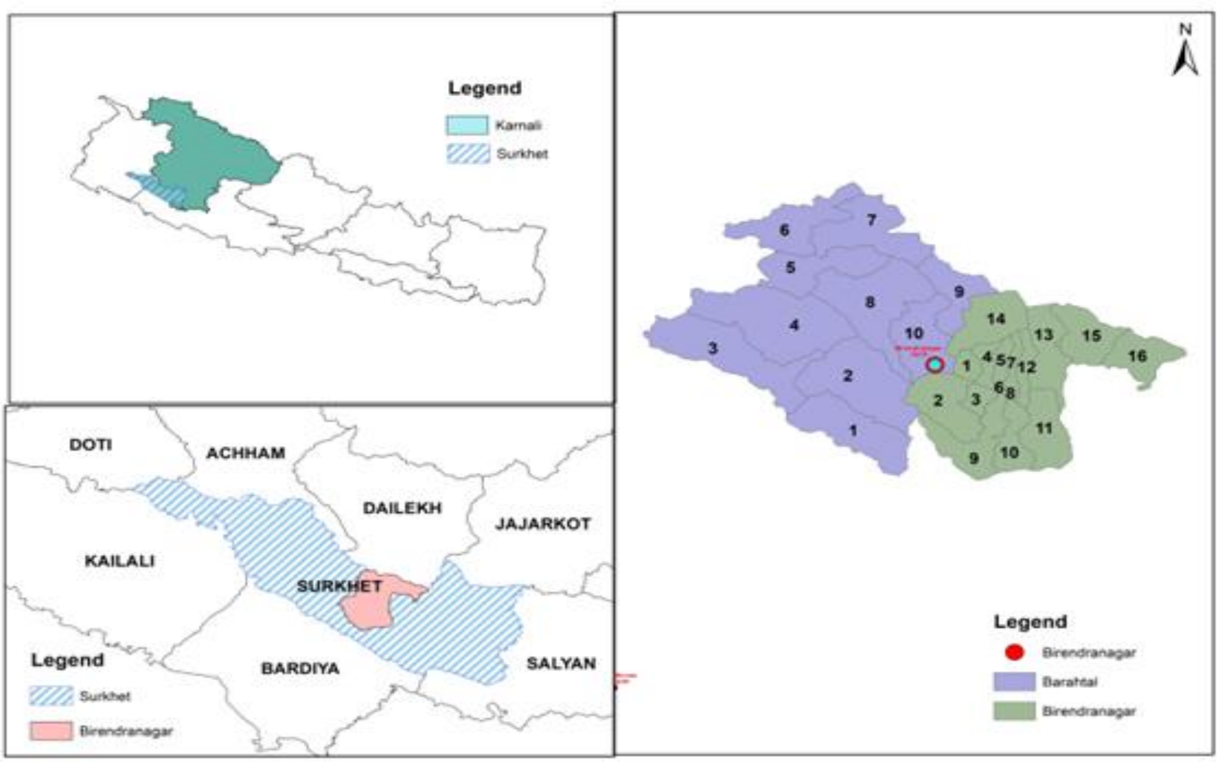

Figure 8 Location map of FSTP in Birendranagar

Components of the treatment plant

The facility incorporates nature-based treatment technologies. It features planted sludge drying beds (SDBs) for dewatering and stabilizing the sludge. A collection tank integrated into the system captures the effluent from the drying beds. Following this stage, the effluent undergoes aeration in a polishing pond, which further improves its quality prior to final discharge.

Table 3 Descriptions on components and size of Birendranagar FSTP

SN	Component	Numbers	Size
Sludge Liquid Separation Unit			
1	Feeding tank	1	
2	Bar Screen	1	
3	Planted Sludge Drying Bed	2	102 m^2 and 95 m^2
Liquid Treatment Unit			
4	Collection tank	2	
5	Polishing Pond	1	

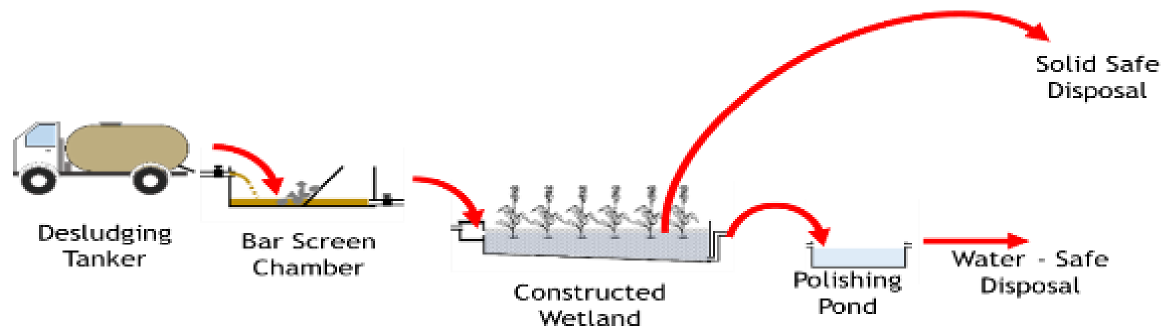

Figure 9 The components and FS flow diagram of Birendranagar FSTP

The treatment plant was originally designed to treat 11 m^3 of faecal sludge per day. Currently, it treats an average of 10 m^3 per day. According to the municipality, the increased number of fully lined containment systems has led to more frequent desludging. The fecal sludge emptied from these systems is typically highly diluted and relatively fresh. As a result, stakeholders have expressed concern about the effectiveness of treatment using only planted sludge drying beds. Additionally, the accumulation of sludges in beds has been relatively low. Table 4 shows the effluent quality from the treatment plant.

Table 4 The effluent quality of Birendranagar FSTP

Parameters	National Standard (Source: Gon)	Value
pH	6 to 9	7.6
BOD (mg/l)	50	49
COD (mg/l)	250	312
TSS (mg/l)	60	114
Potassium (mg/l)		155.5
Total Phosphorus (mg/l)		30.9
Total Kheldal Nitrogen (mg/l)		484

Sampling date: 29 April 2024

Butwal FSTP

Butwal Sanitary Pvt. Ltd. is a privately owned company co-founded by a consortium of nine desludging service providers operating in the Butwal and Tilottama municipalities. In 2021, the company established its own FSTP within Butwal Municipality.

The plant was initially constructed solely to treat the faecal sludge collected by the company. However, it has been upgraded with the focus on resource recovery, particularly the production of compost from the treated sludge. This is the only privately owned FSTP in the country that has been fully invested by the company itself to establish. The plant is operated and managed by Butwal Sanitary Pvt. Ltd.

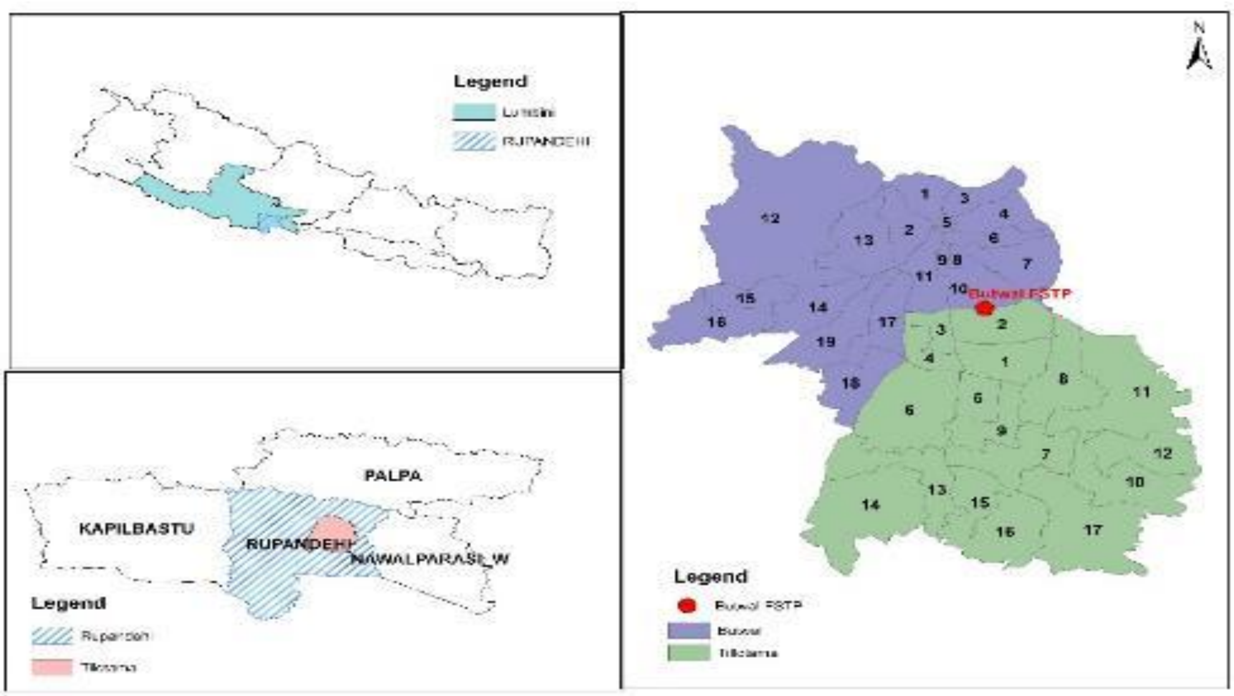

Figure 10 Location map of Butwal Sanitary

Components of the treatment plant

The facility was initially designed with a sludge drying bed which is currently no longer in operation. The leachate from sludge drying bed was previously directed to a septic tank and subsequently treated through a constructed wetland. The upgraded treatment system now includes a thickening tank followed by a sludge mixing tank where FS is combined with cow dung. The resulting mixture is dewatered using a small-scale dewatering machine. The separated liquid is then conveyed to the septic tank for primary treatment and then further processed through the constructed wetland. Table 5 provides a detailed description of the components of the treatment plant.

Table 5 Description of components of Butwal Sanitary

SN	Component	Numbers	Size
Sludge Liquid Separation Unit			
1	Bar Screen	2	
2	Thickening Tank	2	43 m^3
3	Desludging Machine	1	
4	Sludge Drying Bed	2	
Liquid Treatment Unit			
5	Settler	1	81m^3
6	Horizontal flow Constructed wetland	2	32m^2
7	Polishing Pond	1	110m^2

According to the company, the plant was designed to process 40 m^3 of FS per day. Currently, it receives and treats an average of 30 m^3 per day. However, the plant was found to fail in treating the received volume of FS during the study. Observations indicate that the addition of cow-dung and chicken manure has increased the organic load in the effluent, subsequently overloading the downstream treatment units. Effluent test results from the plant are presented in Table 6.

Table 6 The effluent quality from Butwal Sanitary

Parameters	National Standard (Source: Gon)	Value
pH	6 to 9	8.08
BOD (mg/l)	50	265
COD (mg/l)	250	1290
TSS (mg/l)	60	1028
Potassium (mg/l)		155.2
Total phosphorous (mg/l)		16.6
Total Kjeldahl Nitrogen (mg/l)		183.1

Sampling date: 17 April 2024

Charali FSTP

The FSTP at Charali was constructed in 2020 by the Department of Water Supply and Sewerage Management (DWSSM) under the Third Small Town Water Supply and Sanitation Project. It is located in Charali within Mechinagar Municipality.

The facility is currently operated and managed by the Charali Water Supply and Sanitation User's Committee. The FSTP serves Mechinagar Municipality and surrounding areas.

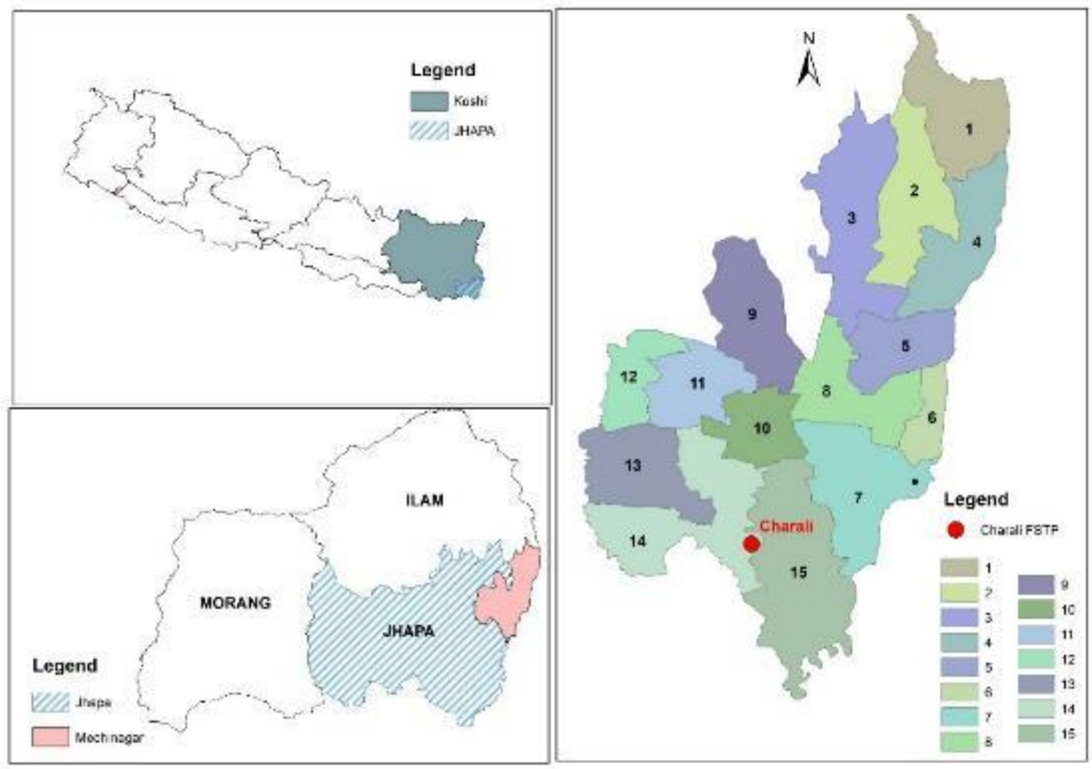

Figure 11 Location map of Charali FSTP

Components of the treatment plant

The facility comprises a planted sludge drying bed for dewatering of sludge along with a liquid treatment system that includes a settler, an anaerobic baffled reactor and a horizontal flow constructed wetland.

