SFD Report

Gulariya Municipality
Nepal

Final Report

This SFD Report - SFD level 2 - was prepared by
Environment and Public Health Organization (ENPHO)

Date of production: 08/08/2023

Last update: 16/03/2024

SFD Report Gulariya Municipality, Nepal, 2024

Produced by:

Asmita Shrestha, ENPHO

Jagam Shrestha, ENPHO

Buddha Bajarchaya, ENPHO

Sabuna Gamal, ENPHO

Rupak Shrestha, ENPHO

Anita Bhuju, ENPHO

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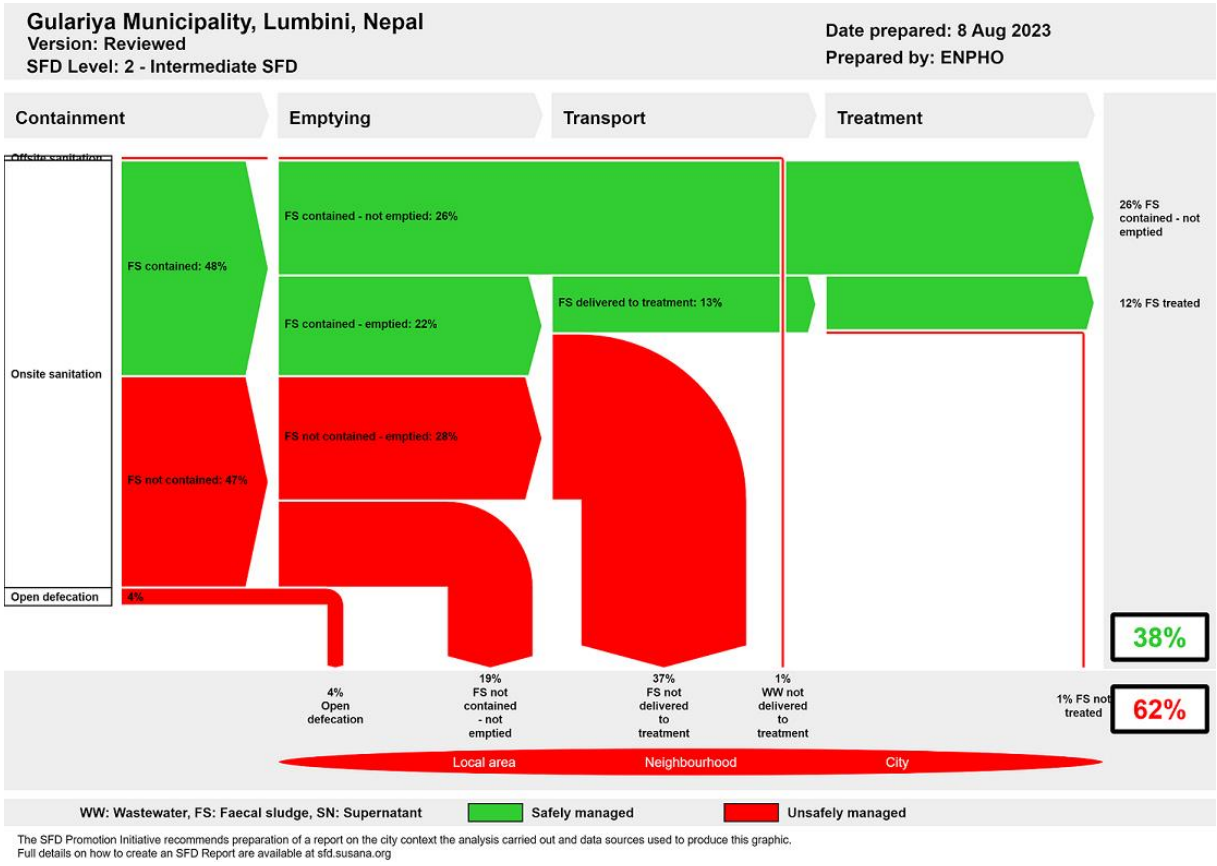
1. The SFD Graphic



The SFD Promotion Initiative recommends preparation of a report on the city context the analysis carried out and data sources used to produce this graphic.
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2. Diagram information

SFD Level:

This SFD is a level 2 - Intermediate report.

Produced by:

Environment and Public Health Organization (ENPHO).

Collaborating partners:

Gulariya Municipality

Municipal Association Nepal (MUAN)

United Cities Local Government-Asia pacific (UCLG-ASPC)

Status:

Final SFD Report.

Date of Production:

08/08/2023

3. General city information

Gulariya, a municipality in Nepal's Bardiya district, was established in 2053 BS (1997 AD) and later restructured in 2073 (2016 AD). Comprising 12 political wards over 118.21 square kilometres in the southern plains of the Terai region and positioned 35 kilometres west of Nepalgunj, Gulariya has an elevation of 187 metres.

The 2021 national population and housing census reported a population of 74,505 individuals in 16,002 households, experiencing an annual growth rate of 0.86%. The climate exhibits extreme seasonal variations, with a hot season from April to June and a cool season from December to February.

The topography, situated in the west Terai region, features fertile plains along the Babai River, with urban expansion potential and

irrigation benefits, despite flood risks in the northeastern area.

4. Service outcomes

This section provides a quick summary of the various sanitation technologies used across the municipality's sanitation value chain. All data in this section are from the household and institutional surveys conducted for this study (ENPHO, 2023). Despite municipality being declared as Open Defecation Free (ODF), still 4% of the total population are deprived from access to basic sanitation facilities and defecate in open places.

Containment:

Of the total population, 96% has access to improved sanitation, with a small proportion utilizing offsite sanitation systems. Despite the absence of a sewer network, stormwater drainage is prevalent in many areas. Illegitimate connections of blackwater to stormwater drains are observed in approximately 1% of toilets, while 95% use onsite sanitation systems. Notably, only 1% of households have well-designed septic tanks, with 8% opting for fully lined tanks without soak pits, 10% biogas digesters, 13% using lined tanks with impermeable walls and open bottoms, and 63% adopting lined pits with semipermeable walls and open bottom constructed with pre-cast concrete rings.

All 81 surveyed institutions in the municipality have access to a safely managed sanitation system: 52% have fully lined tanks, 33% have lined tanks with impermeable walls and open bottoms, 9% have lined pits with semipermeable walls and open bottoms, and a minimal 6% have septic tanks.

Emptying and transportation:

Notably, among the 96% of households with containment, 62% have emptied their containment due to faecal sludge overflow, where lined pit with semipermeable walls and open bottom are emptied more frequently. Furthermore, 35% of institutional containments have been emptied at least once since installation. Mechanical emptying is prevalent in the municipality while manual emptying still in practice. The municipal Faecal Sludge Management (FSM) service initiated in 2017, utilizing a 5,000-litre capacity exhauster truck, offers on-demand emptying services, with costs varying based on containment shape. Within the municipality, the cost is a minimum of $2.99 (Rs. 400) per concrete ring and $26.20 (Rs. 3,500) per trip for rectangular tanks, while on-demand services beyond the municipality are charged at $52.39 (Rs. 7,000) per trip.

The municipal desludging team, comprising 3 - 4 staff, conducts 1-2 trips weekly even in the off-season, increasing to 2-3 trips per day during the peak season. The usual emptying interval for ring tanks is every 6 months, and for holding tanks, it is on a yearly basis, averaging 10 trips per month.

Treatment and Disposal:

Gulariya has implemented an innovative Faecal Sludge Treatment Plant (FSTP), situated approximately 1 kilometre from the town, representing the first of its kind in Nepal. Initiated by ENPHO in coordination with the municipality, the FSTP has a design capacity of 3 cubic metres per day. The plant includes a settler, an Anaerobic Baffler Reactor (ABR), sludge drying beds, and a constructed wetland for further treatment. Gulariya Municipality has even devised a business plan for the sustainable operation and maintenance of the FSTP, aiming for an integrated model with solid waste management on the same premises. Despite municipal desludging services, manual emptying persists, with some households using faecal sludge as compost on farms or opting for pit dumping due to ample space availability and lack of affordability on high cost of mechanical emptying.

Risk Assessment:

The survey findings indicate that 81.87% of households primarily consume groundwater, 15.47% have a private tap at home, and 0.27% depend on public taps. Additionally, 1.60% use jar water, and 0.53% rely on tanker water for

drinking. Key Informant Interviews (KIIs) highlight the efforts of Khairapur Water Sanitation Users Committee and Gulariya Water Sanitation Users Committee, providing piped water in specific wards. Khairapur Water Sanitation Users Committee serves 450 households mainly in wards 1 and 2, while Gulariya Deshro Water Sanitation Users Committee covers wards 3 and 4, supplying water to 475 households.

People who use open-bottom tanks and handpumps with a horizontal distance of less than 25 feet (7.6 m) from the source of pollutants and a depth of up to 100 feet (30.4 m) are thought to be at significant risk of groundwater pollution. While households who have installed lined pits with semi permeable walls and open bottom are at high risk of ground water contamination as they pumped through handpump for water consumption.

The SFD graphic shows that 38% of the excreta or faecal sludge generated are safely managed while 62% are unsafely managed. The safely managed Faecal Sludge (FS) generated by 26% of the population is temporary as this FS is only contained. So, once the containment gets filled and the FS from the containment is emptied, the percentage of unsafely managed FS would increase.

5. Service delivery context

Access to drinking water and sanitation has been defined as fundamental rights to every citizen by the constitution of Nepal. To respect, protect and implement the rights of citizen embedded in the constitution, the Government of Nepal (GoN) has endorsed the Water Supply and Sanitation Act 2022 which has emphasized on a right to quality sanitation services and prohibited direct discharge of wastewater and sewage into water bodies or public places.

Several policies have been in place to accomplish the sanitation need of people. Particularly, the National Sanitation and Hygiene Master Plan (NSHMP) 2011 has proved as an important strategic document for all stakeholders to develop uniform programs and implementation mechanism at all levels. It strengthens institutional set up with the formation of water and sanitation coordination committee at every tier of government to actively engage in sanitation campaigns. Currently, the municipality has planned to operate the solid waste management along with faecal sludge treatment showcasing an integrated model for managing both solid and liquid waste.

6. Overview of stakeholders

Based on the regulatory framework for Faecal Sludge Management (FSM), the major stakeholders for effective and sustaining service delivery as presented in Table 1.

Table 1. Overview of Stakeholders.

Key Stakeholders	Institutions / Organizations
Public Institutions at Federal Government	Ministry of Water Supply
Public Institutions at Provincial Government	Ministry of Water Supply, Rural and Urban Development
Public Institutions at Local Government	Gulariya Municipality, Khairapur WSUC, Gulariya Deshraj WSUC
Non-governmental Organizations	Environment and Public Health Organization (ENPHO)
Private Sector	Public toilet operators.
Development Partners, Donors	MuAN, BMGF, UCLG ASPAC

7. Credibility of data

The major data were collected from proportionate stratification random sampling. Altogether, 375 households and 81 institutions were surveyed from 12 wards of the municipality. Primary data on emptying, transportation, and current sanitation practices in the municipality are validated from Key Informant Interviews (KIIs) with municipal desludgers, water service providers, public toilet caretaker and other different sanitation and environmental stakeholder. The overall data and findings were shared with the stakeholders of the municipality and validated through a sharing program on 14th August, 2023.

8. Process of SFD development

Data on sanitation situation is collected through household and institutional surveys (ENPHO, 2023). Enumerators from the municipality were mobilized after providing orientation on sanitation technologies, objectives of the survey and proper use of mobile application, KOBOCOLLECT for collection of data for survey. Along with this, KIIs were conducted with officers and engineer of municipality city and private desludging service providers to understand the situation practices across the service chain. Types of sanitation technologies used in different locations were mapped using ARCGIS. To produce the SFD graphic, initially a relationship between sanitation technology used in questionnaire survey and SFD PI methodology was made. Then, data were fed into SFD graphic generator to produce the SFD graphic.

9. List of data sources

The list of data sources to produce this executive summary is as follows:

- ENPHO. (2023). Sanitation Survey on Gulariya Municipality. Gulariya.
- MICS. (2020). Multiple Indicator Cluster Survey, 2019. Kathmandu, Nepal: Central Bureau of Statistics.
- Gulariya Municipality. (2019). Municipal Profile of Gulariya Municipality.
- NSO. (2022). National population and housing census 2021. Kathmandu: National Statisitics Office.

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ABBREVIATIONS

BMGF	Bill and Melinda Gates Foundation
DWSSM	Department of Water Supply and Sewerage Management
ENPHO	Environment and Public Health Organization
FS	Faecal Sludge
FSM	Faecal Sludge Management
GoN	Government of Nepal
HH	Household
IRF	Institutional and Regulatory Framework
KII	Key Informant Interview
KM	Kilometres
MDG	Millennium Development Goal
MICS	Multiple Indicator Cluster Survey
MoUD	Ministry of Urban Development
MuNASS-II	Municipalities Advocacy on Sanitation in South Asia – II
mm	Millimetre
MoH	Ministry of Health
MoHP	Ministry of Health and Population
MoUD	Ministry of Urban Development
MoWS	Ministry of Water Supply
MuAN	Municipal Association of Nepal
NGO	Non-Governmental Organization
NPC	National Planning Commission
NWSSP	National Water Supply and Sanitation Policy
ODF	Open Defecation Free
PPP	Public Private Partnership
RWSSNP	Rural Water Supply and Sanitation National Policy
SDP	Sector Development Plan
SFD	Shit Flow Diagram
SFD PI	Shit Flow Diagram Promotion Initiative
SN	Supernatant
UCLG ASPAC	United Cities and Local Governments Asia Pacific
UNICEF	United Nations Children's Education Fund
VDC	Village Development Committee
WASH	Water, Sanitation and Hygiene
WHO	World Health Organization
WSUC	Water Supply and User's Committee
WW	Wastewater

1 City context

Gulariya is a municipality situated in Bardiya district, Lumbini Province of Nepal. The municipality is named as Gulariya after the tree Gular found in one of its villages (Municipality, Gulariya, 2076). Serving as the headquarters of Bardiya district, Gulariya is one of eight municipalities in the district. It was established in the year 1997 (2053 BS) by merging 3 Village Development Committee (VDC) named Mathurahardwar, Khairapur and Gulariya VDC, which was again restructured in December, 2016 (2073 BS) by merging Mahammadpur VDC (Gulariya Municipality, 2019).

Gulariya comprises 12 political wards spread across 118.21 square kilometres of geographical area in the southern plains of the Terai region.

Figure 1 shows the map of the municipality with its ward boundaries.

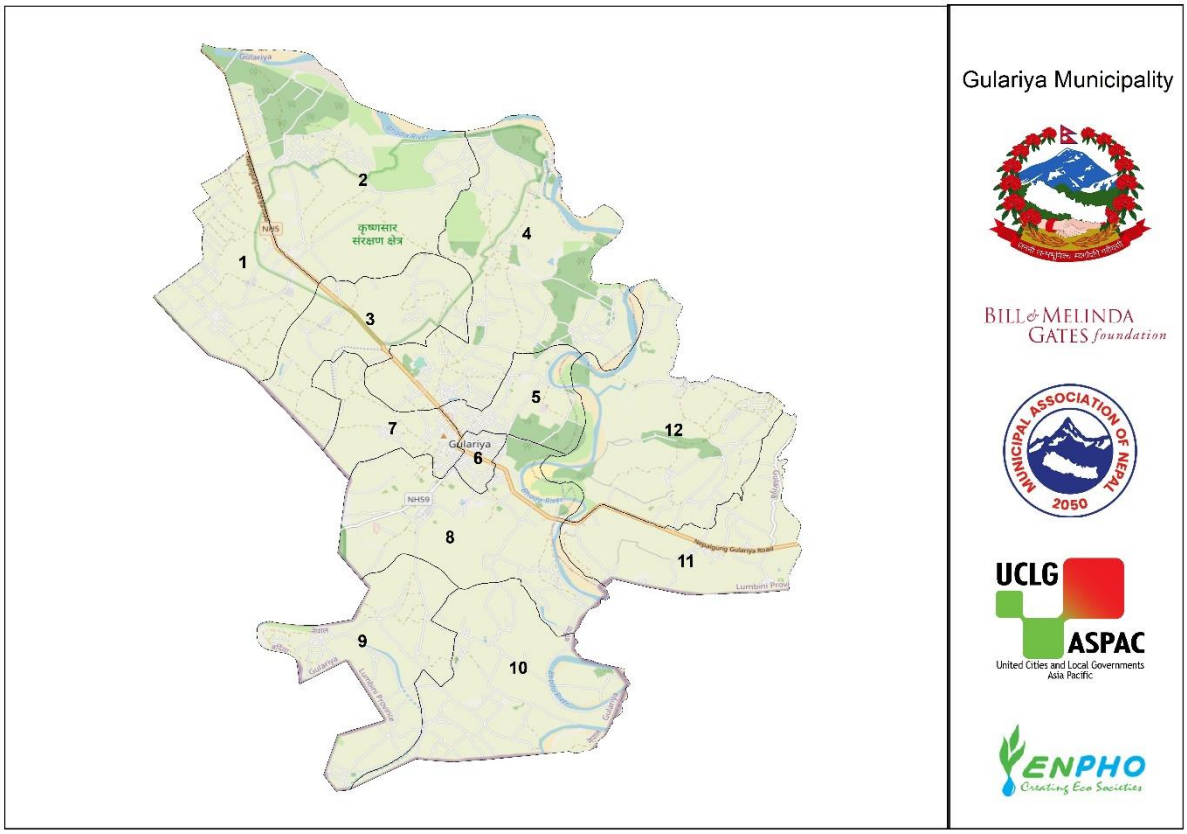

Figure 1: Map of Gulariya Municipality with ward boundaries.

1.1 Population

The municipality's population, according to the 2021 National Population and Housing Census, stood at 74,505 individuals distributed across 16,002 households. The male and female populations were 36,727 and 37,778 respectively (NSO, 2021). The municipality has experienced an annual growth rate of 0.86% per annum, resulting in a population density of 630.3/km² (City Population, Gulariya, 2021) .

1.2 Climate

In Gulariya, the wet season is hot, oppressive, and partly cloudy, while the dry season is warm and mostly clear. Throughout the year, temperatures usually range from 12°C to 39°C, rarely dropping below 9°C or exceeding 43°C. The hot season spans from April to June, with an average daily high temperature above 97°F (36°C). The hottest month is May, with an average high of 103°F (39°C) and a low of 81°F (27°C). The cool season extends from December to February, with an average daily high temperature below 77°F (25°C). The coldest month is January, with an average low of 53°F (12°C) and a high of 72°F (22°C). The clearest period starts around September with May being the clearest month (Figure 2). Gulariya experiences extreme seasonal variation in monthly rainfall with July having the most rain at an average of 10.5 inches (266.7 mm) and November being the driest month at an average rainfall of 0.2 inches (5,08 mm) (weatherspark, 2023).

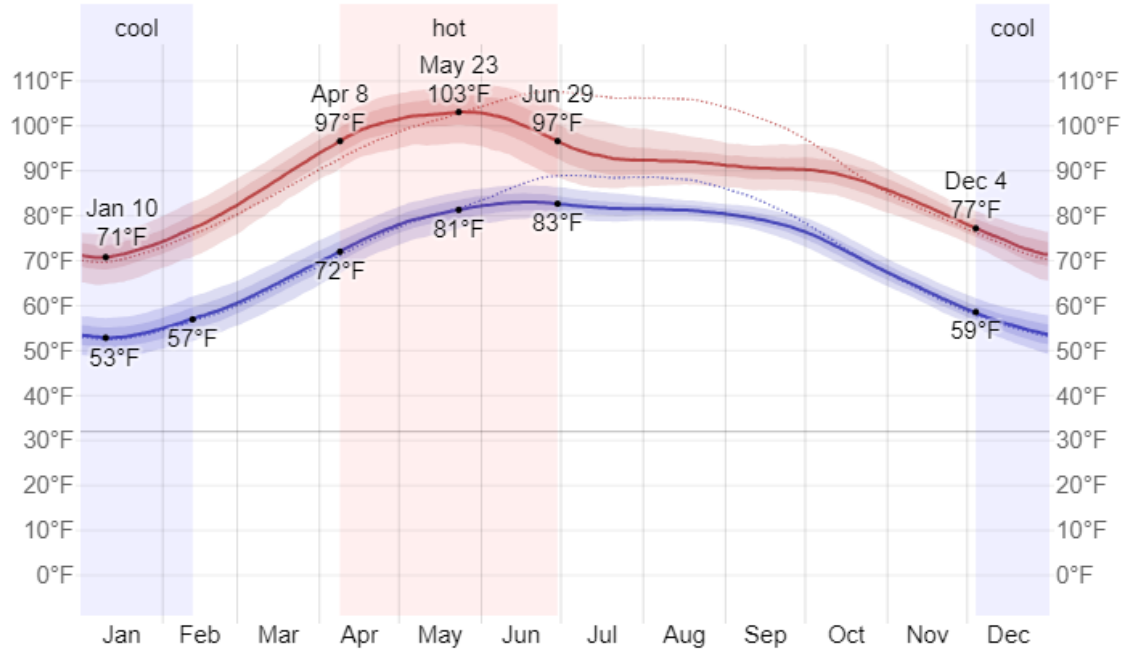

Figure 2: Average high and low temperature in Gulariya Municipality. Source: (Weatherspark, 2023).

1.3 Topography

Gulariya Municipality, situated in the west terai region of Nepal at an altitude of 145 metres above sea level, has geographical coordinates ranging from 28º 8'1'' North to 28º 17'12'' North latitude and 81º16'49'' East to 81º24'48'' East latitude. To the east lies Badhaiya Rural Municipality, Madhuvan Municipality is to the west, Barbardia Municipality is to the north, and the southern border connects with the Bahraich district, Uttar Pradesh, India. Positioned 35 kilometres west of Nepalgunj and approximately 10 km north of Murtiha transit or railway station in India. The area occupies a basin along the Babai River, characterized by wet and irrigated land in the fertile plains of the terai (Municipality, Gulariya, 2076).

The city holds the potential for urban expansion, being close to the east-west highway of Nepal. The Babai River flows through the north-eastern area, presenting both benefits of irrigation and challenges of flood risk to the region.

2 Service Outcomes

2.1 Overview

The country has persistently worked towards achieving its current sanitation status for over three decades. On September 30, 2019, the Government of Nepal declared the nation free of open defecation, marking universal access to improved sanitation facilities nationwide. Meanwhile, Gulariya achieved Open Defecation Free (ODF) status in May 2015, initiating a new phase of sanitation management to address the challenges of treating fecal waste collected from toilets (Gulariya Municipality, 2019).

Despite the nationwide ODF declaration in 2019, the sanitation situation in many places remains unsatisfactory across the country. Data on sanitation situation were collected through household and institutional surveys (ENPHO, 2023). To assess the sanitation status across the entire sanitation value chain, a household survey was conducted in 375 sampled households using a proportionate sampling across the 12 wards of Gulariya municipality (further details are presented in section 4). The results obtained after the triangulation and validation of the data with all the data sources including literature reviews, Key Informant Interviews (KIIs) and a validation workshop is presented in this section.

2.1.1 Sanitation Systems in household buildings

The National Population and Housing Census, 2021 indicates that 8% of the population lacks access to basic sanitation facilities. Additionally, findings from this survey in 2023 reveals that 4% of the total population lacks access to improved sanitation facilities. An improved sanitation facility is defined as one that hygienically separates human excreta from human contact. Improved sanitation facilities include flush or pour flush to piped sewer systems, septic tanks or pit latrines, ventilated improved pit latrines, pit latrines with slabs and composting toilets (MICS, 2019).

In the municipality, 96% of the population has access to improved sanitation facilities, with small proportion utilizing an offsite sanitation system. Offsite sanitation refers to a sanitation system in which excreta (referred to as wastewater) is collected and transported away from the plot where it originates (Susana, 2018) . Notably, the municipality lacks a sewer network, but stormwater drainage has been developed in many areas. Despite the illegality of directly connecting blackwater to stormwater drains, around 1% of toilets have such connection, while 95% utilize onsite sanitation systems.

Figure 3 depicts wastewater mixage in a stormwater drain near the highway.

Figure 3: Wastewater being disposed of directly in stormwater drainage.

Any sanitation technology or system involving the collection and storage of excreta (referred to as faecal sludge) on the plot where it is generated is known as onsite sanitation (Susana, 2018). In the municipality, only 1% of households have a well-designed septic tanks for storing faecal sludge from toilets. Instead, 8% of households installed fully lined tanks with a single or double chamber, lacking provision for soak pits, and 10% have biogas built.

Additionally, 13% of households have constructed lined tanks with impermeable walls and an open bottom. Twin pits are installed by 4% of households, while single offset pits are a popular choice, adopted by 59% of households who use pre-cast concrete rings to assemble the pits.

Table 1 illustrates the various types of onsite sanitation technologies used in the municipality and the corresponding proportion of households utilizing each.

Table 1: Sanitation system showing open defecation, offsite and different onsite sanitation system at households with different types of containments in Gulariya Municipality. (ENPHO, 2023).

Types of containment	Construction material used in the wall of the containment	Construction material used in the bottom of the containment	Number of Chambers	Number of containments	%	Recategorized as SFD	%
Biogas Digester	NA	NA	NA	NA	10%	Fully lined tank	18%
Fully Lined tank	Cemented brick/stone walls or concrete wall	PCC or plaster	One or two	NA	8%		
Septic tank	Cemented brick/stone walls or concrete wall	PCC or plaster	Two or more than two	NA	1%	Septic tank	1%
Lined tank with impermeable walls and open bottom	Cemented brick/stone walls or concrete wall	Soiling or nothing	One or two or more than two	NA	13%	Lined tank with impermeable walls and open bottom	13%
Single Pit	Concrete rings in piled up form	Soiling or nothing	NA	One	59%	Lined pit with semipermeable walls and bottom	63%
Twin Pits	Concrete rings in piled up form	Soiling or nothing	NA	Two	4%		
Offsite sanitation	NA	NA	NA	NA	1%	Toilet discharges directly to open drain or storm sewer	1%
Open defecation	NA	NA	NA	NA	4%	Open defecation	4%
						Total	100%

Biogas: A biogas digester, an effective energy conversion technology, treats household-generated faecal sludge through anaerobic digestion. This process reduces sludge size, eliminates harmful pathogens, and yields biogas and nutrient-rich slurry, biologically stable to use as a soil conditioner (Linda Strande, 2014). The Alternative Energy Promotion Centre (AEPC) has promoted biogas technology in 77 districts of Nepal, contributing to improved health and sanitation (AEPC, 2018). In the municipality, 10% of households have biogas digesters. When creating a SFD graphic, biogas is reclassified as SFD containment, considering it as a fully lined tank. Figure 4 is the biogas digester as seen in one of the sampled household of Gulariya Municipality.