Table 7 Descriptions of components of Charali FSTP

SN	Component	Numbers	Size
	Sludge-Liquid Separation Unit		
1	Bar Screen	2	
2	Planted Sludge Drying Bed	28	Each 60 m^2
	Liquid Treatment Unit		
3	Settler with Anaerobic Baffle Reactor	1	unknown
4	Horizontal Flow Bed Constructed Wetland	4	Each 30 m^2
5	Polishing Pond	1	

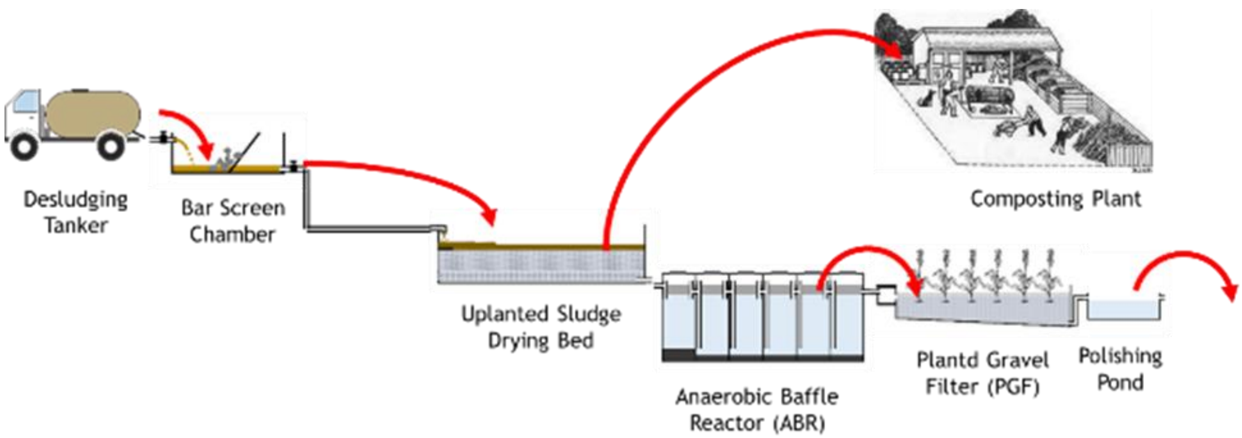

Figure 12 The components and FS flow diagram for Charali FSTP

The treatment plant was designed with a capacity to handle 27 m^3 of FS per day. However, it currently receives and processes an average of 5.5 m^3 per day. A key challenge facing the facility is the limited inflow of faecal sludge which is mainly due to long haulage distances and the lack of regulatory enforcement to prevent haphazard disposal. Date of effluent quality from the polishing pond is presented in Table 8.

Table 8 The effluent quality from Charali FSTP

Parameters	National Standard (Source: Gon)	Value
pH	6 to 9	6.8
BOD (mg/l)	50	42
COD (mg/l)	250	187
TSS (mg/l)	60	7
Potassium (mg/l)		130.8
Total phosphorous (mg/l)		2.5
Total Kheldal Nitrogen (mg/l)		

Sampling date: 30 April 2024

Dhankuta FSTP

The Faecal Sludge Treatment Plant (FTSP), located at Municipal Solid Waste Management Center in Dhankuta Municipality, was constructed by the Department of Water Supply and Sewerage Management (DWSSM) under small town water supply and sanitation project, with financial support from Asian Development Bank (ADB). Dhankuta Municipality oversees all the operation and maintenance of the facility. This FSTP serves areas within Dhankuta Municipality.

Components of the treatment plant

The facility is constructed based on the natural treatment process of faecal sludge. It consists of unplanted sludge drying beds to treat sludge as mentioned in conversation with municipal officials.

The FSTP, located at the Municipal Solid Waste Management Center in Dhankuta Municipality, was constructed by the Department of Water Supply and Sewerage Management (DWSSM) under the Small-Town Water Supply and Sanitation Project with financial support from the Asian Development Bank (ADB). The operation and maintenance of the FSTP are solely managed by Dhankuta Municipality.

Components of the Treatment Plant

There were not any documents about design capacity of the plant available during visit. The FSTP consists of unplanted sludge drying beds only. It is situated downstream of the solid waste management system and is not easily accessible. Currently the plant was under partial operation.

Table 9 Descriptions of components of Dhankuta FSTP

SN	Component	Numbers	Size
	Sludge-Liquid Separation Unit		
1	Unplanted Sludge Drying Bed	4	NA

Gulariya FSTP

Gulariya municipality, constructed the treatment plant in 2016 under SAFA and SWASTHA Gulariya Project with financial support from Practical Action Nepal and UK Aid and technical support from ENPHO. The plant is located in Ward Number 8 and serves the entire municipality.

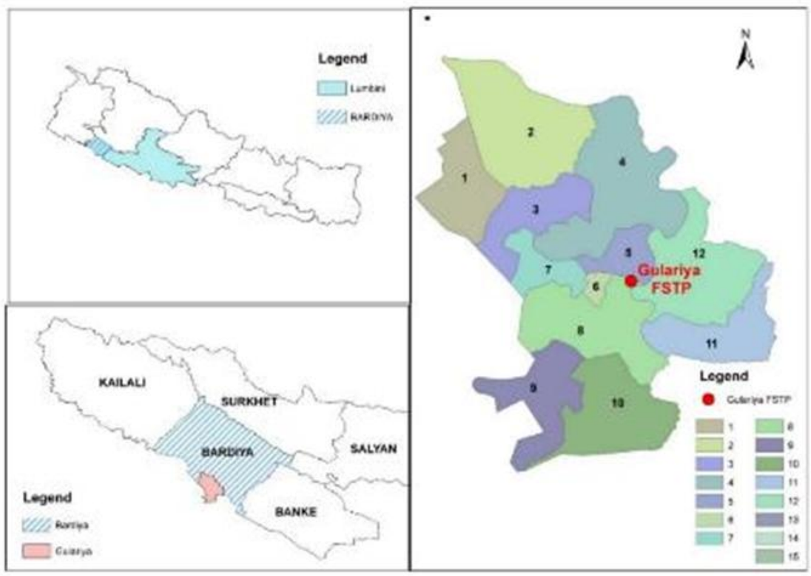

Figure 13 Location map of Gulariya FSTP

Components of the treatment plant

The treatment plant comprises sludge drying beds for dewatering of FS along with effluent treatment system including a settler, an anaerobic baffle reactor and a constructed wetland. Recently, an anaerobic bio-digester was added upstream of the drying beds to enhance sludge digestion. However, it was not operational at the time of the study visit. The facility is operated by Gulariya Municipality.

Table 10 Descriptions of components of Gulariya FSTP

SN	Component	Numbers	Size
	Sludge Liquid Separation Unit		
1	Biogas Digester	2	Unknown
2	Sludge Drying Bed	7	Each 21 m^2
	Liquid Treatment Unit		
3	Settler	1	3.7 m^3
4	Anaerobic Baffle Reactor	1	4.6 m^3
5	Horizontal Flow Bed Constructed Wetland	2	Each 28 m^2

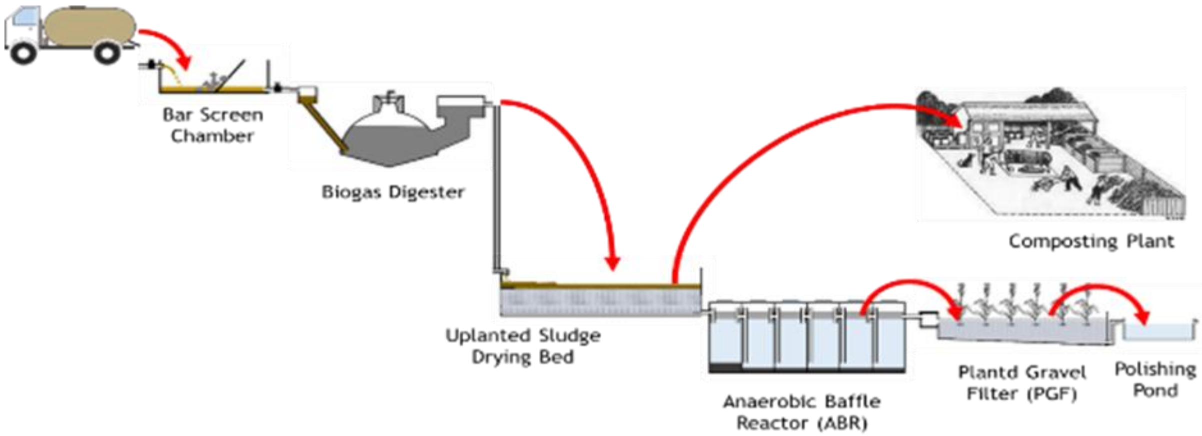

Figure 14 The component and FS flow diagram for Gulariya FSTP

The treatment plant was designed to process 3 m³ of faecal sludge per day. Although a bio-digester has recently been added to the system, it was not operational at the time of the study, and its design capacity was not documented. Currently, the plant receives and treats an average of 1.5 m³ of faecal sludge per day. The facility is operated by Gulariya Municipality. Effluent quality from the outlet of the constructed wetland is presented in Table 11.

Table 11 The effluent quality of Gulariya FSTP

Parameters	National Standard (Source: GoN)	**Value**
pH	6 to 9	7.7
BOD (mg/l)	50	32
COD (mg/l)	250	104
TSS (mg/l)	60	126
Potassium (mg/l)		164.2
Total phosphorous (mg/l)		1.9
Total Kheldal Nitrogen (mg/l)		274.6

Sampling date: 18 April 2024

Kakarbhitta FSTP

The feacal sludge treatment plant in Kakarbhitta was constructed in 2020 by DWSSM under third small town water supply and sanitation project supported by ADB. The facility is intended to serve Mechinagar Municipality and is currently managed by Kakarbhitta Water Supply and Sanitation User's Committee.

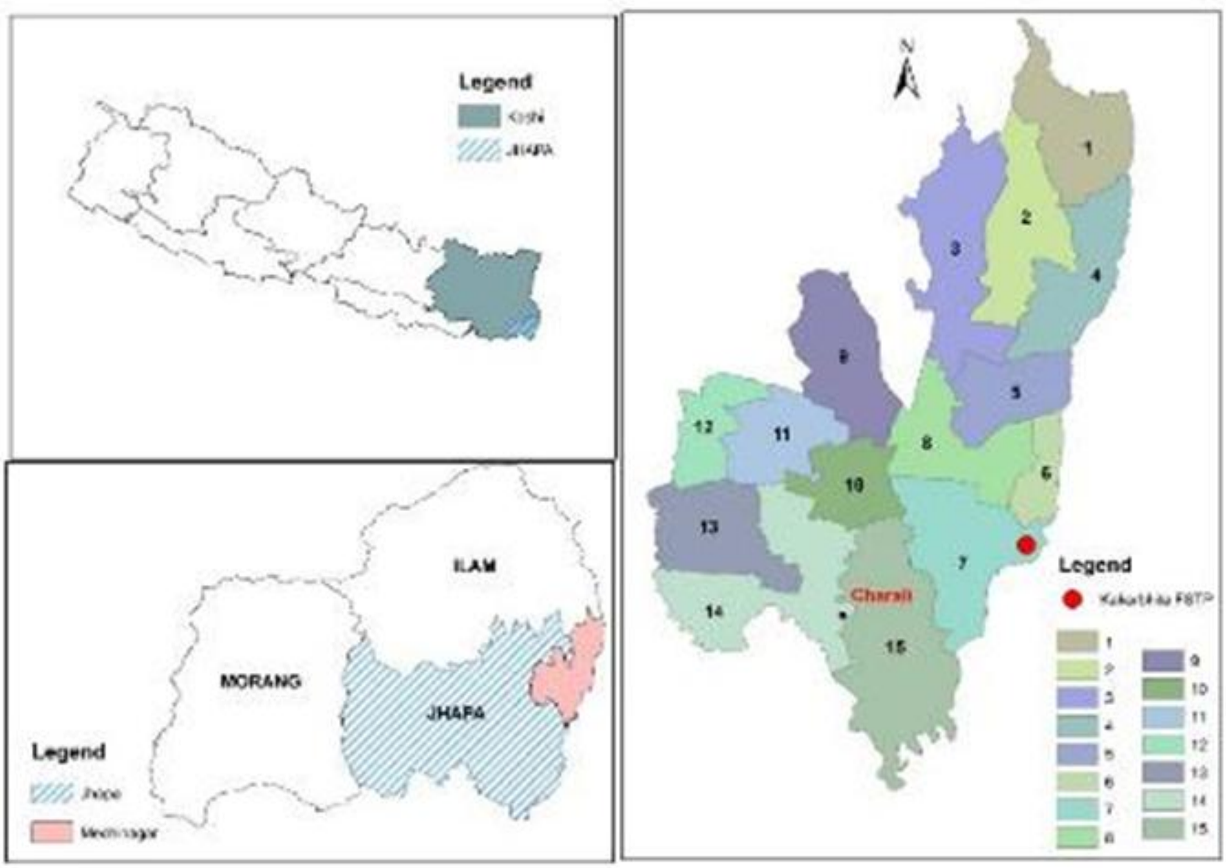

Figure 15 Location map of Kakarbhitta FSTP

Components of the treatment plant

The facility consists of bio-digester, which stabilizes the feacal sludge before it is loaded into the drying bed, followed by a planted sludge drying bed for dewatering of FS. A set of treatment technologies such as settlers, anaerobic baffled reactors and horizontal flow constructed wetlands, has been provided to treat the liquid stream. However, the bio-digester was not in operation during the study visit.