Figure 4: Biogas as seen in one of the households of Gulariya Municipality.

Septic Tank: A septic tank is a well-sealed and waterproof rectangular chamber with an inlet and outlet, featuring two or more chambers for better storage and stabilization of faecal sludge (FS). This properly sealed technology discharges effluent into a soak pit (Susana, 2018) . A well-maintained septic tank efficiently handles wastewater, reducing environmental pollution and safeguarding public health. In Gulariya Municipality, only a minimal fraction of the population (1%) has installed a properly designed septic tank in their homes.

Fully Lined Tank: A fully lined tank is a rectangular tank with impermeable walls and a base, engineered to prevent leakage or seepage of faecal sludge into the surrounding environment. This design ensures the safe storage of faecal sludge, protecting against groundwater contamination (Linda Strande, 2014). In the municipality, 8% of households have fully lined tanks.

Lined Tank with Impermeable Walls and Open Bottom: This rectangular onsite technology involves constructing tanks with impermeable walls and a permeable base, allowing the infiltration of effluents that could potentially contaminate groundwater (Peal, et al., 2020). In the municipality, 13% of households have installed this type of containment.

Twin Pits: Ideally, twin pits consist of two properly constructed and well-maintained pits with semi-permeable, honeycombed lined walls and an open, permeable base designed for infiltration, ensuring structural integrity and preventing contamination. These pits effectively treat faecal sludge when there is no exfiltration of water. (Saxena & Den, 2022) The two sets of pits are used alternately to store blackwater, with one pit in use while the other undergoes natural decomposition. These pits are either dug or made by assembling precast concrete rings at a minimum horizontal distance of 1.2m. Both pits are connected through a diversion box. However, many twin pits installed by households do not adhere to the design. In the municipality, the minimum distance between two sets of pits is not maintained, and the connection pipes to the pits are in series. Consequently, these pits function only as pits with semi-permeable walls and open bottoms. 4% of the households have twin pits installed in their house.

Following are the two different pictures of twin pits with different design: one on left constructed according to the design, with a 1.2 metre distance, separate pipe connections connected through diversion box, and another picture of right side with pipes connected in series and no maintained distance, not adhering to design (Figure 5).

Figure 5: Picture illustrating the 2 different design of twin pits installed at the household level.

Single Pit: A properly constructed and well-maintained pit with semi-permeable, honeycombed lined walls and an open, permeable base facilitating infiltration (Susana, 2018). Unlike fully lined tanks, single pits lack a specifically designed outlet for effluent, allowing percolation into the soil. In the municipality, 59% of households have single pits (Figure 6).

Figure 6: Pictures of a single pit found in different households of the municipality.

According to the District Water Induced Disaster Prevention (DWIDP) the municipality is located in the floodplain of the Babai River which faces a high risk of floods and erosion during the monsoon. Communities in Gulariya Municipality often experience regular flooding and occasional extreme flood events, particularly notable in early 2015 (Anup Dahal, 2022). To mitigate flood risks, households in flood-prone areas have constructed raised concrete platforms, elevating the containment structures two to three feet (0.6 to 0.9 m) above ground level. The area is consistently inundated during the monsoon season, leading many households to raise the plinth level of their containments to prevent the inflow of surface runoff.

Figure 7 illustrates the plinth level raised on construction of toilets and containment.

Figure 7: Containments with plinth level raised

above ground to prevent inflow of runoff.

Figure 8 shows a map locating different types of containment in Gulariya Municipality.

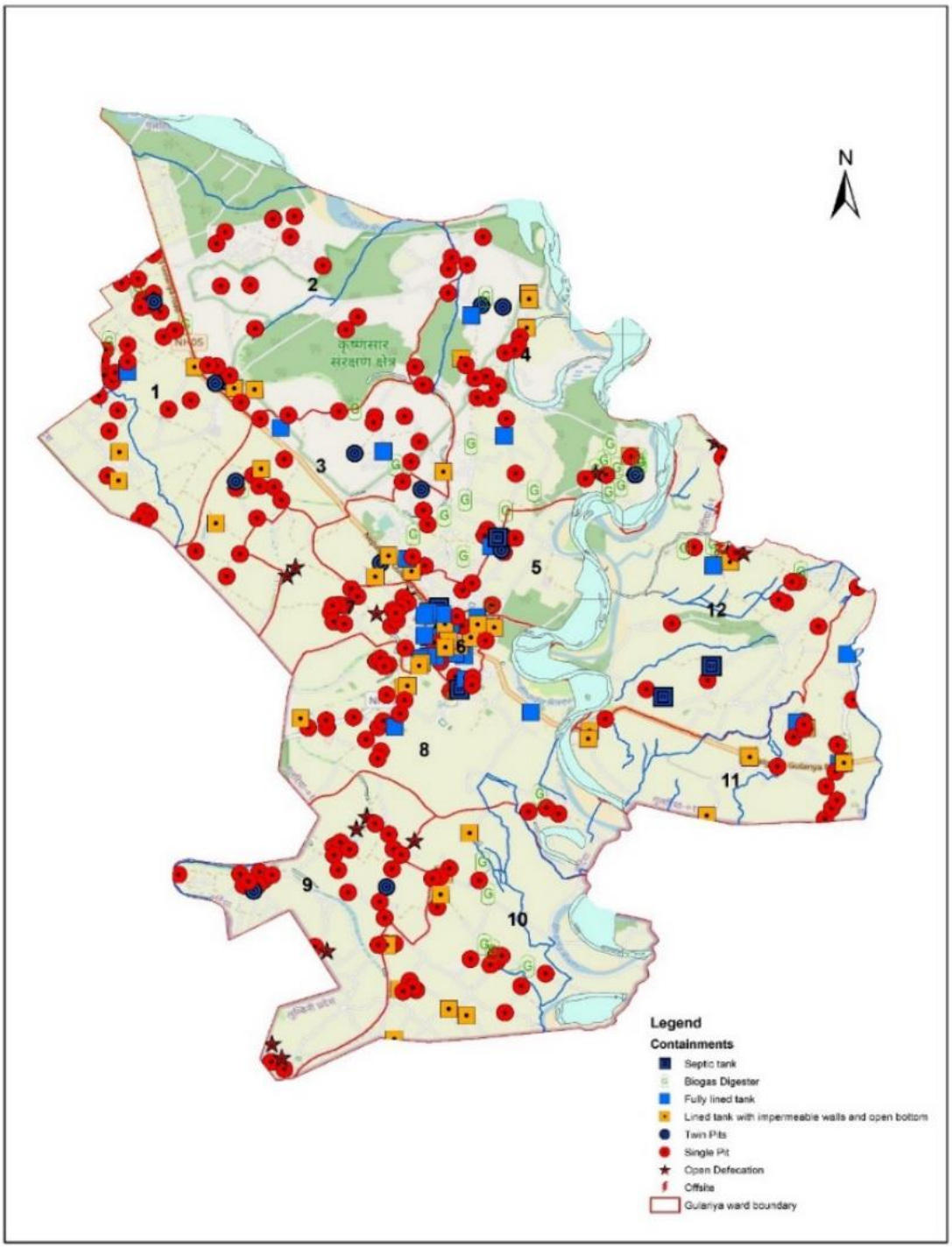

Figure 8: Map locating different types of containment in Gulariya Municipality.

2.1.2 Sanitation System in Institutional Buildings

All the surveyed 81 institutions had access to a safely managed sanitation system in the municipality. Different 34 educational institutes, 32 government and non-government offices, 14 health care centres and 1 hotel with lodging facility were surveyed.

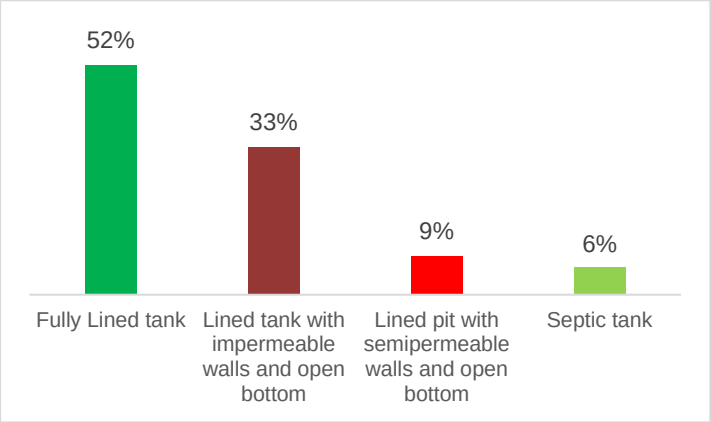

Figure 9: Containments used in institutional buildings.

The findings showed that 52% institutional buildings had made fully lined tanks, 33% had lined tanks with impermeable walls and open bottom, 9% had lined pits with semipermeable walls and open bottom and very minimal 6% had built septic tanks. The proportion of different types of sanitation technologies are showed in sampled institutions as shown in Figure 9.

2.1.3 Public Toilets

In total, there are 5 public toilets constructed in different areas where there is increased flow of people as Buspark, temple premises and Haatiya Bazaar.

Public Toilet in Temple Area

As per the nearby local people there are no any caretaker specified for the toilet and that particular toilet is mainly used by the visitors or devotees visiting the temple. The toilet has very simple physical infrastructure made of cement and brick and has one single squatting pan.

Following is the picture of the toilet inside the premises of one local temple in ward 1 (Figure 10).

Figure 10: Public toilet as seen in premises of local temple, ward 1.

Public Toilet in Haatiya Bazaar

There is one public toilet in ward 1 which is mainly used during Haatiya Bazaar when there is increased flow of people. Sadly, the toilet is not in fully functional stage and the cleanliness was totally neglected. There was no caretaker specified for maintain cleanliness and hygiene resulting in unsanitary condition of toilet. Following are some pictures demonstrating the situation of the toilet (Figure 11).

Figure 11: Public Toilet in ward 1.

Public toilet of Buspark Area, ward 6

The interview was performed with Abdum Sala, caretaker of the public toilet located in the Buspark area. The toilet was constructed with the help of ENPHO. There are separate compartments for male, female and third gender. However, the toilet is not disable friendly. Although the toilet had all the necessity amenities as hand wash basin, disposal bin, separate compartment for urination, pan and commode in each compartment, proper ventilation, light bulbs but the maintenance is totally not seen in the place. The physical status of the toilet was very poor. Only one male toilet is opened and others are being used for storage purpose and is not functional at the moment. Along with overseeing toilet there is one shop in the same toilet building used for haircutting purpose (Figure 12).

The groundwater is pumped through over-head tank and being supplied in toilet. The toilets are connected to a septic tank which is made outside of the building. On financial part, $0.03 (Rs.5) is collected for urination and $0.07 (Rs. 10) for defecation. There are no proper accounting records for the fee collected on a daily basis. The sanitary condition of the toilet is not that good and the service takers even complain about the unsanitary condition of toilet. According to Sala, customers are mainly those visiting shops for hair cutting purpose with very few other locals utilizing the toilet (KII-6, 2023).

Figure 12: Public toilet near Buspark Area.

2.1.4 Emptying and Transportation Services of Containment

Emptying of containment

Emptying is one of the major components of the sanitation service chain. Regular emptying of the containment prevents sludge overflow and blockages (Strande, 2014). It ensures the proper functioning of containment basically for the septic tank which functioned well until the volume of sludge is one-third of the total volume of the tank. Interestingly, of the total 96% of households with containment, 62% have emptied their containment due to faecal sludge overflow. Single offset pits and twin pits are emptied more frequently. Given the easier accessibility of concrete circular rings, more households install ring pits, leading to a higher rate of emptying compared to rectangular tanks (KII-2, 2023).

Surprisingly, data indicates that only 13% of the population opts for mechanical emptying despite municipality offering desludging service, while a significant 87% still relies on manual methods. One of the contributing factors for manual emptying is high cost associated with emptying containment through desludging vehicles and another is the use of faecal sludge as fertilizer and compost in farmland in an unsafely way (KII-2, 2023).