Although the plant was designed to treat 12 m^3 of faecal sludge per day, it currently receives 6.6 m^3 of FS per day on average. Effluent quality from the outlet of the constructed wetland is shown in table 13.

Table 12 Descriptions of components in Kakarbhitta FSTP

SN	Component	Numbers	Size
Sludge Liquid Separation Unit			
1.	Bar Screen	1	
2.	Biogas Digester	1	88 m^3
3.	Stabilization Tank	2	Each 12 m^3
4.	Planted Sludge Drying Bed	16	Each 60 m^2
5.	Collection tank with pumping system	1	
Liquid Treatment Unit			
6.	Settler with Anaerobic Baffle Reactor	1	
7.	Horizontal Flow Bed Constructed Wetland	2	
8.	Polishing Pond	1	

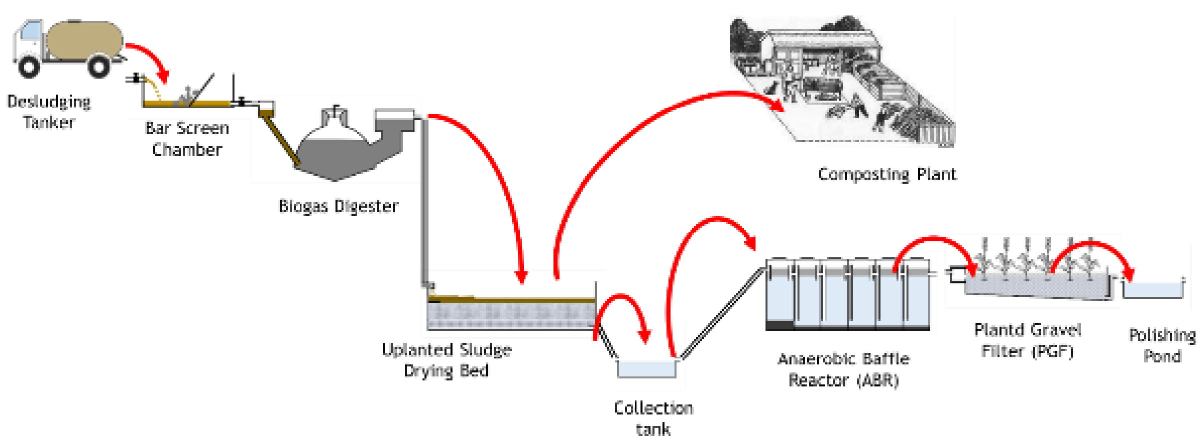

Figure 16 The component and FS flow diagram for Kakarbhitta FSTP

Table 13 The effluent quality from Kakarbhitta FSTP

Parameters	National Standard	Value
pH	(Source: GoN)	8.53
BOD (mg/l)	6 to 9	40
COD (mg/l)	50	291
TSS (mg/l)	250	33
Potassium (mg/l)		130.8
Total phosphorous (mg/l)		0.3
Total Kheldal Nitrogen (mg/l)		14.2

Sampling date: 30 April 2024

Teku Septage Treatment Plant (Kathmandu)

The Septage Treatment Facility in Teku, Kathmandu, was the country's first FSTP, established in 1998. The facility was constructed by Kathmandu Metropolitan City and operated by its Urban Environment Section. It remained operational until 2004 but was shut down since 2005 due to technical and managerial challenges (HPCIDBC, 2011). The facility has since been demolished.

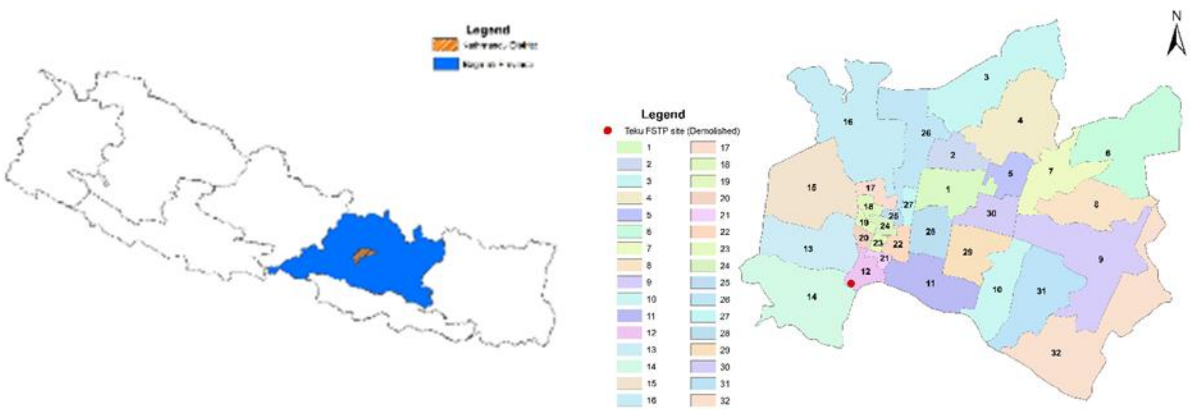

Figure 17 Location map of Septage TP at Teku, Kathmandu

Components of the treatment plant

Table 14 Components of Teku Treatment facility

SN	Components	Nos	Size
	Sludge-Liquid Separation Unit		
1	Settlement tank	3	200 m^3
	Liquid Treatment Unit		
2	Sand and Gravel Bed	3	257 m^2
3	Vertical Flow Constructed Wetlands (VFCW)	1	380 m^2

Lubhu FSTP

The plant was initially constructed to treat FS generated from temporary rescue camps established after the Nepal Earthquake-2015 where temporary toilet containment systems were filling up rapidly, posing significant health and environmental risks. To address these issues, ENPHO with support from BORDA, built the facility in 2016. It is the only FSTP in the country established on private property which belongs to a community-based organization named Saligram Balgriha. After the relocation of the camps, the FSTP was converted into demonstration site for resource recovery from FS. The location map of Lubhu FSTP is shown in Figure 20.

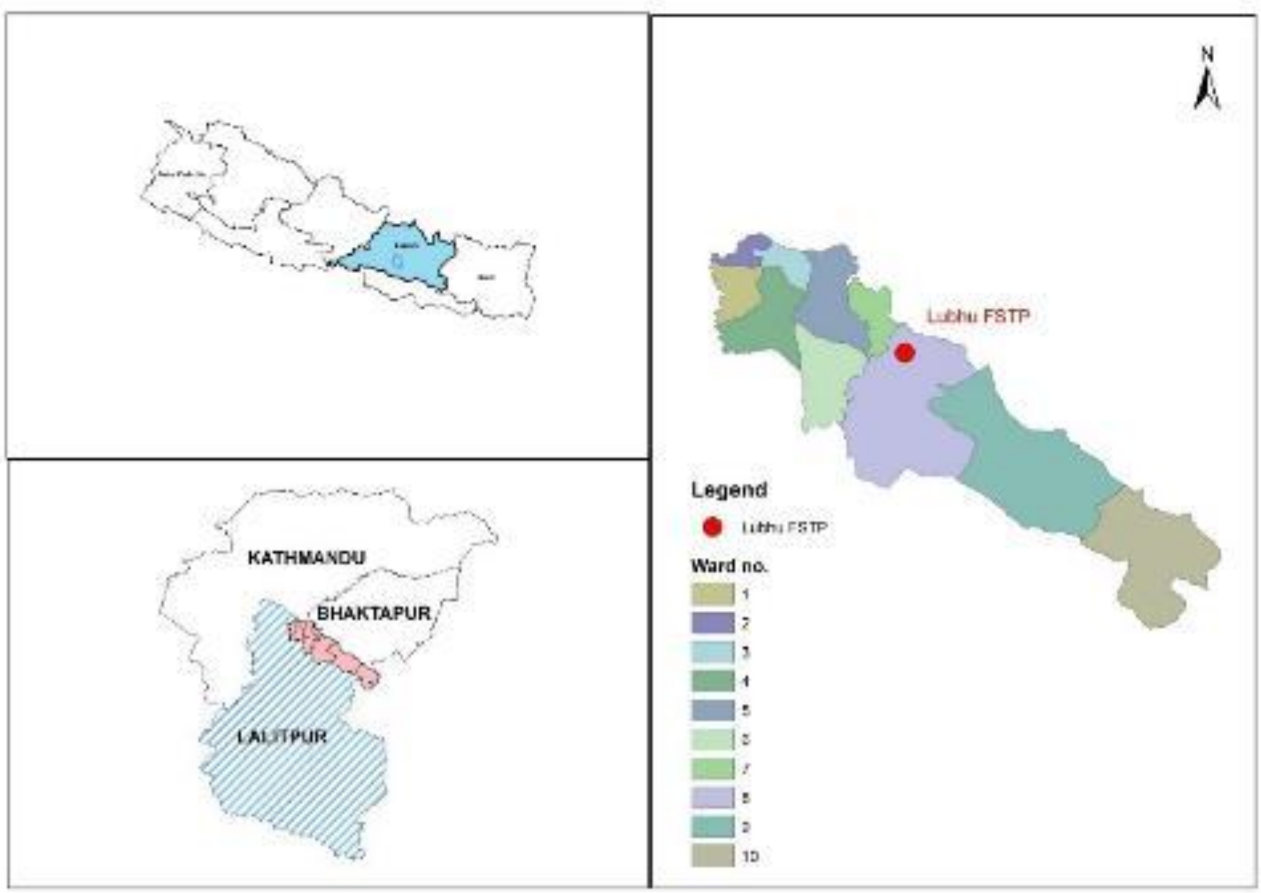

Figure 18 Location map of Lubhu FSTP

Components of the treatment plant

The facility consists of a thickening tank, a bio-digester and stabilization tank to stabilize FS coming into the plant. Sludge is then dewatered through sludge drying bed. The leachate from SDB and supernatant from thickening tank are treated via a series of treatment units such as anaerobic baffled reactor, anaerobic filter, horizontal flow constructed wetland and polishing pond.

Table 15 Descriptions of components of Lubhu FSTP

S.N	Component	Numbers	Size
	Sludge-Liquid Separation Unit		
1	Feeding Tank with bar screen	1	4 m^3
2	Biogas Digester	2	6 m^3 each
3	Stabilization Tank	1	10m^3 with 3 nos. of chambers
4	Unplanted Sludge drying Bed	3	20m^2 each bed
	Liquid Treatment Unit		
5	Anaerobic Baffle reactor cum AF (5)	1	10m^3 with 3 nos. of chambers
6	Planted Gravel Filter	1	15m^2
7	Polishing Pond	1	10m^3

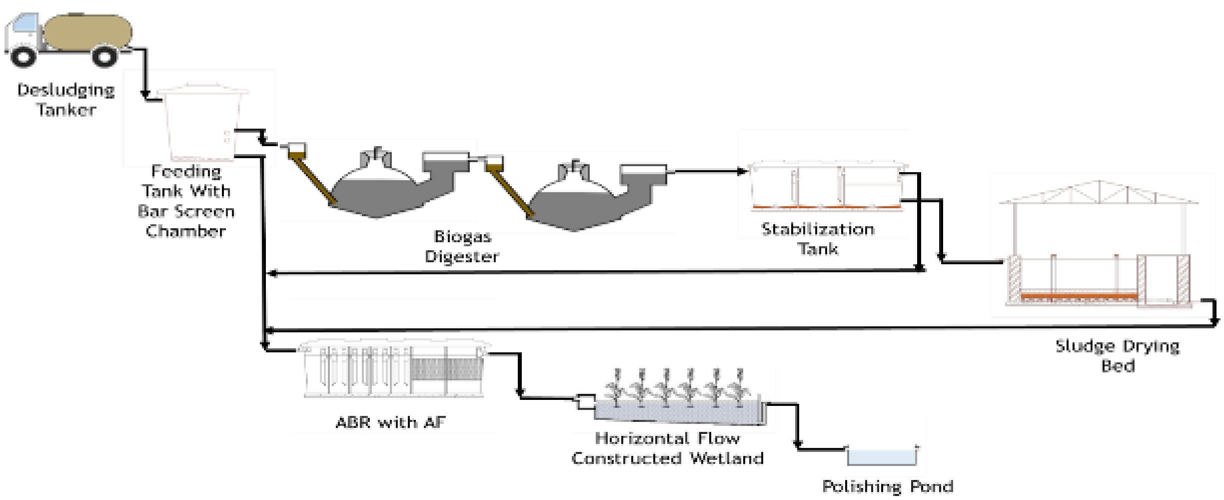

Figure 19 The components and FS flow diagram in Lubhu FSTP

The plant was designed to treat 6 m³ of FS per week and has been operating at full capacity since its establishment. It is jointly managed by Mahalaxmi Municipality and Saligram Balgriha, with technical support from ENPHO under a tripartite agreement. Effluent quality data collected from the polishing pond is presented in Table 16.