Transportation services

With the purchase of an exhauster truck, the municipality introduced a municipal Faeca Sludge Management (FSM) service, offering on-demand emptying services. It has initiated this service in 2072 BS (2016 AD). The desludging vehicle has a capacity of 5.000 litres (Figure 13). The average cost per trip varies based on the containment shape, charging a minimum of $2.99 (Rs. 400) per concrete ring and $26.20 (Rs. 3,500) per trip for rectangular tanks. Outside the municipality, on-demand services are provided at $52.39 (Rs. 7,000) per trip. The desludging team consists of a total of 4 staff, including the driver and helper. 1-2 trips are conducted weekly even in the off-season, increasing to 2-3 trips per day during the peak season. For usual emptying interval of ring tanks, the emptying frequency is every 6 months, and for holding tanks, it is on a yearly basis. The average number of trips per month is 10 (KII-2, 2023).

Figure 13: Municipal desludging vehicle for emptying of the containment in Gulariya Municipality.

2.1.5 Treatment and Disposal/Reuse of Faecal Sludge

An innovative faecal sludge treatment plant, located approximately 1 kilometre from Gulariya Municipality, has been constructed to treat waste and convert it into a saleable resource, specifically compost. This composting Faecal Sludge Treatment Plant (FSTP) is the first of its kind in Nepal, initiated by ENPHO in coordination with the municipality (Figure 14).

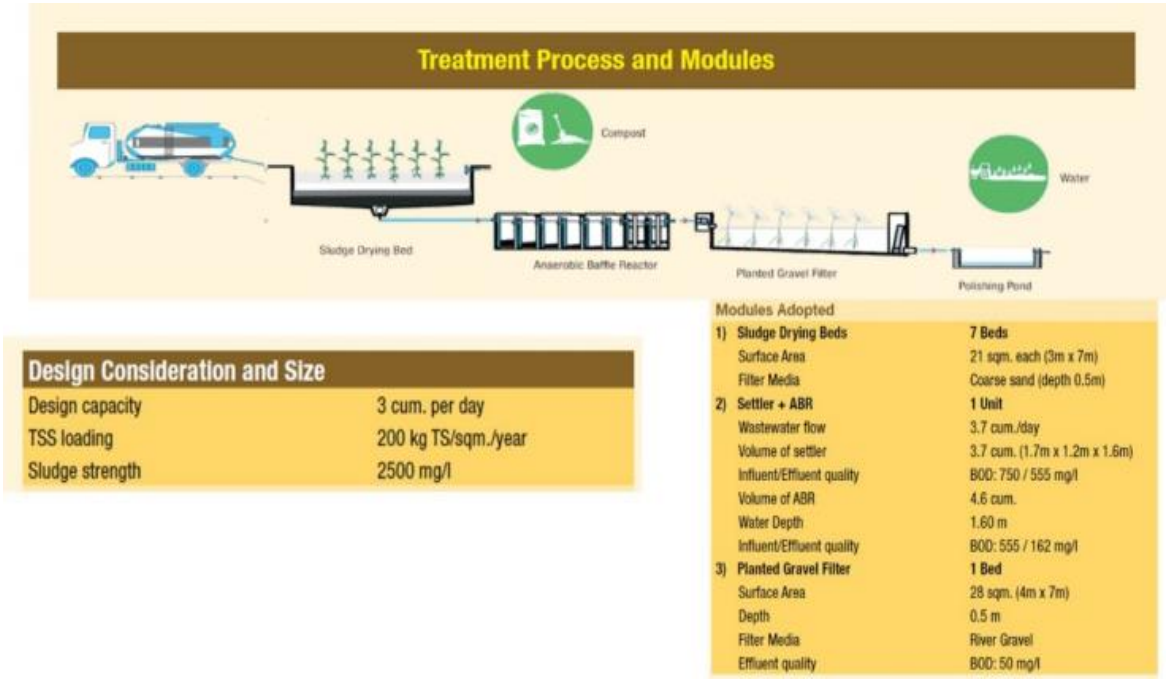

Figure 14: Treatment process and modules of Gulariya treatment plant. Source: (ENPHO, 2021).

The treatment plant has a design capacity of 3 cubic metres per day and comprises 1 unit of settler (volume: 3.7 m^3), an Anaerobic Baffler Reactor (ABR) (Volume: 4.6 m^3), 7 sludge drying beds (each with a surface area of 21 m^2 and coarse sand filter media at a depth of 0.5 m). Additionally, there is 1 planted gravel filter bed with a surface area of 28 m^2, using river gravel as filter media (Figure 15). The treated wastewater from the ABR undergoes further treatment in a constructed wetland with a horizontal flow bed planted with *Canna lily* and *Phragmites karka* (ENPHO, 2021).

Recently, 2 big biogas digesters has been added in support of Ministry of water supply, rural and urban development (KII-7, 2023). The municipality plans to operate the FSTP system alongside solid waste management (SWM) on the same premises, showcasing an integrated model for managing both solid and liquid waste. The premises have been developed as a solid and liquid waste management (SLWM) facility (KII-5, 2023).

Figure 15: Desludging faecal sludge at drying bed of treatment plant, Gulariya.

Despite the availability of municipal desludging services, manual emptying is still practised. Those who engage in manual emptying often directly apply faecal sludge to farms, using it as compost but considered as an unsafely managed disposal. Additionally, many individuals adopt the practice of digging new pits and dumping the old ones due to the availability of ample space.

The treatment plant also produces faecal manure, exemplifying the reuse of human waste for agricultural purposes (Figure 16). These manures are typically distributed to farmers for use in farmland. However, there is a prevailing stigma and hesitancy associated with using human waste in farmlands, impacting the proper marketing of such products in the market and acceptance among the people.

Figure 16: Manure made from human faecal sludge as seen in treatment plant.

2.1.6 Risk assessment of groundwater pollution from open bottom containment

The risk of groundwater pollution was assessed based on source of drinking water, secondary data on water quality and the depth and vulnerability of the aquifer with regards to lateral spacing between sanitation system and groundwater sources.

a. Sources of Drinking Water

As per the findings of this survey, 81.87% of households consume groundwater as main source of drinking water, 15.47% have private tap in their home and 0.27% rely on public taps. Likewise, 1.60% drinks jar water and 0.53% depends on tanker water for drinking purpose. Key informant interviews (KII-3, 2023; KII-4, 2023) findings indicate that Khairapur Water Sanitation Users Committee and Gulariya Water Sanitation Users Committee provide piped drinking water supply in wards 1, 6, 3, and 4. Khairapur Water Sanitation Users Committee distributes water to 450 households in the municipality, mainly from wards 1 and 2 (KII-3). Similarly, Gulariya Deshro Water Sanitation Users Committee supplies water to wards 3 and 4, covering 475 households (KII-4, 2023).

b. The vulnerability of the aquifer and lateral spacing between sanitation systems and groundwater source

The term aquifer pollution vulnerability is intended to represent the varying level of natural protection afforded by the contaminant attenuation capacity of the unsaturated zone or semi-confining beds above an aquifer, because of physicochemical processes (filtration,

biodegradation, hydrolysis, adsorption, neutralization, volatilization, and dispersion)—all of which vary with their texture, structure, clay content, organic matter, pH, redox and carbonate equilibria. Groundwater vulnerability is specific to containment type and pollution scenarios (Andreo, 2013). Here, among the various types of onsite sanitation technologies, lined tank with impermeable walls and open bottom and lined pits are more prone to contribute to aquifer pollution as the nature of such containments impose more containment load from the land surface to groundwater.

A key determinant of risk variation is the soil and geological setting. Especially for consolidated hard rock sediments with poor soil cover and shallow water tables, the risk is higher. According to World Health Organization (WHO) criteria, if the travel time of pollutant to groundwater source is less than 25 days, there is significant risk to contamination; low risk, if the travel time is between 25 and 50 days; and very low risk if the travel time is greater than 50 days (Krishnan, 2011). The size of pores in the soil determines the infiltration rate.

In the sandy loam soil, the permeability is approximately 2.5 cm per hour. Thus, between 25 and 50 days the pollutant could travel to the depth of approximately 30 metres (100 feet) in sandy loam soil. People using open bottom tanks and consuming water from the handpumps with the depth up to 100 feet (30.4 m) and horizontal distance of the pump within 25 feet (7.6 m) from the source of pollutants are assumed at significant risk to groundwater pollution.

Figure 17 illustrates the depth of hand pumps and their horizontal distance from lined pits with semi-permeable walls and an open bottom (twin pits and single offset pits). In total, 63% of households have installed lined pits with semi-permeable walls and an open bottom. Among these, 89% of households use groundwater as a source of drinking water, and it was found that 74% of these households are at high risk of groundwater contamination due to the water being pumped through hand pumps. Thus, the population with lined pits having semi-permeable walls and an open bottom, without outlet or overflow, and presenting a significant risk of groundwater pollution (T2A5C10) is 41% (calculated as 63% x 89% x 74% = 41%).

Figure 17: Depth of hand pumps and lateral spacing of it with containment types: lined pit with semi-permeable walls and open bottom.

Figure 18 illustrates the depth of hand pumps and their horizontal distance from lined tanks with impermeable walls and an open bottom. Specifically, 13% of households have installed lined tanks with impermeable walls and an open bottom, of which 77% rely on groundwater for drinking. Among these households, it was revealed that 49% are at a high risk of groundwater contamination due to the water pumped through hand pumps. Consequently, the population with lined tanks having impermeable walls and an open bottom without outlet or overflow and presenting a significant risk to groundwater pollution (T2A4C10) is 5% (calculated as 13% x 77% x 49% = 5%).

Figure 18: Depth of hand pumps and lateral spacing of it with containment types lined tank with impermeable walls and open bottom.

2.2 SFD Selection Grid

The SFD grid consist of different containment technology used in list A and its connection in list B. Sanitation technologies selected in the SFD grid in Gulariya Municipality are shown in Figure 19. The vertical column in the left side of the SFD selection grid has a list of technologies to which the toilet is connected to, and households without toilet resorting to open defecation. Similarly, horizontal row at the top of the selection grid shows options for connection made for the outlet or overflow of discharge from the toilet.

As per the containment definition by Shit Flow Diagram Promotive Initiative (SFD PI), various containments are categorized into different SFD categories. For example, biogas is reclassified as a fully lined tank, given that the walls and bottom of the biogas structure are water-sealed and share similar features with a fully lined tank. Similarly, single pits and twin pits, constructed by assembling pre-cast concrete rings on top of each other, are collectively referred to as lined pits with semipermeable walls and an open bottom. However, fully lined tanks and septic tanks do not require reclassification and remain unchanged. After the reclassification of these containments, the types of sanitation technologies and their connections are chosen in the SFD selection grid, as illustrated in Figure 19.

List A: Where does the toilet discharge to? (i.e. what type of containment technology, if any?)	List B: What is the containment technology connected to? (i.e. where does the outlet or overflow discharge to, if anything?)									
	to centralised combined sewer	to centralised foul/separate sewer	to decentralised combined sewer	to decentralised foul/separate sewer	to soakpit	to open drain or storm sewer	to water body	to open ground	to 'don't know where'	no outlet or overflow
No onsite container. Toilet discharges directly to destination given in List B					Significant risk of GW pollution Low risk of GW pollution	T1A1C6				Not Applicable
Septic tank					Significant risk of GW pollution T1A2C5					
Fully lined tank (sealed)					Significant risk of GW pollution Low risk of GW pollution					T1A3C10
Lined tank with impermeable walls and open bottom	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution			T1A4C8		T2A4C10 T1A4C10
Lined pit with semi-permeable walls and open bottom	Not Applicable									T2A5C10 T1A5C10
Unlined pit										Significant risk of GW pollution Low risk of GW pollution
Pit (all types), never emptied but abandoned when full and covered with soil										Significant risk of GW pollution Low risk of GW pollution
Pit (all types), never emptied, abandoned when full but NOT adequately covered with soil										
Toilet failed, damaged, collapsed or flooded										
Containment (septic tank or tank or pit latrine) failed, damaged, collapsed or flooded										
No toilet. Open defecation	Not Applicable							T1B11 C7 TO C9		Not Applicable

Figure 19: SFD selection grid for Gulariya Municipality.

A brief explanation of terms used to indicate different frames selected in the SFD selection grid is explained in Table 2.

Table 2: Explanation of terms used to indicate frame selected in the SFD selection grid.

T1A1C6	This is a fully functioning toilet discharging directly to an open drain or storm sewer. The excreta is raw, untreated and hazardous and since it discharges directly to an open drain or storm sewer, all the excreta in this system is considered not contained.
T1A2C5	This is a correctly designed, properly constructed, fully functioning septic tank with a supernatant/effluent outlet connected to a correctly designed, properly constructed, fully functioning soak pit. However, it's important to note that the supernatant/effluent flowing from the tank is only partially treated and remains hazardous, but since it is captured in the soak pit, all the excreta in this system is considered contained.
T1A3C10	A correctly designed, properly constructed, and well maintained fully lined tank with impermeable walls and base. Since the tank is not fitted with a supernatant/effluent overflow this system is considered contained.
T1A4C8	A correctly designed, properly constructed and well-maintained lined tank with sealed, impermeable walls and an open, permeable base, through which infiltration can occur. Since the tank is fitted with a supernatant/effluent overflow connected to open ground, the excreta in this system is considered not contained.
T2A4C10	A correctly designed, properly constructed and well-maintained lined tank with sealed, impermeable walls and an open, permeable base, through which infiltration can occur - the excreta is therefore likely to be partially treated. The tank is not fitted with a supernatant/effluent overflow but since there is a 'significant risk' of groundwater pollution this system is considered not contained.

T1A4C10	A correctly designed, properly constructed and well-maintained lined tank with sealed, impermeable walls and an open, permeable base, through which infiltration can occur. However, since the tank is not fitted with a supernatant/effluent overflow this system is considered contained.
T1A5C10	A correctly designed, properly constructed and well-maintained pit with semi-permeable, honeycombed lined walls and an open, permeable base, through which infiltration can occur. The tank is not fitted with a supernatant/effluent overflow, so this system is considered contained.
T2A5C10	A correctly designed, properly constructed and well-maintained pit with semi-permeable, honeycombed lined walls and an open, permeable base, through which infiltration can occur. The tank is not fitted with a supernatant/effluent overflow but since there is a 'significant risk' of groundwater pollution this system is considered not contained.
T1B11C7 to C9	With no toilet, users defecate in water bodies, on open ground and to don't know where; consequently, the excreta is not contained.

2.3 SFD matrix

2.3.1 Proportion of Faecal Sludge from types of sanitation technologies

In the second step of developing an SFD graphic, the proportion of Faecal Sludge (FS) in each type of sanitation technology is calculated. Following detailed instructions in SFD PI, a default "100%" value is applied when onsite containers are connected to soak pits, water bodies, or open ground, representing the entire contents as faecal sludge, with a portion being periodically emptied.

For onsite containers connected to a sewer network or open drains, a "50%" value is used, indicating that half the contents are modelled as faecal sludge, with periodic emptying. The remaining fraction contains faecal sludge in the container and infiltrate (for open-bottomed tanks), while the other half is modelled as supernatant discharging into the sewer network or open drains. The formula for calculating FS proportion is provided below:

$$\frac{(Onsite\ container\ connected\ to\ soak\ pit, no\ outlet, water\ bodies\ or\ open\ ground) * 100 + (Onsite\ container\ connected\ to\ sewer\ network\ or\ open\ drain) * 50}{Onsite\ Container}$$

The calculated FS proportion in each type of sanitation technologies are:

i. The proportion of FS in septic tanks is 100% as the effluent is connected to soak pit.

ii. The proportion of FS in fully lined tanks is calculated as 100% as there are no connections made to an open drain, the tank maintains a 100% FS proportion.

iii. The FS proportion from lined tanks with open bottoms and all types of pits is 100%, as there are no connections of lined tanks with impermeable walls and open bottoms to open drains.

After determining the proportion of FS in each type of sanitation technology, the corresponding population proportions from the selected technologies in the SFD selection grid are set. Figure 20 illustrates the SFD matrix of the municipality.

Gulariya Municipality, Lumbini, Nepal, 8 Aug 2023. SFD Level: 2 - Intermediate SFD
Population: 74505
Proportion of tanks: septic tanks: 100%, fully lined tanks: 100%, lined, open bottom tanks: 100%

Containment						
System type	Population	WW transport	WW treatment	FS emptying	FS transport	FS treatment
	Pop	W4c	W5c	F3	F4	F5
System label and description	Proportion of population using this type of system (p)	Proportion of wastewater in open sewer or storm drain system, which is delivered to treatment plants	Proportion of wastewater delivered to treatment plants, which is treated	Proportion of this type of system from which faecal sludge is emptied	Proportion of faecal sludge emptied, which is delivered to treatment plants	Proportion of faecal sludge delivered to treatment plants, which is treated
T1A1C6 Toilet discharges directly to open drain or storm sewer	1.0	0.0	0.0			
T1A2C5 Septic tank connected to soak pit	1.0			32.0	100.0	95.0
T1A3C10 Fully lined tank (sealed), no outlet or overflow	18.0			53.0	100.0	95.0
T1A4C10 Lined tank with impermeable walls and open bottom, no outlet or overflow	7.0			19.0	33.0	95.0
T1A4C8 Lined tank with impermeable walls and open bottom, connected to open ground	1.0			32.0	100.0	95.0
T1A5C10 Lined pit with semi-permeable walls and open bottom, no outlet or overflow	22.0			51.0	0.0	0.0
T1B11 C7 TO C9 Open defecation	4.0					
T2A4C10 Lined tank with impermeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	5.0			38.0	38.0	95.0
T2A5C10 Lined pit with semi-permeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	41.0			62.0	6.0	95.0

Figure 20: SFD Matrix of Gulariya Municipality.

2.3.2 Proportion of Faecal Sludge Emptied (F3)

The column labelled "Population (Pop)" in Figure 20 displays the proportion of contents for each type of onsite container (septic tanks, fully lined tanks (sealed), lined tanks with impermeable walls and open bottom, and lined pits with impermeable walls and open bottom). The variable F3 represents the proportion of contents in each type of onsite container that undergo at least one emptying after construction. The calculation of the proportion of faecal sludge emptied (F3) is based on the percentage of containment emptied (ENPHO, 2023) and the amount of faecal sludge (FS) emptied during the process (KII-2, 2023).

According to findings from household surveys and Key Informant Interviews (KII-2, 2023), approximately 80% of the FS in the containment is emptied. This is attributed to most containments getting filled due to groundwater intrusion, resulting in a high liquid content that can be easily pumped out by desludging vehicles. However, an average of 20% of the FS in the containment, characterized by high thickness and poor water solubility, remains un-removed during emptying, as reported from KII-2 with desludger information. The calculation of the emptied proportion of FS is adjusted accordingly as follows (Table 3).

$$Actual\ Proportion\ of\ FS\ emptied\ (F3) = percentage\ of\ containment\ emptied \times proportion\ of\ FS\ removed\ during\ emptying$$

Table 3: Sanitation technologies and proportion of emptied faecal sludge (ENPHO, 2023[(1)]; KII-2, 2023[(2)]).

SN	Sanitation Technologies	SFD Reference Variable	Percentage of Emptied Containment (1)	Emptied Proportion of FS during emptying (2)	Actual Proportion of Emptied FS (F3)
1	Septic tank connected to soakpit (Low Risk)	T1A2C5	40%	80%	32%
2	Fully lined tank (sealed), no outlet or overflow	T1A3C10	66%	80%	53%
3	Lined tank with impermeable walls and open bottom, no outlet or overflow (High Risk)	T2A4C10	47%	80%	38%
4	Lined tank with impermeable walls and open bottom, no outlet or overflow	T1A4C10	24%	80%	19%
5	Lined tank with impermeable walls and open bottom, connected to an open ground	T1A4C8	40%	80%	32%
6	Lined pit with semi-permeable walls and open bottom, no outlet or overflow	T1A5C10	64%	80%	51%
7	Lined pit with semi-permeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution(High Risk)	T2A5C10	77%	80%	62%

2.3.3 Proportion of FS emptied which is delivered to Treatment Plant (F4 and F5)

The municipality operates a treatment plant for faecal sludge treatment. Operational biogas systems are classified as treated (F5), and other emptied containments transported through mechanical desludging are treated in the designated facility. In the provided SFD matrix, 18% of fully lined tanks, including 10% with functioning household biogas digesters, are considered treated (F4=100%) with 95% efficiency (F5=95%). Similarly, sludge transported to the treatment plant is not considered 100% treated; instead, it is recognized as 95% treated based on on-site observations and Key Informant Interviews (KIIs) with the treatment plant operator (KII-7, 2023).

2.3.4 Proportion of Wastewater Delivered to Treatment Plant (W4a and W5c)

All wastewater from the toilets discharging directly to open drain or storm sewer is disposed of untreated in the environment.

2.4 Summary of Assumptions

Offsite sanitation Systems:

- ✓ 1% of the households depends on offsite sanitation systems as they have connected toilets directly with sewer network. All wastewater (system T1A1C6) is disposed of untreated in the environment and hence values for variables W4c and W5c are both set to 0%.

Onsite Sanitation Systems:

- ✓ The proportion of FS in septic tanks was set to 100%, the proportion of FS in fully lined tanks was set to 100% and the proportion of FS in lined tanks with impermeable walls and open bottom and all types of pits was set to 100% according to the relative proportions of the systems, as per the guidance provided by SuSanA.
- ✓ Variables F3, F4 and F5 for all onsite sanitation systems were derived from the household survey and cross-checked with KIIs conducted.
- ✓ 100% of the emptied FS from septic tanks connected to soak pits (system T1A2C5) is delivered to treatment and treated in the FSTP (F4 = 100% and F5 = 95%).
- ✓ 100% of the emptied FS from lined tanks with impermeable walls and open bottom, connected to open ground (system T1A4C8) is delivered to treatment and treated in the FSTP (F4 = 100% and F5 = 95%).
- ✓ 33% of the emptied FS from lined tanks with impermeable walls and open bottom, no outlet or overflow (system T1A4C10) is delivered to treatment and treated in the FSTP (F4 = 33% and F5 = 95%).
- ✓ 38% of the emptied FS from lined tanks with impermeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution (system T2A4C10) is delivered to treatment and treated in the FSTP (F4 = 38% and F5 = 95%).
- ✓ 6% of the emptied FS from lined pits with semi-permeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution (system T2A5C10) is delivered to treatment and treated in the FSTP (F4 = 6% and F5 = 95%).

- ✓ 0% of the emptied FS from lined pits with semi-permeable walls and open bottom, no outlet or overflow (system T1A5C10) is delivered to treatment (F4 = 0% and F5 = 0%).

2.5 SFD Graphic

Figure 21 presents diagrammatic representations of the excreta flow within Gulariya Municipality. The color scheme signifies the nature of sanitation systems, with green indicating safely managed systems and red denoting unsafely managed ones. The diagram reveals that FS generated from 38% of the population is safely managed, represented by "Green" arrowheads, indicating FS stored in containment without significant risk to groundwater. Conversely, FS from 62% of the population is unmanaged, represented by "Red" arrowheads. This signifies uncontained FS and openly dumped FS emptied from the containments, both considered unsafe. The SFD diagram illustrates four different factors across the sanitation value chain, arranged from left to right.

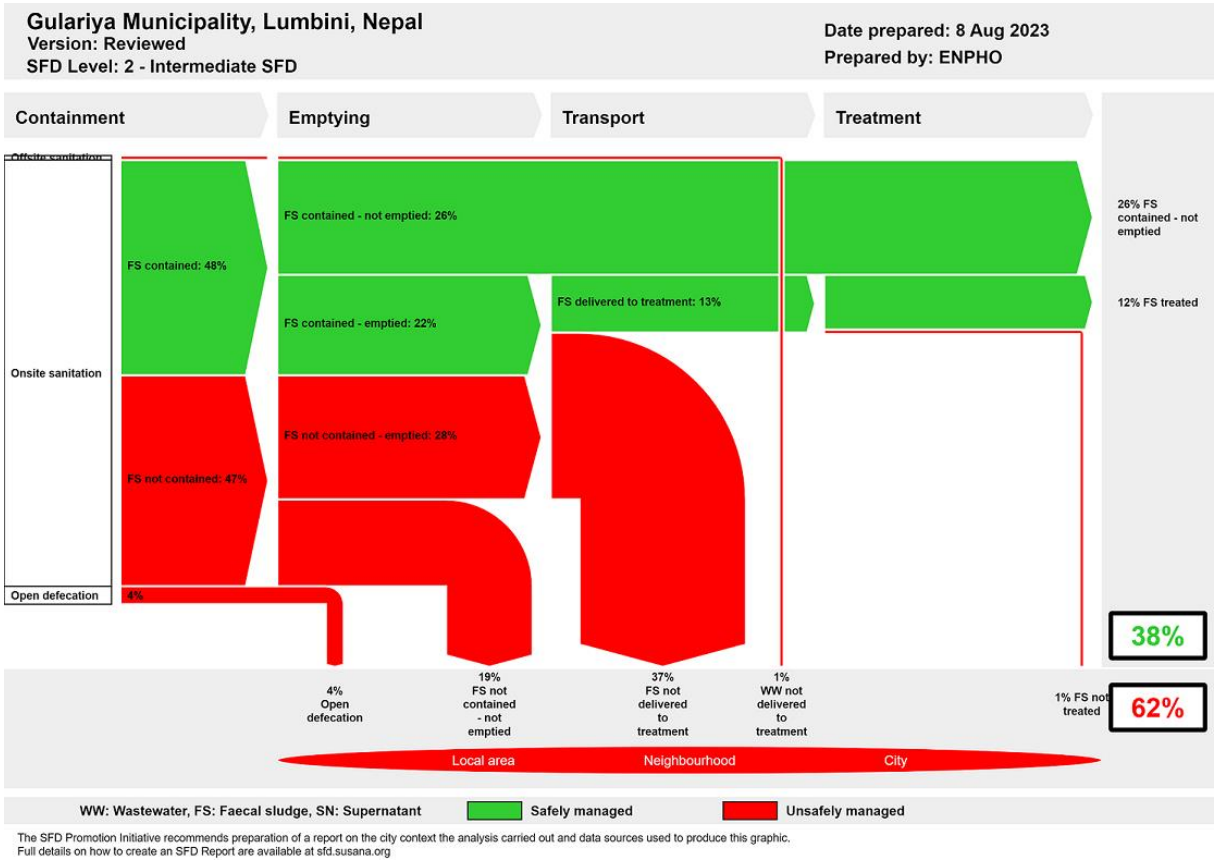

Figure 21: SFD Graphic of Gulariya Municipality.