Table 16 The effluent quality from Lubhu FSTP

Parameters	National Standard (Source: GoN)	Value
pH	6 to 9	8.21
BOD (mg/l)	50	27
COD (mg/l)	250	214
TSS (mg/l)	50	136

Sampling date: 21 May 2024

Madhuban FSTP

The FSTP in Madhuvan Municipality was constructed in 2019 with financial and technical assistance from ENPHO and BORDA. However, the plant was found to be non-operational and appeared to be abandoned. It was found to almost damaged at the time of study visit. According to municipal authorities, the facility has remained unused since its construction due to the absence of an established desludging service within the municipality which deliver FS into the plant.

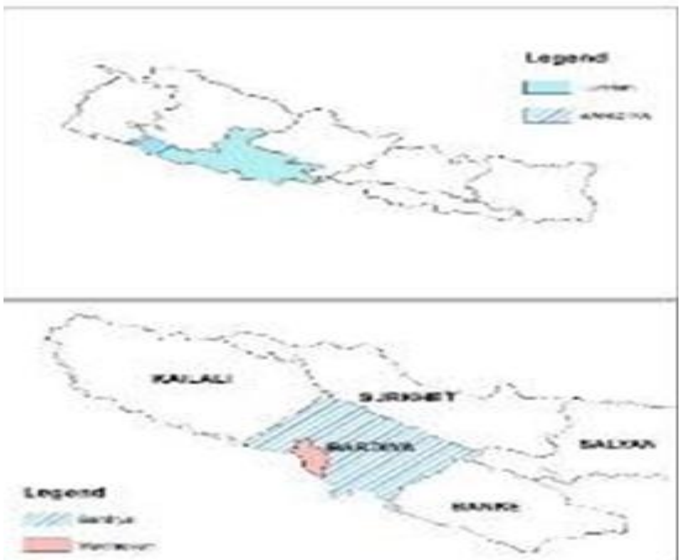

Figure 20 Location map of Madhuban Faecal Sludge Treatment Plant

Components of the treatment plant

The treatment plant consists of anerobic digesters for the stabilization of incoming sludge and SDBs for sludge-liquid separation. The effluent from the SDB is further treated through Anaerobic Baffle Reactor, horizontal flow constructed wetland and polishing pond. The design capacity of the plant is 3 m^3 FS per day.

Table 17 Descriptions of components of Madhuban Faecal Sludge Treatment Plant

Component	Numbers	Size
Sludge-Liquid Separation Unit		
Anaerobic Digester (AD)	30	94 m^2
Sludge Drying Bed (SDB)	10	174 m^2
Liquid Treatment Unit		
Anaerobic Baffle Reactor (ABR)	1	44 m^2
Horizontal Flow Constructed Wetlands (HFCW)	1	60 m^2

Polishing Pond (PP)	1	82 m^2

Mukundapur FSTP

The FSTP of Gaindakot Municipality was constructed by Mukundapur water supply users committee in 2017. The treatment plant was constructed under the Second Small Towns Water Supply and Sanitation Sector Project supported by the Department of Water Supply and Sewerage Management, the Ministry of Water Supply and the Asian Development Bank. During the visit, the plant was found to be non-operational and appearing to be abandoned and almost completely damaged.

Components of the treatment plant

The treatment system comprises a SDB for dewatering and a Horizontal Flow Constructed Wetland designed to treat the percolate from the SDB.

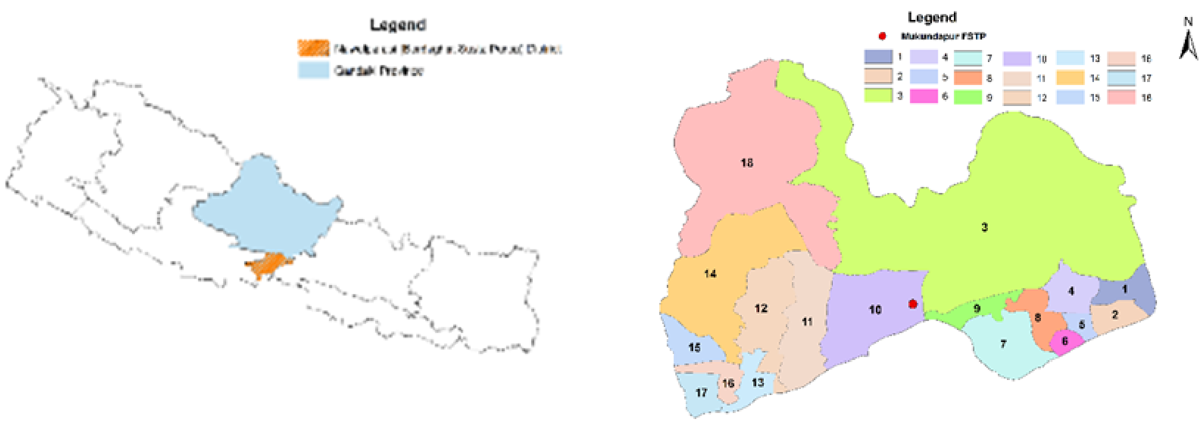

Figure 21 Location map of Mukundapur FSTP

Table 18 Components of the Mukundapur FSTP

SN	Components	Nos	Size
	Sludge-Liquid Separation Unit		
1	Sludge Drying Bed (SDB)	NA	NA
	Liquid Treatment Unit		
2	Horizontal Flow Constructed Wetlands (HFCW)	NA	NA

Pokhara Septage Treatment Plant

In 2000, Septage Treatment Plant was constructed in Pokhara under the Pokhara Environment Improvement Project funded by the Asian Development Bank (ADB). The plant was designed to treat the leachate from the landfill site and faecal sludge in combination. The treatment plant was demolished after the construction of the Pokhara International Airport, as it was located within the buffer zone of the Airport.

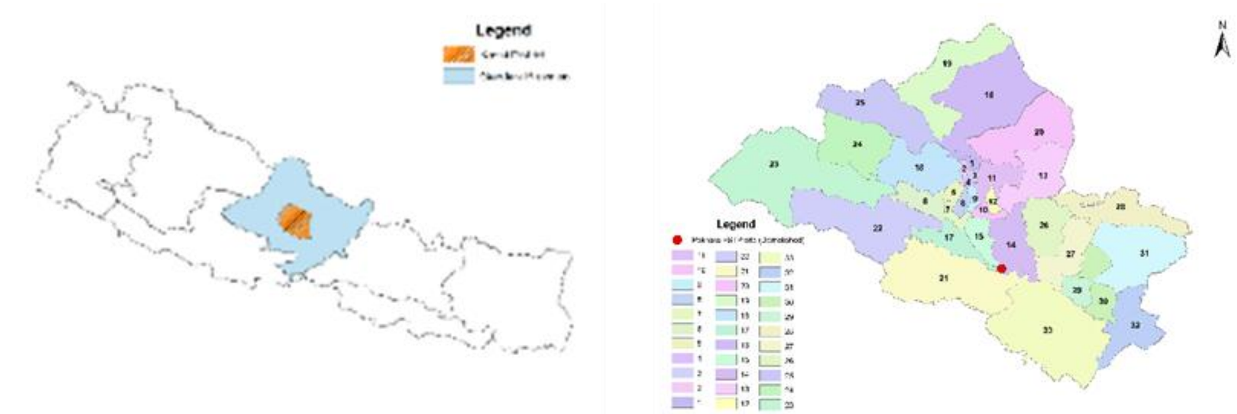

Figure 22 Location map of Pokhara septge treatment plant

Components of the treatment plant

The plant was designed with an equalization tank and a SDB for dewatering faecal sludge. The percolate from the SDB, along with leachate from the nearby landfill site, was intended to be treated through a series of horizontal and vertical flow constructed wetlands. The designed treatment capacity of the plant is 115 m^3 of faecal sludge per day.

Table 19 Description of the components of Pokhara FSTP

SN	Components	Nos	Size
	Sludge-Liquid Separation Unit		
1	Bar Screen	1	NA
2	Sludge Drying Bed (SDB)	7	Each 235 m^2
	Liquid Treatment Unit		
3	Horizontal Flow Constructed Wetlands (HFCW)	7	Each 590 m^2
4	Vertical Flow Constructed Wetlands (WFCW)	4	Each 375 m^2

Shreekhandapur wastewater and faecal sludge Co-Treatment Plant (CTP)

The Shreekhandapur Treatment Plant, located along the banks of the Punyamata River in Dhulikhel Municipality, was initially constructed in 2008 to treat wastewater generated by the nearby community. The project was implemented by the municipality with financial support from UN-Habitat and technical assistance from ENPHO.

In 2024, the facility was upgraded to enable the co-treatment of faecal sludge, with continued technical support from ENPHO. This upgradation was part of the Municipalities Network Advocacy in Sanitation in South Asia (MuNASS I) project, supported by UCLG-ASPAC. The plant was previously operated and managed by the Shreekhandapur Wastewater Treatment Plant Users' Committee. Its management responsibilities have been transferred to Dhulikhel Municipality after upgradation. Figure 25 illustrates the location of the treatment plant.

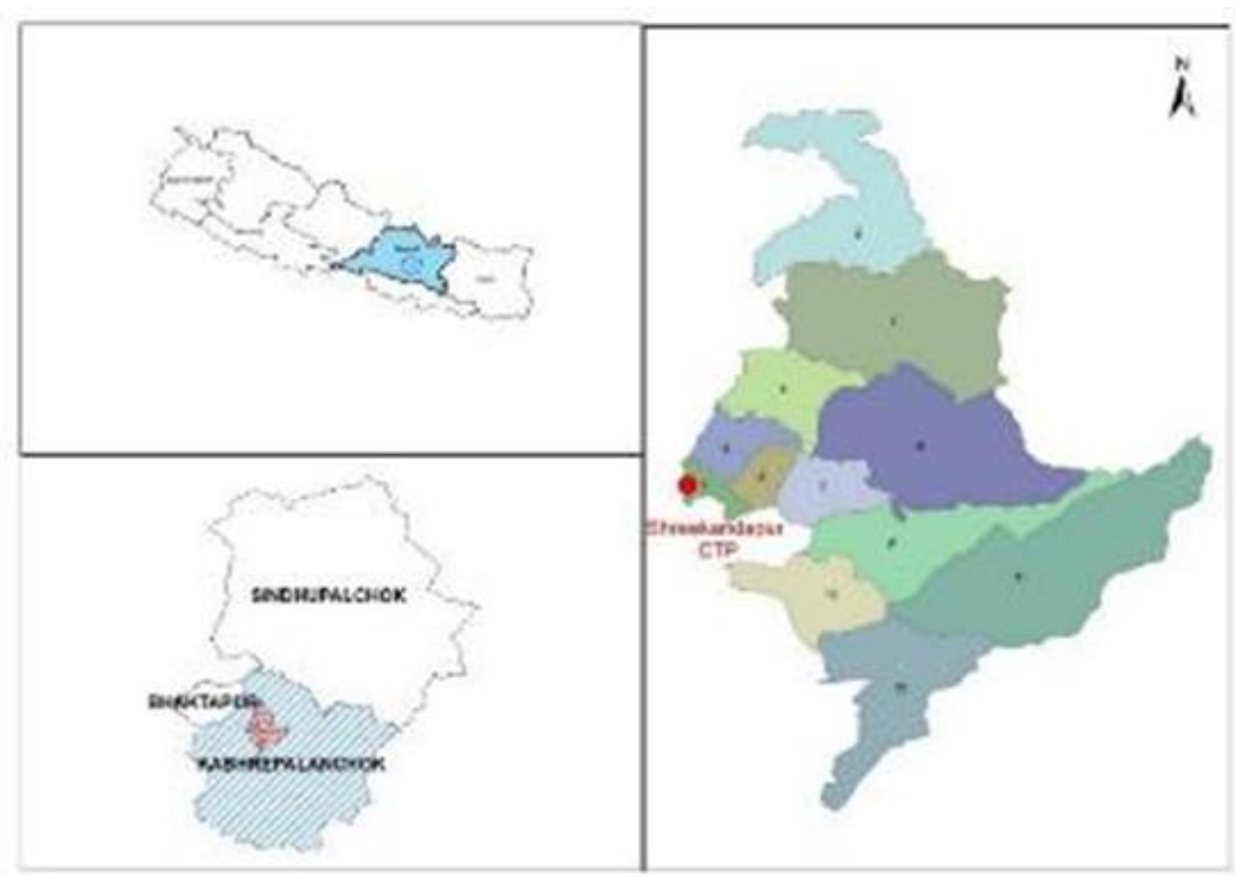

Figure 23 Location map of Shreekhandapur Co-treatment Plant

Components of the treatment plant

The plant was initially designed to treat only wastewater and comprised of biodigester followed by horizontal flow constructed wetlands. It was recently upgraded with additional treatment units for liquid waste to enhance the co-treatment.

In the upgraded plant, both wastewater and faecal sludge are fed into the biodigester. The resulting effluent then flows into a septic tank, followed by an anaerobic baffled reactor (ABR). Effluent from the ABR is further treated through a horizontal flow constructed wetland and a polishing pond.

The upgraded system is designed to treat up to 50 m^3 of wastewater and 3 m^3 of faecal sludge per day. Figure 21 illustrates the schematic diagram and components of the treatment plant.

Table 20 Descriptions of components of Shreekhandapur Co-treatment Plant

Component	Numbers	Size
Sludge-Liquid Separation Unit		
Bar screen & Grit Chamber for WW	1	
Feeding tank with Bar screen for FS	1	1 m^3
Biogas Digester	2	7.5 m^3 each
Septic tank	2	21.6 m3 each
Liquid Treatment Unit		
Anaerobic Baffle reactor	2	Total 31.2 m3
Horizontal Flow Constructed wetland	2	Total 70 m2
Sludge Drying Bed	1	Total 64 m2
Polishing Pond (7)	1	28 m^3

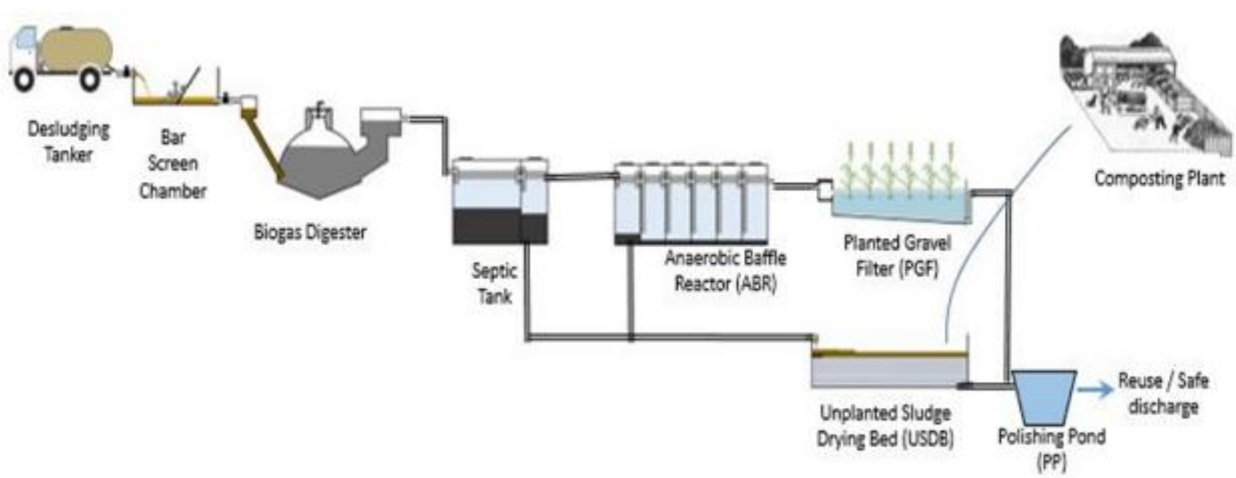

Figure 24 The components and FS flow diagram of Shreekhandpur Co-treatment Plant

Tikapur FSTP

The FSTP was constructed in 2021 under the Urban Water Supply and Sanitation Sector Project, financed by the ADB. It is located in Ward No. 1 of Tikapur Municipality, Kailali. The project was implemented by the Department of Water Supply and Sewerage Management (DWSSM).

Initially, operational responsibility was embedded within the construction contract, with ITECO Nepal Pvt. Ltd., the contractor, managing the plant upon completion. Recently, management of the facility has been transferred to Tikapur Municipality.

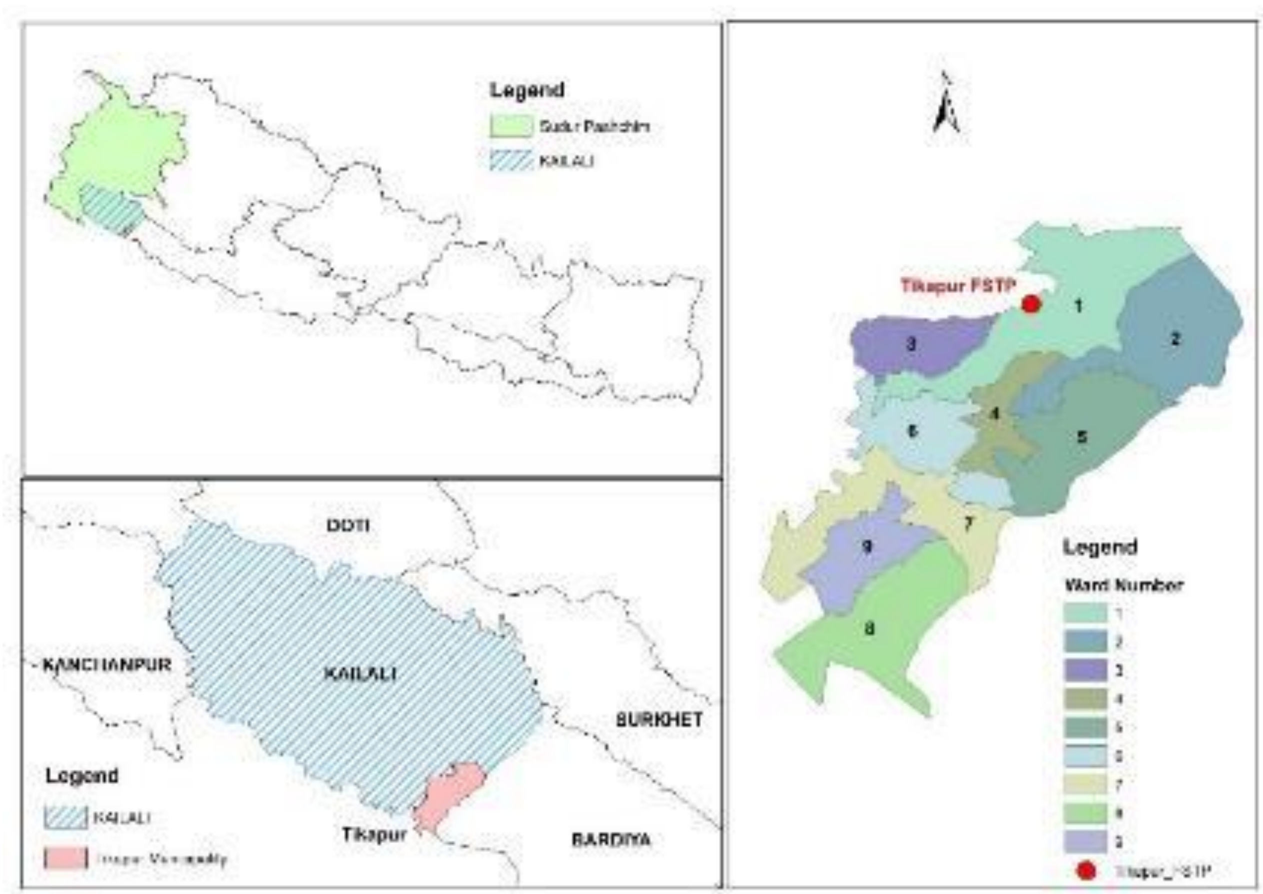

Figure 25 Location map of Tikapur FSTP

Components of the treatment plant

The FSTP comprises an anaerobic digester for sludge stabilization and unplanted sludge drying bed for dewatering. The percolate from the SDB is treated through a series of units includingan anaerobic baffle reactor, an anaerobic filter and a horizontal flow constructed wetland and a polishing pond.

The designed capacity of the treatment plant was 9 m^3 of faecal sludge per day. Currently, an average of 2.5 m^3 of faecal sludge is being treated daily. The effluent quality sampled from polishing pond of Tikapur FSTP is presented in table 22.

Table 21 Descriptions on components of Tikapur FSTP

SN	Component	Numbers	Size
	Sludge Liquid Treatment Unit		
1.	Bar Screen	2	
2.	Anaerobic Digester	26	Each 9 m^3
3.	Sludge Drying Bed	26	Total area 35 m^2
	Liquid Treatment Unit		
4.	Anaerobic Baffle Reactor with Anaerobic Filter		Total area 35 m^2
5.	Collection Tank	1	
6.	Horizontal Flow Constructed Wetland	4	Total area 33 m^2
7.	Polishing Pond		15

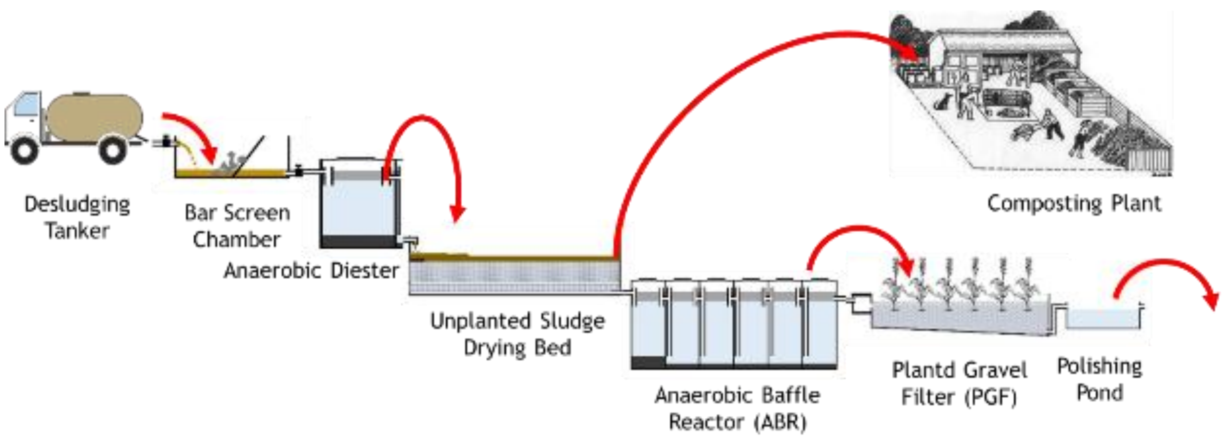

Figure 26 The components and FS flow diagram for Tikapur FSTP

Table 22 The effluent quality of Tikapur FSTP

Parameters	National Standard (Source: GoN)	Value
pH	6 to 9	8
BOD (mg/l)	50	36
COD (mg/l)	250	187
TSS (mg/l)	60	126
Potassium (mg/l)		102.8
Total phosphorous (mg/l)		3.9
Total Kheldal Nitrogen (mg/l)		12.7

Sampling date: 19 April 2024

Vyas FSTP

The treatment plant was established by the Department of Water Supply and Sewerage Management (DWSSM) under the Second Small Towns Water Supply and Sanitation Sector Project, financed by ADB. During the field visit, it was observed that although the major components of the plant had been completed, some components appeared to be unfinished. Discussions with municipal representatives further revealed that the plant operation responsibility remains unclear.

Components of the Treatment Plant:

A sludge drying bed and a horizontal flow constructed wetland were confirmed to have been constructed. However, the presence and completion status of other components could not be clearly verified during the visit.

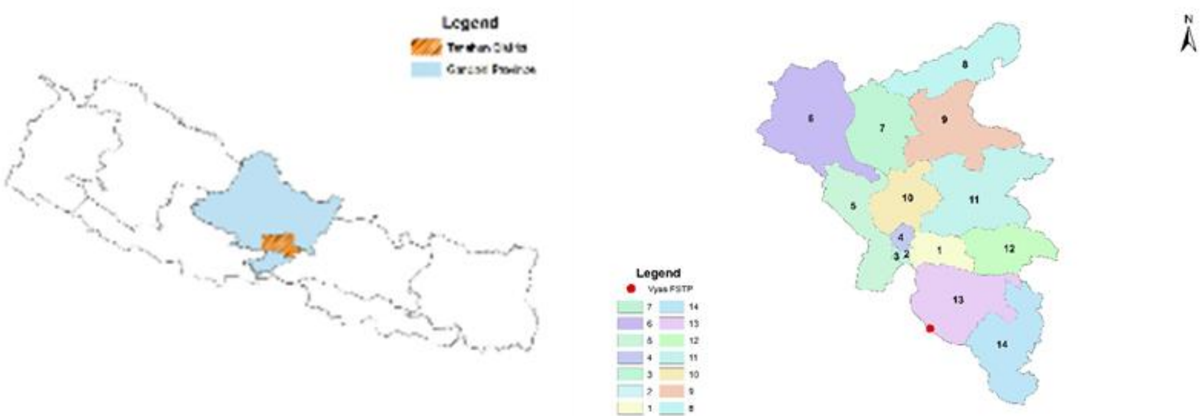

Figure 27 Location map of Vyas FSTP

Table 23 Description of Components of Vyas FSTP

SN	Components	Nos	Size
	Sludge-Liquid Separation Unit		
1	Sludge Drying Bed (SDB)	NA	NA
	Liquid Treatment Unit		
2	Horizontal Flow Constructed Wetlands (HFCW)	NA	NA

Waling FSTP

The FSTP was established in 2020 by Waling Municipality with technical support from ENPHO as a part of the Municipalities Network Advocacy on Sanitation in South Asia (MuNASS) project funded by United Cities and Local Governments Asia Pacific (UCLG ASPAC).The plant is situated within the premises of the Sanitation Resource Centre, located on the banks of the Adhikhola River in Ward No. 1 of the municipality. It is managed by the municipality, with a dedicated caretaker appointed to ensure its daily operation and maintenance. The entire site has been landscaped into a park contributing to its recognition as one of the model treatment plants in the country. The location of the FSTP is illustrated in Figure 30.