2.5.1 Offsite Sanitation

Gulariya Municipality lacks a sewer network; however, 1% of households have offsite sanitation systems illicitly connected to stormwater drains. The wastewater produced by these

households is directly discharged untreated into open drains or storm sewers, resulting in the unsafe management of wastewater for this 1% of the population.

Wastewater not delivered to treatment

The wastewater (WW) is obtained from containments connected to stormwater sewer. The total proportion of waste water directly connected to open stormwater drain is 1% of exceta generated by the total population. Since the municipality lacks proper sewer network and wastewater is disposed illegally, the proportion of WW is not delivered to treatment is 1%.

2.5.2 Onsite Sanitation

The 95% of the population in Gulariya Municipality utilizes onsite sanitation technologies. Among them, FS from 48% of the population is appropriately stored in technically effective containment, as depicted by "FS contained" in the SFD graphic. FS from the remaining 47% of the population is stored in unsafe containment, represented as "FS not contained."

FS contained

The term 'FS contained' refers to faecal sludge within an onsite sanitation technology that ensures a safe level of protection from excreta, limiting pathogen transmission to the user or the general public. These containment systems, such as tanks or pits, are correctly designed, properly constructed, fully functioning, and pose little to no risk of polluting groundwater used for drinking (Susana, 2018). FS generated by 48% of the population is contained.

The value of FS contained (48%) is derived from the summation of the percentage of the population using the following containment systems: septic tank connected to soak pit with 'low risk' to groundwater pollution (T1A2C5), fully lined tank without outlet or overflow (T1A3C10), lined tank with impermeable walls and open bottom without outlet or overflow (T1A4C10), and lined pit with semi-permeable walls and open bottom without outlet or overflow (T1A5C10).

FS not Contained

The term 'FS not contained' refers to faecal sludge within an onsite sanitation technology that does not ensure a safe level of protection from excreta, with a likely risk of pathogen transmission. These containment systems, such as tanks or pits, are incorrectly designed, poorly constructed, poorly functioning, and/or pose a 'significant' risk of polluting groundwater used for drinking (Susana, 2018). FS generated by 47% of the population is not contained.

The value of FS not contained (47%) is obtained from the summation of the percentage of the population using the following containment systems: lined tank with impermeable walls and open bottom without outlet (T2A4C10) and open ground (T1A4C8). Additionally, the FS collected in lined pits with semi-permeable walls and open bottoms, without outlet or overflow, poses a 'significant risk' to groundwater pollution (T2A5C10).

FS contained - not Emptied

It is faecal sludge that is contained within an onsite sanitation technology but not removed may persist within the container or infiltrate into the ground, depending on the type of sanitation technology in use (Susana, 2018). The value of 26% is obtained from the proportion of the

population using sanitation systems where the FS is contained and have not emptied their containment. However, this 26% of safely managed FS should be considered as only temporary, as most of the pits and tanks have not yet filled up and the FS generated remains 'not emptied'. Therefore, these systems will require emptying services in the short and medium term as they fill up.

FS contained - Emptied

It is faecal sludge which is removed from an onsite sanitation technology where it is contained and can be emptied, utilizing either mechanical or manual emptying equipment. The value of 22% is obtained from the proportion of population using sanitation systems where the FS is contained and have emptied their containment.

FS not contained - Emptied

In this faecal sludge is removed from an onsite sanitation technology where it is not contained and can be emptied, utilizing either mechanical or manual emptying equipment. The value of 28% is obtained from the proportion of the population using sanitation systems where the FS is not contained and have emptied their containment.

FS not contained - not Emptied

It is faecal sludge that is not contained within an onsite sanitation technology and not removed. It may persist within the container or infiltrate into the ground, depending on the type of sanitation technology in use. The value of 19% is obtained from the proportion of the population using sanitation systems where the FS is not contained and not emptied.

FS not delivered to treatment

The proportion of FS not delivered to treatment, i.e. 37%, is the summation of FS contained - emptied and FS not contained - emptied. Although there is a FSTP, there is still practice of manual emptying and those who manually emptied their containment , such FS are not delivered to treatment plant. The emptied FS is disposed of untreated to farmlands. Therefore, this proportion of disposed FS possesses risk to local area and neighbourhood.

FS delivered to treatment

The proportion of FS delivered to treatment is 13% which comes from the FS contained - emptied. The FS which is transported via mechanical desludging is taken to treatment plant.

2.5.3 Open Defecation

It is a situation where no toilet is in use, and people resort to open defecation in fields, forests, bushes, bodies of water, or other open spaces. Despite municipality having ODF status, 4% of population still defecate openly. Mostly, the households living in poverty and those who do not own land do not have toilets.

3 Service delivery context description

3.1 Policy, legislation, and regulation

The constitution of Nepal 2015 has established right to access to clean drinking water and citizen as fundamental right. In Article 35 (4) related to right to health recognizes citizen's rights to access to clean drinking water and sanitation. In addition, Right to Clean Environment, Article 30 (1) recognizes that every person shall have the right to live in a healthy and clean environment (GoN, 2015). To respect and promote the right of citizens to wards accessing clean drinking water and sanitation services, the government has promulgated and amended necessary laws. The most relevant legislation for promotion of safe sanitation services is discussed here.

Local Government Operation Act, 2017

Local Governance Operation Act 2017 has promulgated to implement the rights of local government and promote co-operation, co-existence, and co-ordination among federal, provincial, and local government. The act defined roles and responsibility of municipalities along with provision and procedure for approving laws and regulations at local level. Regarding the management of sanitation, the act entitles local government to conduct awareness campaigns, design and implement sanitation programs at the local level.

Environment Protection Act, 2019

Environment protection act 2019 is promulgated to prevent and control pollution from different development activities. It defines "Pollution" as the activities that significantly degrade, damage the environment, or harm the beneficial or useful purpose of the environment, by changing the environment directly or indirectly because of wastes, chemical, heat, noise, electrical, electro-magnetic wave, or radioactive ray. It provides the mechanism for appointing environmental inspector to control pollution by federal, provincial, and local government.

Water Supply and Sanitation Act, 2022

The act was promulgated to ensure the fundamental right of citizen to easy access on clean and quality drinking water, sanitation services and management of sewerage and wastewater. It defines sewerage and wastewater management as construction of sewer networks and treatment plants to preserve sources of water. It has entitled federal, provincial, and local level for the operation and management of water and sanitation services. The act also explicitly defines the responsibility of every citizen to preserve, conserve and maintain the sources of water and use responsibly.

Environment Friendly Local Governance Framework 2013

The environment-friendly local governance framework 2013 has been issued to add value to environment-friendly local development concept encouraging environmental protection through local bodies. The framework has set basic and advanced indicators for households, settlement, ward, village, municipality, and district levels for declaration of environment friendly. The use of water sealed toilets in households as basic indicators for sanitation and health. Provision of toilet with safety tank and use as advanced indicators for sanitation. Provision of gender, children and disabled friendly public toilets in parks, petrol pumps and main market as basic indicator for municipal level. Advance indicators such as drainage discharged only after being processed through biological or engineering technique. While it has failed to identify the necessity of faecal sludge treatment plants as it has assumed safety tank in the households is sufficient for treating faecal sludge.

Institutional and Regulatory Framework for Faecal Sludge Management, 2017

Ministry of Water Supply through its Department of Water Supply and Sewerage Management (DWSSM) articulated and endorsed Institutional and Regulatory Framework (IRF) for Faecal Sludge Management in Urban Areas of Nepal in 2017. The main objective of the IRF is to define the specific roles and responsibilities of key institutions for the effective management and regulation of FSM. The framework primarily envisioned featuring FSM in the national policy and issuing policy directives into local government to incorporate FSM in their urban planning along with strengthening and enhancing the capacity of the local government to deliver effective services. A local government has been endowed with overall responsibility to plan, implement, and regulate the FSM services within its jurisdiction. The provision of the ability to engage the private sector and other relevant stakeholders such as the Water and Sanitation Users Committee (WSUC) in the framework reflects a participatory approach that would help in sustaining the interventions.

Total Sanitation Guideline, 2017

Total Sanitation Guideline was promulgated by the Ministry of Water Supply in April 2017 after the successful implementation of National Sanitation and Hygiene master Plan (NSHMP) 2011. It provides guidelines for sustaining ODF outcomes and initiating post-ODF activities through an integrated water, sanitation and hygiene plan at municipalities and districts. The guideline redefined sanitation as management of services and facilities to safely dispose of/reuse faecal sludge, collection and treatment of solid waste and wastewater to establish a hygienic environment and promote public health. Indicators are set to guide total sanitation movement with an arrangement for resource management, monitoring and evaluation, capacity building.

3.1.1. Policy

Historically, the National Sanitation Policy (1994) was the guideline for the planning and implementation of sanitation programs. The policy had promoted sanitation issues together with issues on water supply in rural communities. Also, Rural Water Supply and Sanitation National Policy (RWSSNP) 2004, has set a new target to provide safe, reliable, and affordable water supply with basic sanitation facilities. The policy focused on delivering quality services on water and sanitation to the marginalized and vulnerable groups. Participatory approach, community leadership project development, optimization of local resources and installation of locally appropriate technologies were major principles in the policy. (DWSSM, 2004) However, it was unable to address the complex operational issue of urban water supply and sanitation service delivery. (DWSSM, 2009) Thus, the National Urban Water Supply and Sanitation Sector Policy (NUWSSSP) was formulated and enforced in 2009. It focused on achieving coherent, consistent, and uniform approaches of development in urban areas with the involvement of different agencies and institutions. Both these policies were limited to addressing emerging issues and challenges in the rural and urban areas. Thus, the National Water Supply and Sanitation Policy (NWSSP) was formulated in 2014 by GON to address the emerging challenges and issues with the adoption of new approaches and resolve the inconsistency in RWSSNP and NUWSSSP.

The goal of the NWSSP was to reduce urban and rural poverty by ensuring equitable socio - economic development, improving health and the quality of life of the people and protection of

environment through the provision of sustainable water supply and sanitation services. It adopted innovative technologies and knowledge emerged in the sector. Remarkably, it was the first official document that recognized discharge of untreated wastewater and dumping of septic sludge heavily polluted the surface water sources in urban areas.

Nepal is a signatory of the historical resolution of 2010 United Nations General Assembly on the Human Right to Water and Sanitation. Nepal committed to Millennium Development Goals (MDGs) for 2000- 2015 The goal was accomplished through declaration of the country as free from open defecation on 30th September 2019. National Sanitation and Hygiene Master Plan, 2011 was developed for coordinated planning and implementation of National Sanitation Campaign. The campaign strengthened institutional setup tier of government in a participatory approach. In an alignment total sanitation campaign was initiated formally to sustain ODF. The guideline set various indicators to assess the sustainability of sanitation services. Remarkably, it extended sanitation definition as management of services and facilities to safely dispose of/reuse faecal sludge, collection and treatment of solid waste and wastewater to establish the hygienic environment and promote public health. (NPC, 2017)

Similarly, Nepal Water Supply, Sanitation and Hygiene Sector Development Plan (SDP 2016-2030) was formulated in 2016 for sector convergence, institutional and legal reforms, capacity development and establishing coordination and harmonization in the sector. The SDP classified service system and delineated roles and responsibilities for effective and sustainable service delivery. The SDP highlighted that majority of households rely on onsite sanitation system (70%) that requires effective treatment of faecal sludge. However, there is lack of concrete policies, guidelines, and indicators on faecal sludge management in the sector for effective planning, implementation, and service delivery. Nepal was declared ODF nation on September 23, 2019 (MoWS, 2017) however, the target of 90% households with toilets connected to sewer system or proper FSM is yet to be achieved.

There has been no specific policy made on sanitation and faecal sludge management.

3.1.2. Institutional roles

Federal, provincial, and local government are entitled for implementation of water and sanitation programs to ensure the rights on access to safe water and sanitation.

At Federal Government

National Planning Commission: At the federal government, the National Planning Commission is the specialized and apex advisory body for formulating a national vision, developing policy, periodic plans, and sectoral policies. The NPC assesses resource needs, identifies sources of funding, and allocates budget. It serves as a central agency for monitoring and evaluating development policy, plans and programs. It supports, facilitates, and coordinates with federal, provincial, and local government for developing policy plans and implementation.

Ministry of Water Supply: Ministry of Water Supply is the lead ministry responsible for planning, implementation, regulation, and monitoring and evaluation of sanitation programs in the country (GoN, 2015). Under the MoWS, Department of Water Supply and Sewerage Management (DWSSM) plan and implement water and sanitation projects funded by foreign donors or inter provincial projects or serves at least 15,000, 5,000 and 1,000 people in terai,

hilly and mountain region respectively (GoN, 2015). The organizational structure of DWSSM is shown in Figure 22.

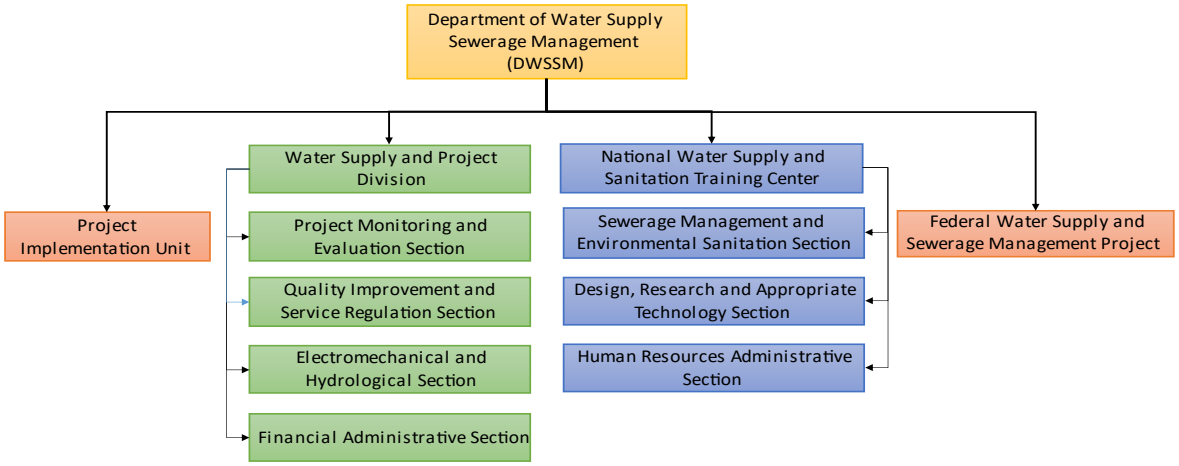

Figure 22: Organizational Structure Department of Water Supply and Sewerage Management (DWSSM).

At Provincial Government

Ministry of Physical Infrastructure: Ministry of water supply and Urban development of provincial government in Lumbini province is major executing body for planning, developing, and implementing water supply and sanitation programs. Planning and implementation of water supply and sanitation infrastructure in the province is executed through Water supply and Sanitation Divisional Office (WSSDO). WSSDO implements the water and sanitation programs meeting the following criteria:

i. Inter local government projects.

ii. Beneficiaries between 5,000 to 15,000 in terai region, 3,000 to 5,000 in hilly region and 500 to 1,000 in Himalayan region.

At Local Government

Municipal council: Figure 23 shows the organography of the municipality. There is no specific sanitation section. However, the sanitation related works come under the Infrastructure Environment and disaster Management Section.

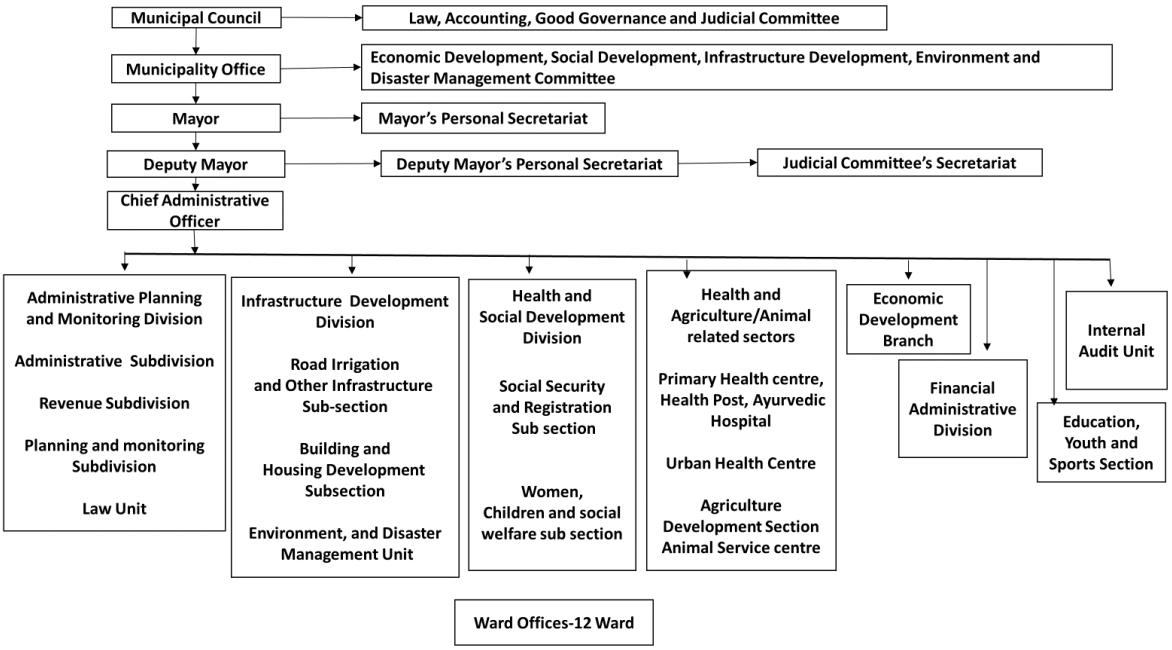

Figure 23: Organogram of Gulariya Municipality.

3.1.3. Service provision

Urban Water Supply and Sanitation Policy 2009 has emphasized the Public-Private Partnership (PPP) in water supply and sanitation to improve service delivery (MoPIT, 2009). Also, the Public-Private Partnership Policy, 2015 encourages private sector investment in the development and operation of public infrastructure services for comprehensive socioeconomic development. The policy has aimed to remedy challenges such as structuring of projects, land acquisition, coordination and approval, payments to private sectors and approval for environment impact (MoF, 2015).

The municipality has earmarked a budget for waste management and sanitation. Furthermore, the municipality is actively involved in providing desludging services, utilizing municipal vehicles to transport sludge to the treatment plant in Gulariya. Additionally, there are plans to implement a Faecal Sludge Treatment Plant (FSTP) system alongside solid waste management (SWM) on the same premises, presenting an integrated model for managing both solid and liquid waste. The premises have been developed as a solid and liquid waste management (SLWM) facility (KII-5, 2023).

3.1.4. Service standards

The sanitation service standards have set by Nepal Water Supply, Sanitation and Hygiene Sector Development Plan (2016-2030). It classifies sanitation services as high, medium, and basic based on sanitation facilities in place. The sanitation service levels with indicators are shown in Table 4. However, FSM specific standards have yet to be developed and implemented.

Table 4: Sanitation Service Level and its Components.

S.N.	Service Components	Service Level		
		High	Medium	Basic
1	Health and Hygiene Education	✓	✓	✓
2	Household Latrine	✓	✓	✓
3	Public and School Toilets	✓	✓	✓
4	Septic tank sludge collection, transport, treatment, and disposal	✓	✓	✓
5	Surface drains for collection, transmission, and disposal of grey water	✓	✓	✓
6	Small-bore sewer collection for toilet and septic tank effluent, low-cost treatment, and disposal		✓	
7	Sanitary sewers for wastewater collection, transmission, non-conventional treatment, and disposal	✓		
8	Sanitary sewers for wastewater collection, the transmission of conventional treatment and disposal	✓		
9	Limited solid waste collection and safe disposal	✓	✓	✓

4 Stakeholder Engagement

4.1 Key Informant Interviews (KIIs)

During the study, Key Informant Interviews (KIIs) were conducted to gather insights from key stakeholders working in the sanitation sector of Gulariya Municipality. The objective was to obtain a comprehensive understanding of current sanitation service practices. Mr. Muktinath Yadav, Mayor of Gulariya municipality, was interviewed specifically regarding sanitation service practices, covering technical, institutional, and financial aspects. Additional interviews were conducted with Mr. Ramprasad Chaudhary, Chairperson of Khairapur Water Sanitation Users Committee, and Ms. Sushma Rana of Gulariya Deshra Water Sanitation Users Committee.

Furthermore, Mr. Shahadev Yadav, the driver of the municipal desludging vehicle, was interviewed to gain insights into faecal sludge (FS) emptying and disposal practices. The discussion covered topics such as types of containments, containment volumes, and the frequency of emptying. Similarly, caretakers from public toilets were interviewed to understand the status of public toilets in the municipality (Table 5).

Table 5: List of Key Informant Interviewed personnel.

S.N.	Name	Designation	Organization/ Company	Purpose of KII	Date
1.	Muktinath Yadav (KII-1)	Mayor	Gulariya Municipality	Sanitation status, Ongoing projects on Sanitation, Policies and plan for Sanitation development	14th May 2023
2.	Shahadev Yadav (KII-2)	Driver	Gulariya Municipality	Emptying practices, finances, requirement, disposal and treatment	14th May 2023
3.	Ram prasad Chaudhary (KII-3)	Chairperson	Khairapur WSUC	Water supply services	13th May 2023
4.	Susma Rana (KII-4)	Staff	Gulariya Deshra WSUC	Water Supply Services	14th May 2023
5.	Mukunda Aryal (KII-5)	Acting Chief Administrative Officer	Gulariya Municipality	Sanitation status, Ongoing projects on Sanitation, Policies and plan for Sanitation development	15th May 2023
6.	Abdum Sala (KII-6)	Caretaker	Public toilet, Gulariya	Sanitation status of toilet	14th May 2023
7.	Hari Ram Bhorji (KII-7)	Managemnet Chairperson	Gulariya Treatment Plant	Functioning status and details of treatment plant	14th May 2023

4.2 Household Survey

Household survey was conducted in all wards of the municipality through mobilization of local enumerators selected by the municipality. The enumerators were given two days orientation about sanitation and methods for conducting the household survey. The household survey was conducted using the mobile application "KOBOCOLLECT" after orientation. SFD team member went on field visits in households to encourage enumerators and observe household sanitation status. Mr. Muktinath Yadav, the mayor of the municipality, provided encouragement and motivated the enumerators before the survey. The pictures below depict the enumerators practising Kobotoolbox for data collection and a group photo featuring the SFD team members along with the enumerators (Figure 24).

Figure 24: Glimpses of SFD orientation to enumerators in municipal hall.

4.2.1 Determining Sample Size

The number of households to be sampled in the municipality was determined by using Cochran (1963:75) sample size formula $no = \frac{z2pq}{e2}$ and its finite population correction for the proportion $n = n_o/(1 + (n_o-1)/N)$.

Where,

Z	1.96	At the confidence level of 95%
p	0.5	Assuming that about 50% of the population should have some sanitation characteristics that need to be studied (this was set at 50% since this percentage would yield the maximum sample size as the percentage of the population practising some form of sanitation is not known at the intervention sites).
q	1-p	
e	+/-5%	Level of precision or sampling error.
N		A total number of population (households in the municipality).

This is followed by proportionate stratification random sampling such that each ward in the municipality is considered as one stratum. The sample sized required in each ward is calculated as $n_h = (N_h/N)*n$, where N_h is a total population in each stratum. Thus, a total of 375 households were sampled from 16,002 households distributed in 12 wards with proportionate stratification random sampling. The household samples surveyed in the municipality is shown in Figure 25.

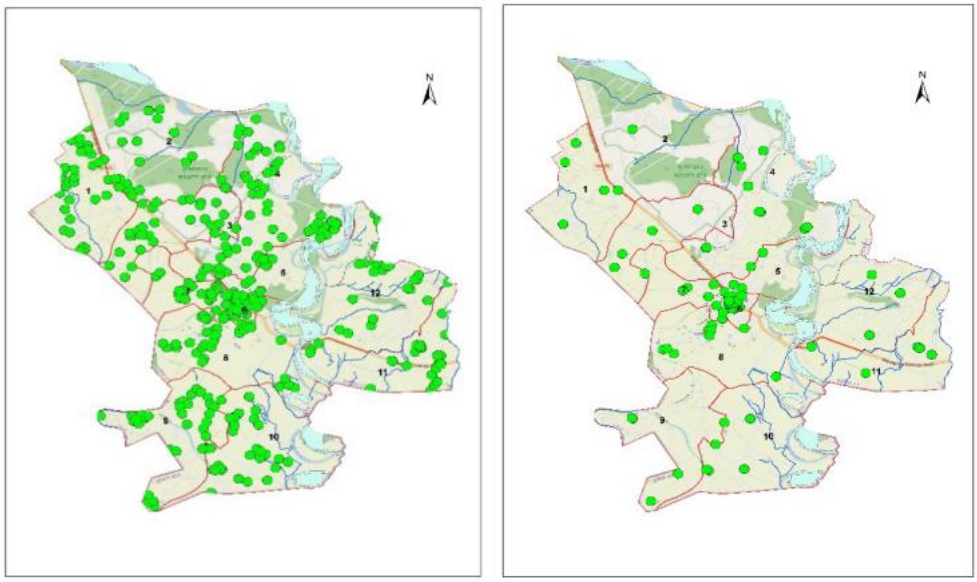

Figure 25: Distribution of sampling points (Left: households. Right: institutional buildings) in different wards of Gulariya Municipality.

4.3 Direct Observation

Various sanitation technologies in the households in all the wards were observed and visual references were kept. Also, observation of the emptying of containments and transportation of faecal sludge were carried out. The disposal site of municipal entrepreneur was observed during the usage.