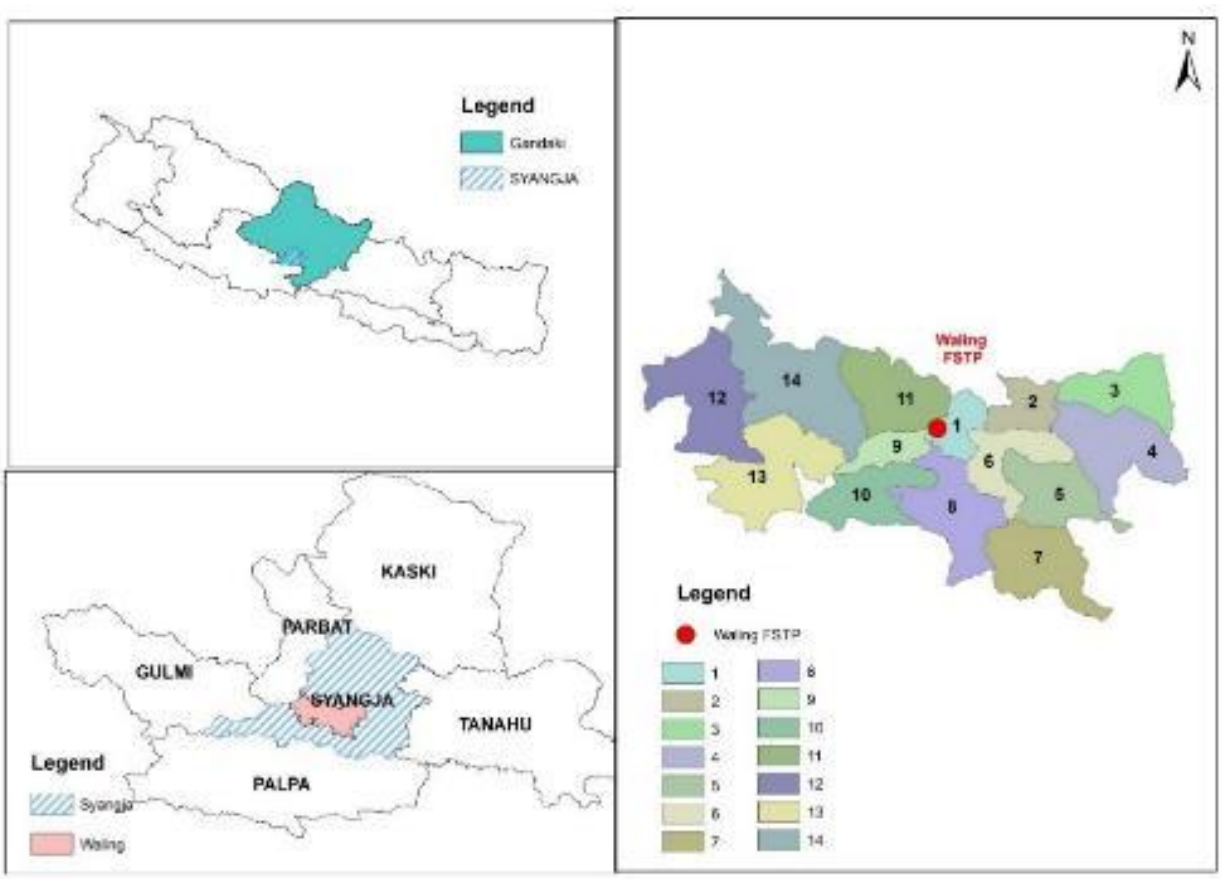

Figure 28 Location map of Waling FSTP

Components of the treatment plant

The facility is equipped with a digester for sludge stabilization and a sludge drying bed (SDB) for dewatering. A series of treatment units has been installed including a settler, an anaerobic baffled reactor, and a horizontal flow constructed wetland to treat the effluent from the SDB. Though the treatment plant was designed to handle 6 m3 of faecal sludge per day, it is currently processing approximately 3 m3 per week.

Table 24 Descriptions of components in Waling FSTP

Sludge-Liquid Separation Unit			
1	Bar Screen	1	
2	Thickening Tank	1	6.3 m^3
3	Settler	1	6.7 m^3
4	Anaerobic Digester	2	Each 10.5 m^3
5	Sludge Drying Bed	15	Each 14 m^2
Liquid Treatment Unit			
6	Anaerobic Baffled Reactor	1	32 m^3
7	Horizontal Flow Constructed Wetland	1	30 m^2

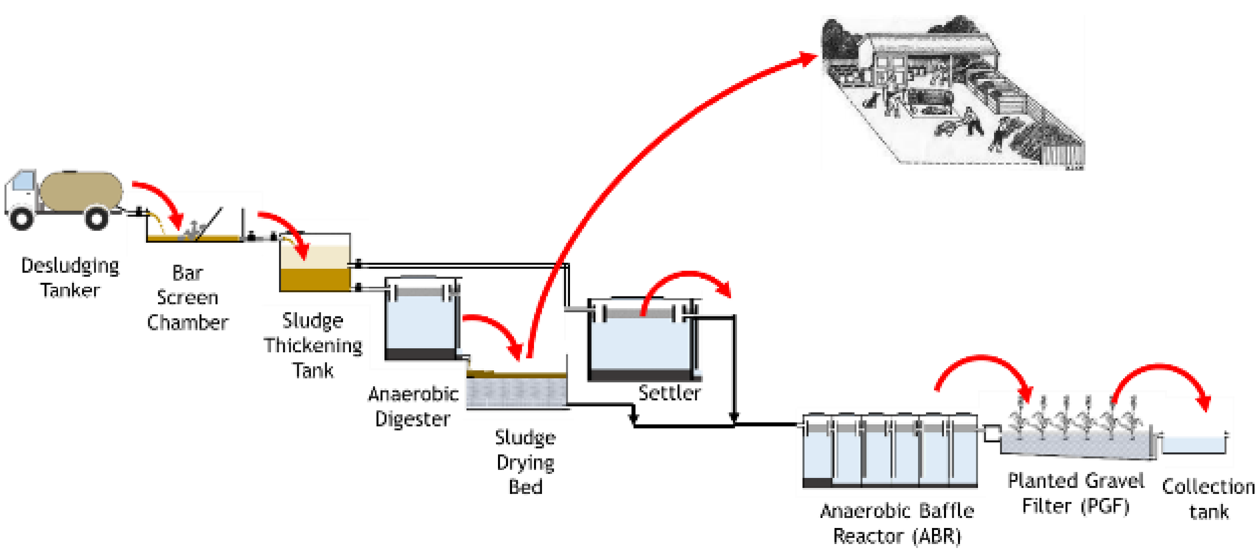

Figure 29 The components and FS flow diagram of Waling FSTP

Deep Row Trenching for FSM service

Deep Row Trenching (DRT), temporary in nature, is an on-site faecal sludge management (FSM) technique used for the safe disposal of treated or partially treated sludge. In this method, deep trenches typically 1 to 2 meters deep are prepared, and the sludge is disposed of into it. Once the trench is filled up it is covered with soil. The process promotes natural drying through percolation of leachate into ground and evaporation, decomposition and nutrient absorption minimizing environmental and health risks. DRT a low-cost, less technicality is suitable for areas with enough available land but limited affordability to advanced treatment facilities. It is often used as an interim FSM option in rural and peri-urban settings. This type of plant is recommended to be installed far from community access as this may smell and affect public health.

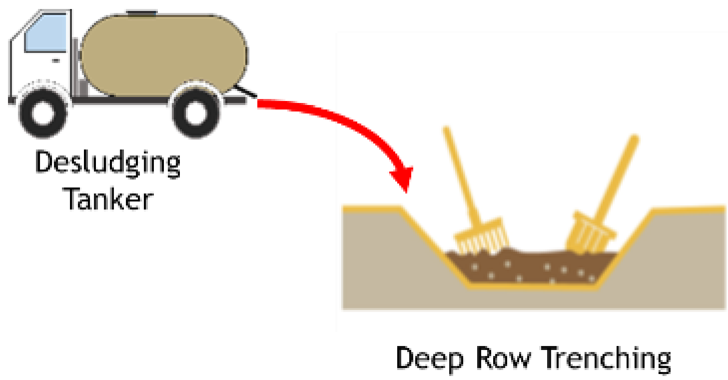

Figure 30 Deep Row Trenching

DRT is designed such that when it is exposed to sunlight, approximately 70-80% of its volume is reduced. This creates additional space for applying sludge.

Table 25 Details of the trenching facilities in Nepal

SN	Name of Municipality	District	Province	No. of Trenches	Length (m)	Depth (m)	Width (m)	Total Volume (m^3)
1	Nepalgunj Sub-metropolitan City	Banke	Lumbini	17	40	1	0.8	544.0
2	Chandannath Municipality	Jumla	Karnali	7	23	1	0.8	128.8
3	Khadak Municipality	Saptari	Madesh	8	22	1	0.8	140.8

Source: SNV Nepal

Chandannath Municipality

Deep row trenching in Chandannath Municipality, Jumla District, Karnali Province was established in 2022 under the WASH SDG project, implemented by SNV Nepal. Figure 32 provides the location map of the deep row trenching site.

The plant has an entire capacity of 129 m3 of sludge. The plant was designed with effective capacity of 226 m3.

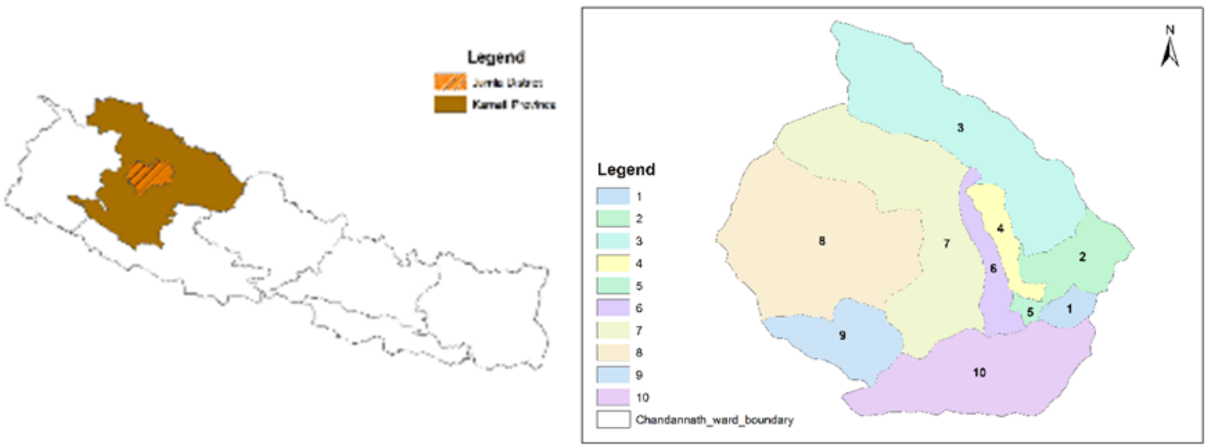

Figure 31 Location of Chandannath municipality

Khadak Municipality

Deep Row Trenching in Khadak Municipality, located in Saptari District of Madhesh Province, was established in 2018 under SNV's Sustainable Sanitation and Hygiene for All (SSH4A) programme. This first phase trenching site was developed with a design life of four years. Following this, a second phase trenching site was constructed in 2021 as a part of the WASH SDG project, implemented by SNV Nepal with support from the Directorate-General for International Cooperation (DGIS). Figure 33 presents the location maps.

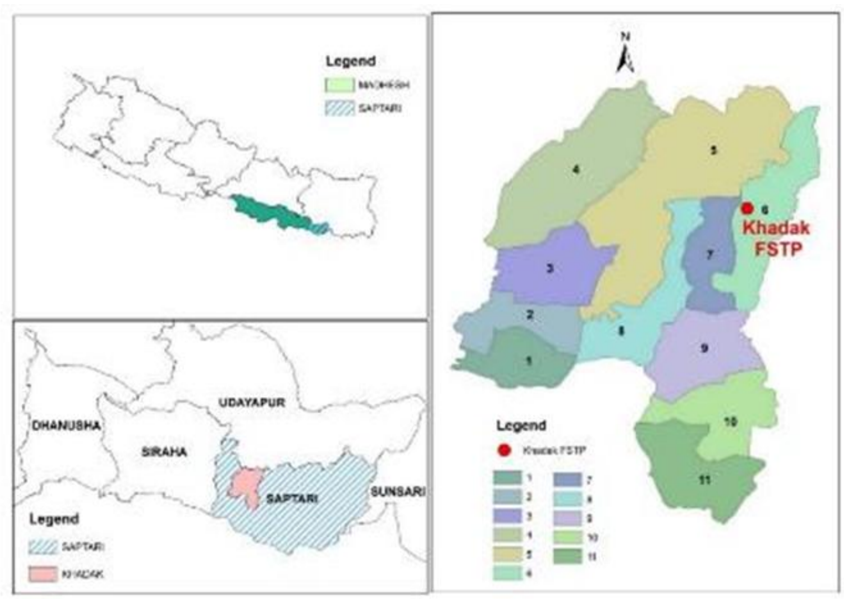

Figure 32 Location map of Deep row trenching in Khadak municipality

The first trenching site in Khadak consisted of 18 trenches, each 20 meters in length, with a total capacity of 288 cubic meters (m^3) and the second trenching site, currently in use, has a capacity of 140 m^3.

Nepalgunj Sub-metropolitan City

Deep Row Trenching system in Nepalgunj Sub-Metropolitan City has been installed as a temporary measure for the safe disposal of faecal sludge. It was constructed in 2023 under the WASH SDG project, implemented by SNV Nepal with support from the Directorate General for International Cooperation (DGIS). Figure 34 presents the location map of the trenching site within the city.

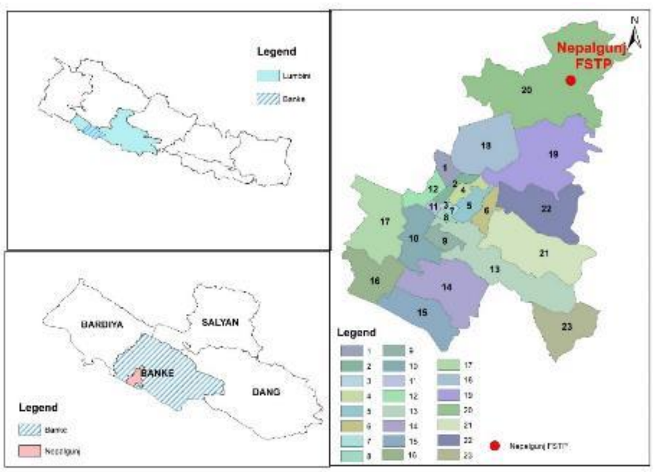

Figure 33 Location map of deep row trenching in Nepalgunj Municipality

The trenching facility has a capacity of 544 cubic meters (m^3) of feacal sludge. It consists of 17 trenches, each measuring 40 meters in length, 1 meter in depth and 0.8 meters in width. The site is securely fenced and managed by Nepalgunj Sub-metropolitan City.

Utilization of WWTP for FSM

Co-treatment refers to the integrated management of multiple waste streams such as solid waste, wastewater and faecal sludge through the optimization of shared resources including land, cost and treatment infrastructure. Conceptually, co-treatment can be categorized into two primary modalities:

- land-sharing, in which multiple waste types are processed within a single premises, and
- Infrastructure-sharing, where existing treatment systems are adapted to accommodate additional waste streams.

Given that land acquisition remains one of the major constraints in the development of waste management facilities, co-treatment enhances resource efficiency, reduces duplication of infrastructure, and lowers both capital and operational costs.

In Nepal, the practice of utilizing existing wastewater treatment plants (WWTPs) for the co-treatment of faecal sludge is gaining prominence as a pragmatic and sustainable faecal sludge management (FSM) strategy. However, the systems currently used for co-treatment were not initially designed for the purpose. These systems were typically designed to manage a single waste stream, municipal wastewater, but it has been started to receive feacal sludge during the operation.

In some cases, WWTPs were found to be systematically assessed and modified to enable them handling technically recommended loads of FS. This approach minimizes the need for constructing new, dedicated FS treatment facilities, improves the efficient use of available land, and supports safer and more compliant sludge management and disposal pathways.

WWTP in Biratnagar Metropolitan City

Biratnagar metropolitan city has a wastewater treatment plant established at Jatuwa in ward number 14 of the metropolitan city under the Secondary Towns Integrated Urban Environmental Improvement Project (STIUEIP) and Regional Urban Development Project (RUDP). The facility was handed over to the metropolitan city in May 2020. Figure 35 shows the location map of Biratnagar wastewater treatment plant.

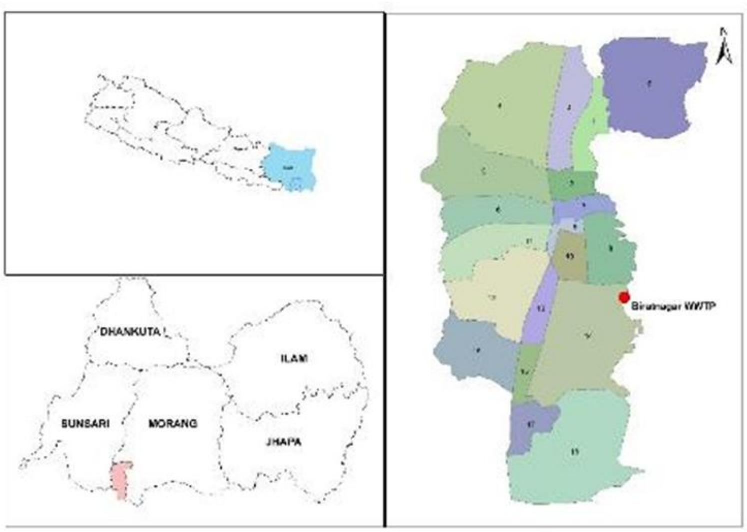

Figure 34 Location map of Biratnagar WWTP

The plant has been designed based on natural degradation of organic waste. It consists of a series of anaerobic and facultative ponds to treat wastewater. Additionally, sludge drying beds have been installed to treat the sludge taken out of the ponds. The schematic diagram of the WWTP in Biratnagar is shown in figure 37.

Components of the treatment plant

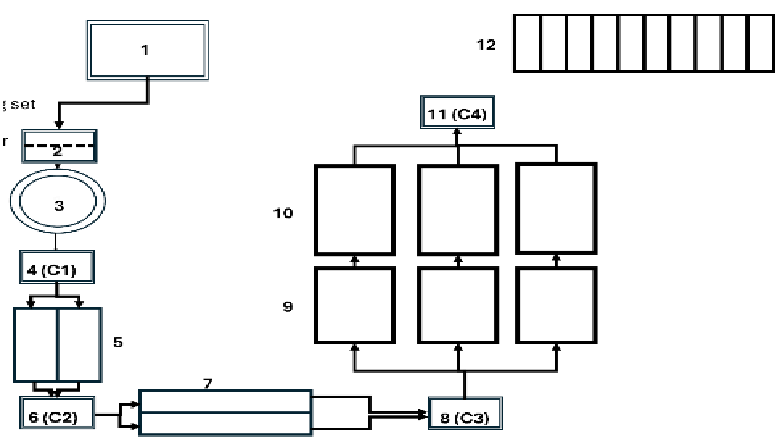

Figure 35 Schematic diagram of the Wastewater treatment plant in Biratnagar

Table 26 shows the descriptions of the dimensions of the different components in the WWTP.

Table 26 Descriptions on components of WWTP in Biratnagar

SN	Components	Number	Dimension
1.	Bypass Chamber	1	277 m3
2.	Bar Screen Chamber	2	1.2m3 and 1.5 m3
3	Sump well with pumping	2	201 m3 each
4.	Collection Chamber (C1)	1	13.5 m3
5.	Oil and Grease Chamber	2	41.5 m3 each
6.	Collection Chamber (C2)	1	7.5 m3
7.	Grit Chamber	2	27 m3 and 33 m3
8	Collection Chamber (C3)	1	18 m3
9.	Anaerobic Pond	3	13924 m3 each
10.	Facultative Pond	3	26262 m3 each
11.	Collection Chamber (C4)	1	19.5 m3
12.	Sludge Drying Bed	10	67.5 m3 each

Source: S. Limbu et.al., 2023

WWTP was designed to treat wastewater from households, commercial and institutional buildings. It was designed with 72 lpcd wastewater generated from households with the design period for 2035. The targeted population within the design period was 248,615. Currently the facility is operating under the design capacity as all households from the service area have not been connected to sewer network. Table 27 shows the design consideration of the treatment plant.

Table 27 Descriptions on design parameters of WWTP in Biratnagar

SN	Parameter	Phase I	Phase II	Total
1	Population Coverage	96433	152182	248615
2	Area Coverage (ha)	598.69	392.07	990.76
3	Domestic Wastewater quantity (lps)	62.69	144.79	207.18
4	Commercial/Institutional/Industrial wastewater quantity (lps)	41.91	57.17	99.08
5	Infiltration rate (lps)	47.9	90.81	138.71
6	Total wastewater quantity (lps)	152.20	292.77	444.97
7	Peak flow (lps)	213.97	436.11	650.08
8	Adopted peak flow (lps)	214.0	436.0	650.00

The treatment plant is managed and operated by Biratnagar Metropolitan City and the management unit has been operating a desludging service for the areas without access to sewer facilities. There are five private desludging vehicles in the city where they were given a permit to dispose of faecal sludge into the plant. As per the in-charge of the WWTP, faecal sludge is disposed of into the facultative pond of the WWTP and at least one trip of faecal sludge is being disposed of daily.

WWTP in Birgunj Metropolitan City

The wastewater treatment located at Chhapkiya, ward number 2 in Birgunj metropolitan city. It was constructed under the Secondary Towns Integrated Urban Environmental Improvement Project (STIUEIP).

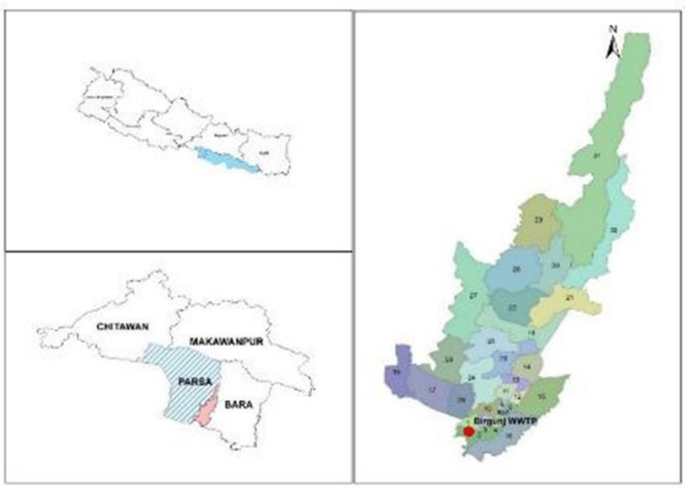

Figure 36 Location map of the WWTP in Birgunj

Components of the treatment plant

Wastewater treatment has adopted natural degradation of organic waste. It consists of a series of anaerobic and facultative ponds to treat wastewater. Additionally, sludge drying beds have been installed to treat the sludge from the ponds. The schematic diagram of the WWTP in Birgunj is shown in figure 39.

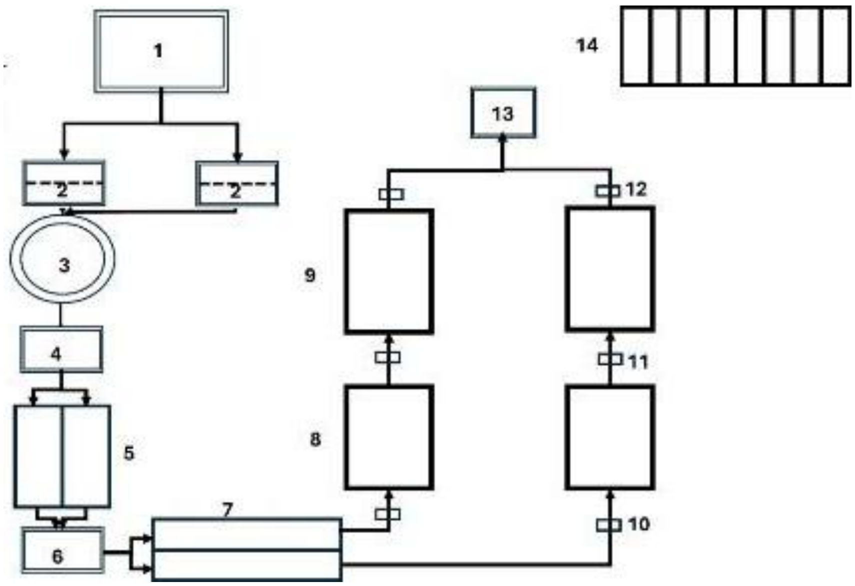

Figure 37 Schematic diagram of WWTP in Birgunj

Table 28 shows the different components, size and number of the treatment plant.

Table 28 Description of components of WWTP in Birgunj

SN	Units	Size	No.
1	Inlet cum Diversion Chamber	3m X 3m X 1m	1
2	Screen Chamber – 2 Channels	4m X 1.2m X 0.4m (LD)	2
3	Sump Well with Pumps	7.5 m diameter X 1.5 m (LD)	1
4	Receiving Chamber	1.7mX2.5mX1.1m (LD) + 0.5m free board	1
5	Grit Chamber with 2 Channels	9mX1.25mX0.75m (LD)+0.3m free board	2
6	Parshall Flume	5mX0.7mX0.7m (LD) +0.5m free board	1
7	Distribution Chamber	3mX3m X 1m (LD) +0.5m free board	1
8	Anaerobic Ponds	At Top: 35mX59mX4.5m (LD) + 0.5m free board At Bottom: 15mX39m; at Mid water depth- 24mX 48m +0.5 m free board	2
9	Facultative Pond	At Top: 62.5mX204mX2m (LD)+0.5 m Free Board At Bottom: 52.5m X 194m At Mid-water Depth- 56.5m X 198 m	2
10	Inlet to Anaerobic Ponds	4mX4mX2.75m (LD)+0.5m Free Board	2
11	Inlet to Facultative Ponds	4mX4mX1.8m (LD)+0.5m Free Board	2
12	Outlet of Facultative Ponds	4mX5mX2.2m (LD)+0.5m Free Board	2
13	Facultative Pond Outlet Collection Chamber	Collection Chamber 1: 2mX2mX1.55m (LD) Collection Chamber 2: 3mX3mX1.8m (LD)	2
14	Sludge Drying Beds	20mX11mX0.3 (SD)+0.5m Free Board	8

WWTP at Chhapkaiya was designed to treat wastewater from Sirsiya Catchment area. The estimated catchment area of Sirsiya is 1106 ha. The total population estimated to serve within the design period in 2035 was 269,154. The water supply rate has been estimated at 80 lpcd and wastewater generation at 80% of water supply. Similarly, the institutional and industrial wastewater was estimated at 10% of total household wastewater.

Table 29 Descriptions of design parameters for WWTP in Birgunj

Description	Unit	Sirsiya Catchment
Total Area	ha	1106.5
Undeveloped area	ha	202.93
Effective/developed area	Ha	903.57
Population		140219
Water Supply Rate	Lpcd	80
Sewage return factor	%	80
Domestic sewage quantity	l/s	103.87
Institutional/Industrial Wastewater	%	10%
Institutional/Industrial Wastewater	l/s	10.39
Average wastewater quantity	l/s	114.25
Average wastewater quantity	MLD	9.87
Peak factor		2.5
Infiltration rate to WWTP	%	10
Infiltration quantity	l/s	11.42
Design Capacity (2035)	l/s	125.67
Design Capacity (2035)	MLD	10.85

The treatment plant was not operating at full capacity; however, the metropolitan city has been disposing of faecal sludge in the facility. On average, monthly 15 to 20 trips of faecal sludge are discharged into the treatment plant. The faecal sludge is currently disposed of in the sludge drying beds which were initially designed to treat sludge generated from the anaerobic and facultative ponds of the wastewater treatment plant.

WWTP in Ratnanagar Municipality

There are two decentralized wastewater treatment plants has been constructed in the bank of Budikhola under Urban and Environmental Improvement Project in Ratnanagar municipality, Chitwan District by Department of Urban Development and Building Construction (DUDBC) in 2010. Its service area covers ward numbers 1,2, 4 and 10 of the municipality.

The wastewater treatment plants were designed to treat daily 1,425 m3 of wastewater. However, the municipality has been disposing of faecal sludge collected through the municipal desludging service into septic tank of the treatment plant. Information regarding the number of trips of FS discharge to the facility is not available. FS disposal service is not provided to desludging service providers in the municipality.

The treatment plants are managed by Ratnanagar Municipality. Currently, both facilities are not operating at full capacity due to physical damage to several components of the treatment system.

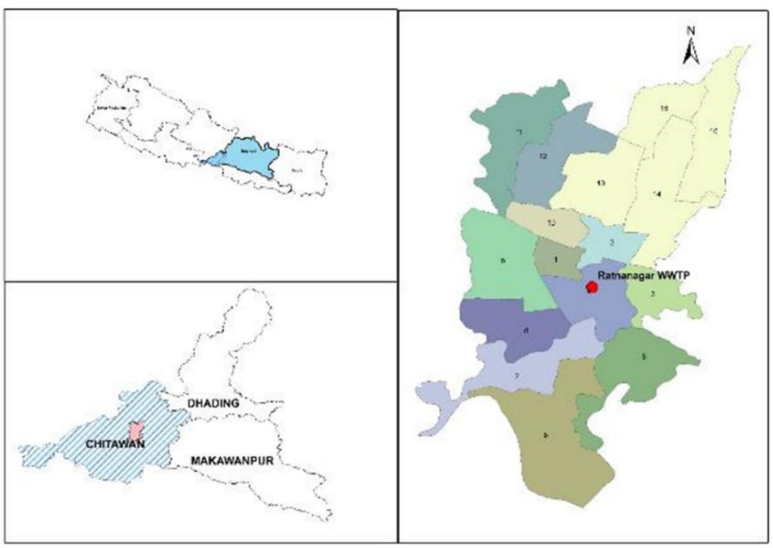

Figure 38 Location map of WWTP in Ratnanagar Municipality

Components of the treatment plant

The wastewater treatment plants consist of septic tanks for the primary degradation of organic waste in the wastewater. The effluent from the septic tank is subsequently treated in a horizontal flow constructed wetland which provides secondary treatment through natural filtration and biological processes. Sludge drying beds are provided on-site for the treatment and dewatering of sludge accumulated in the septic tank. Figure 41 presents the schematic layout of the wastewater treatment plants.

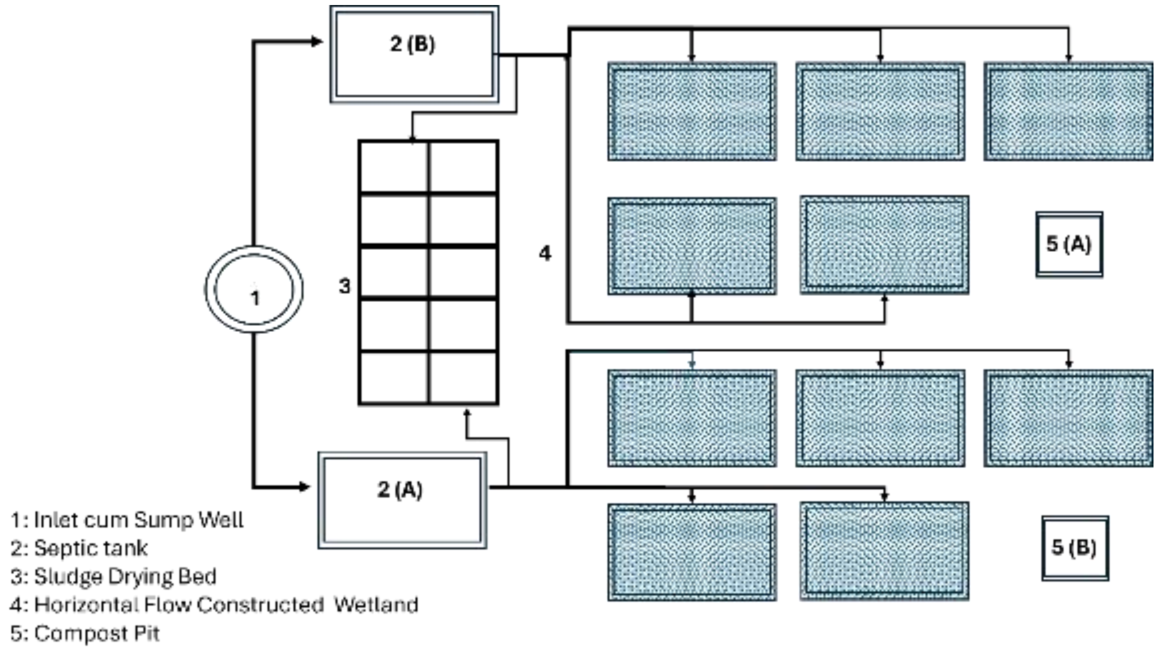

Figure 39 Schematic diagram of WWTP in Ratnanagar Municipality

Table 30 shows the dimensions of different components of the wastewater treatment plants in each bank.

Table 30 Descriptions of components in WWTP in Ratnanagar Municipality

SN	Units	Size	Number
1	Inlet cum Sump Well	Outer diameter: 2.4m, Depth: 3.3m	1
2	Septic tanks	11.3m X 5.5 m X 3.2m (each)	2
3	Horizontal Flow Constructed Wetland	22m X 15m X 0.75m (each)	10
4	Sludge Drying Bed	22m X 5 m (each), depth of media: 0.45m	2

Discussion

The findings of this study present a detailed assessment of the status and performance of faecal sludge treatment plants (FSTPs) in Nepal, outlining key operational challenges and emerging opportunities for strengthening faecal sludge management (FSM). This section evaluates the operational condition of existing FSTPs, analyzes treatment efficiency and capacity utilization, and discusses the institutional and technical factors influencing system performance.

Nepal has established FSTPs across all seven provinces, ensuring a minimum of one treatment facility per province. Despite this progress, the operational performance of these systems remains inconsistent. Of the assessed facilities, 13 are fully operational, while three operate only partially, and another three remain non-functional or incomplete. These variations reflect differences in resource availability, technical expertise, and operational management at the municipal level. Notably, the Teku Septage Treatment Facility the first FSTP constructed in Nepal has remained non-operational since 2005 due to unresolved technical and management issues. Similarly, the FSTP constructed in Madhuvan Municipality in 2019 has yet to commence operation, indicating gaps in post-construction commissioning and operational readiness.

Capacity utilization remains a critical concern, with FSTPs operating at approximately 51% of their designed capacity. Underutilization is influenced by multiple factors, including the continued prevalence of manual desludging, the widespread use of leaky or improperly designed containment systems, and the unwillingness of private desludging operators to transport faecal sludge to treatment facilities. Furthermore, the practice of applying untreated faecal sludge directly to agricultural land reduces the volume reaching FSTPs and poses significant public health risks. Addressing these issues will require improvements in desludging service delivery, reinforcement of regulatory frameworks for safe disposal, and public awareness initiatives promoting mechanical desludging and compliant waste handling.

Effluent quality analysis indicates mixed performance across the FSTPs. While pH levels consistently fall within the national standard range (6–9), key parameters such as BOD, COD, and TSS frequently exceed permissible limits. For example, the Birendranagar FSTP reported a BOD concentration of 265 mg/L, well above the national standard of 50 mg/L. Similarly, COD values at the Butwal Sanitary and Kakarbhitta FSTPs exceeded the allowable limit of 250 mg/L. These performance gaps indicate limitations in treatment technology, operational inefficiencies, insufficient maintenance, or overloading beyond design specifications. Improvements in treatment processes, enhanced monitoring, and targeted operator capacity-building are required to address these constraints.

Multiple stakeholders including government agencies, development partners, and non-governmental organizationshave contributed to the establishment and operation of FSTPs in Nepal. The Department of Water Supply and Sewerage Management (DWSSM) has played a central role in integrating FSM into national sanitation initiatives, while organizations such as ENPHO and SNV have provided technical and financial support. Collaborative models, such as the Gulariya Municipality–ENPHO partnership under the SAFA and SWASTHA Gulariya Project, demonstrate the potential of coordinated efforts in improving FSM outcomes. However, the dependence on external support raises concerns regarding long-term operational sustainability. Strengthening municipal capacity, ensuring adequate budgeting for O&M, and enhancing institutional accountability will be critical for sustaining FSM interventions.

Despite ongoing challenges, several innovative and context-specific practices have emerged. Trenching methods employed in Chandannath, Khadak, and Nepalgunj offer low-cost alternatives for faecal sludge disposal in resource-limited settings. Furthermore, the co-treatment of faecal sludge in existing wastewater treatment plants, as practiced in Biratnagar, Birgunj, and Ratnanagar, demonstrates a feasible approach to FSM in municipalities lacking dedicated treatment infrastructure. These examples highlight the importance of flexible, context-appropriate solutions that align with local resource availability and operational capacity.

Conclusion

Nepal has made notable progress in expanding faecal sludge treatment infrastructure across the country; however, significant challenges remain in achieving full operational efficiency, capacity utilization, and compliance with national effluent standards. Many FSTPs continue to face issues related to underutilization, inadequate treatment performance, limited operational capacity, and management shortcomings. Strengthening FSM in Nepal will require sustained technical, financial, and institutional support, along with targeted capacity enhancement for plant operators and municipal authorities.

Improving containment systems, promoting mechanical desludging, discouraging unsafe disposal practices, and enforcing regulatory compliance are essential to increasing the volume of faecal sludge reaching treatment facilities. Furthermore, upgrading treatment technologies, implementing routine monitoring systems, and ensuring adequate operation and maintenance budgets will be critical to improving treatment efficiency.

Collaborative engagement between government agencies, municipalities, development partners, private operators, and communities remains central to sustaining progress. With continued commitment and integrated interventions, Nepal can achieve safe, efficient, and sustainable faecal sludge management, contributing to improved public health, environmental protection, and urban sanitation resilience.