4.4 Sharing and Validation of Data

The Shit Flow Diagram Sharing and Validation workshop was conducted in the municipality to share the finding of the sanitation situation survey and receive the suggestion from municipal stakeholders. Altogether, 27 participants including the deputy mayor, acting CAO, ward chairpersons and other members from municipal executive council, sectoral staffs etc. actively participated on the workshop and provided the valuable suggestions. The list of participants with their designation is attached in Appendix 1.

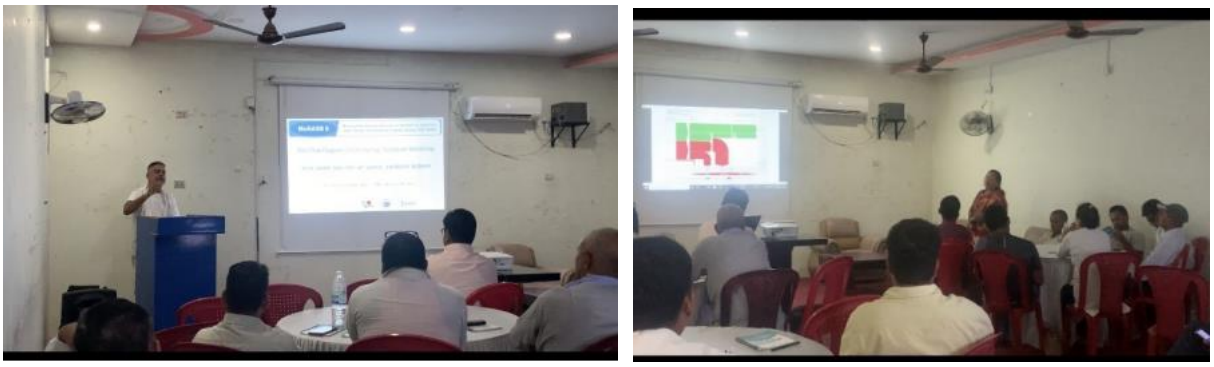

Figure 26: Discussion on SFD by stakeholder of the municipality in validation sharing program.

5 Acknowledgements

We would like to acknowledge the organizations involved in the Municipalities Advocacy on Sanitation in South Asia – II (MuNASS-II) project for their collaboration and coordination, namely the United Cities Local Government – Asia Pacific (UCLG ASPAC) as the executing agency and the Municipal Association of Nepal (MuAN) as the implementing agency, for their coordination with the municipality.

We extend our sincere appreciation to the individuals who provided invaluable support and guidance during the study: Mr. Muktinath Yadav, Mayor, Ms. Sabitra Gautam, Deputy Mayor of Gulariya Municipality for continuous support in the study. We would also like to thank Mr. Mukunda Aryal, Chief of planning section of the municipality and Mr. Gangadhar Sigdel, officer from revenue section, Mr. Suresh Gupta for facilitating the enumerators and continuous support throughout the study.

We would like appreciate Dr. Roshan Raj Shrestha, Deputy Director of Bill and Melinda Gates Foundation (BMGF), Mr. Ashok Kumar Byanju Shrestha, Former President, UCLG ASPAC, Dr. Bernadia Irawati Tjandradewi, Secretary General, UCLG ASPAC and Mr. Satish Jung Shah, Knowledge Management Officer, UCLG ASPAC. Similarly, we are very much obliged to Mr. Bhim Prasad Dhungana, President, MUAN and Co. President, UCLG ASPAC, Mr. Kalanidhi Devkota, Executive Director, MUAN Mr. Muskan Shrestha, Sanitation Advocacy Specialist, MuAN for their gracious support during the study.

Our heartfelt appreciation also goes to Ms. Bhawana Sharma, Executive Director, and Mr. Rajendra Shrestha, Program Director of Environment and Public Health Organization (ENPHO) for their tremendous support and guidance throughout the study. We are grateful to the entire ENPHO team for their gracious support, as well as the MuNASS-II team, without whom this study would not have been possible.

Finally, we extend our thanks to the enumerators: Mr. Madhav Kumar Oli, Mr. Suraj Khairaha, Mr. Sanoj kumar Yadav, Mr. Mithun Chaudhary, Mrs. Sapana Tharu, Mrs. Mangla Basnet, Ms. Deepa K.C, Ms. Nagma Manihar, Mr. Ajay Kumar Pasi, Mr. Aadarsh kumar Pandit, Mr. Rizwan Khan and Mr. Amrit Kumar Tharu for their support during the survey.

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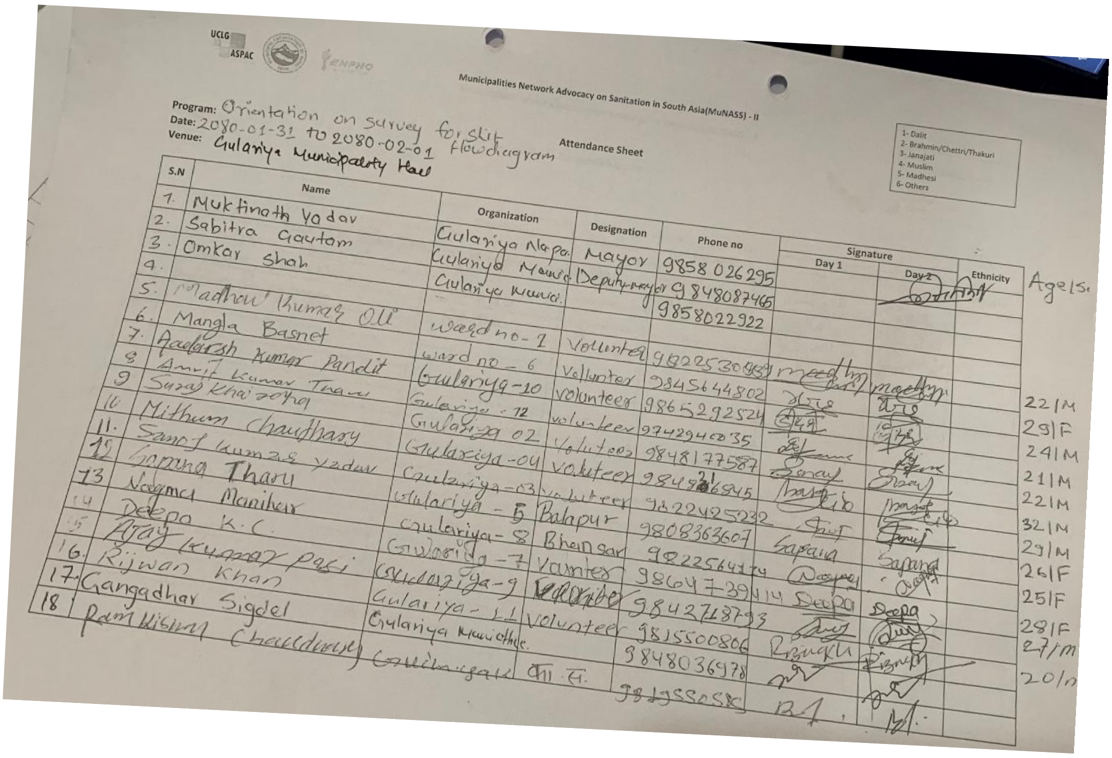
7 Appendix

7.1 Appendix 1: Roles and Responsibility of Various Tiers of Governments Delineated in Drafted SDP 2016 – 2030

System Classification		**Minimum Key HR Required**	**Regulation & Surveillance**	**Financing & Construction**	**Ownership of System**	**Service Delivery**	
Size	Sanitation					Provision	Production
Small	Onsite sanitation	Water Supply and Sanitation Technician (WSST)	Federal and or Provincial Government	User+/ community+/ other			
Medium	Septage Management	Sub-engineer	Federal and or Provincial Government	Provincial+/ Local Govt+/ Community+/ Private Sector		Local Govt	Users committee/ Utility manager
Large	Septage or FSM Management	WASH Engineer + finance & admin staff	Federal and or Provincial Government	Provincial+/ Local Govt+/ Community+/ Private Sector		Local Govt	Utility Manager
Mega	Septage/ FSM Management	WASH Engineer + finance & admin staff	Federal and or Provincial Government	Provincial+/ Local Govt+/ Community+/ Private Sector		Local Govt	Utility Manager

7.2 Appendix 2: List of enumerators in SFD orientation



Municipalities Network Advocacy on Sanitation in South Asia(MuNASS) - II

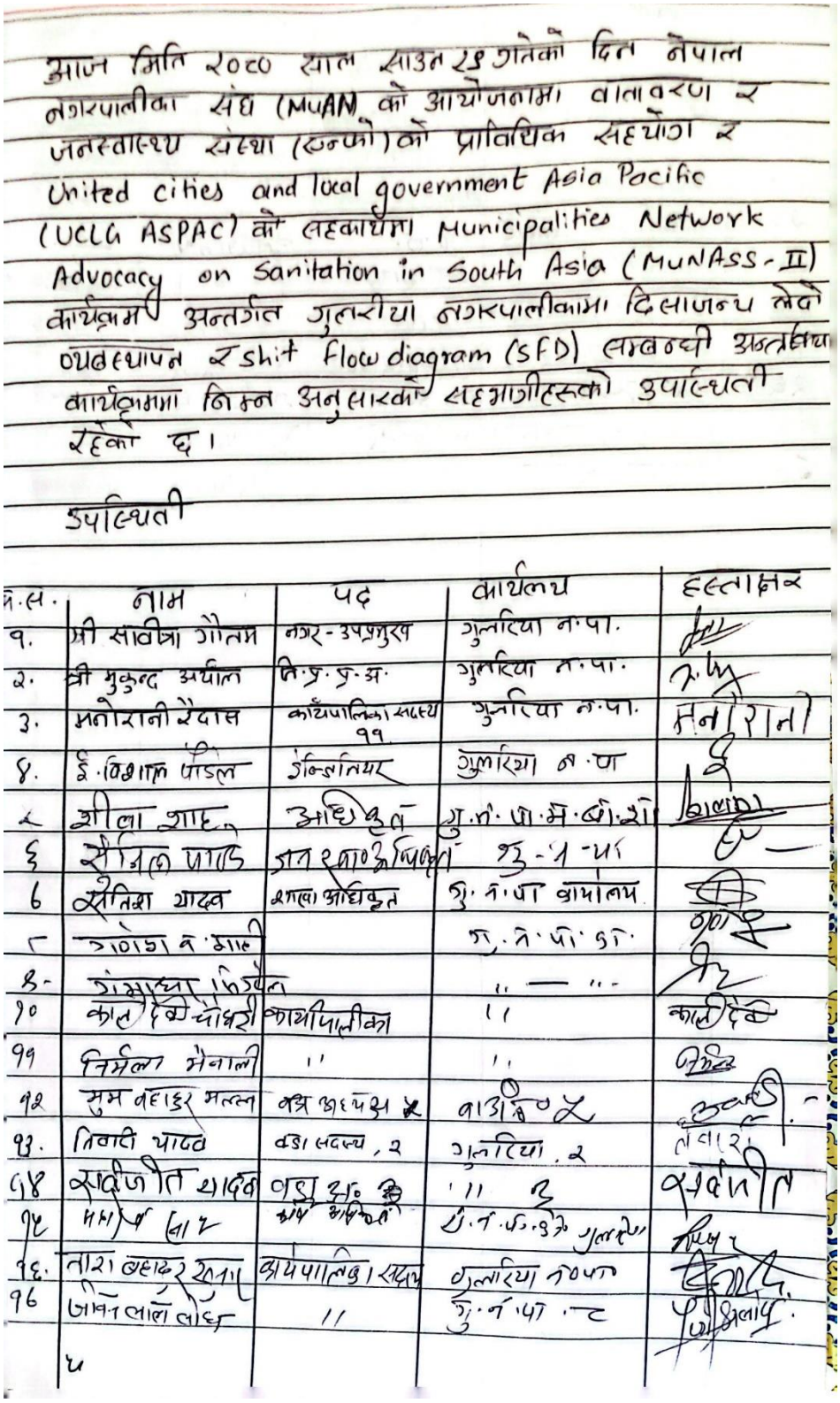
Program: Orientation on survey for SFD Flowdiagram
Date: 2080-01-31 to 2080-02-01
Venue: Gulariya Municipality Hall

Attendance Sheet

1- Dalit
2- Brahmin/Chettri/Thakuri
3- Janajati
4- Muslim
5- Madhesi
6- Others

S.N	Name	Organization	Designation	Phone no	Signature Day 1	Signature Day 2	Ethnicity	Age/Sex
1.	Muktinath Yadav	Gulariya N.pa.	Mayor	9858026295				
2.	Sabitra Gautam	Gulariya Munic.	Deputy-mayor	9848087465				
3.	Omkar Shah	Gulariya Munic.		9858022922				
4.								
5.	Madhav Kumar Oli	ward no-1	Volunter	9822530989				
6.	Mangla Basnet	ward no-6	Vollunter	9845644802				
7.	Aadarsh Kumar Pandit	Gulariya-10	volunteer	9865292524				22/M
8	Amrit Kumar Tharu	Gulariya-12	volunteer	9742940035				29/F
9	Suraj Khairaha	Gulariya 02	Volunteer	9848177587				24/M
10	Mithun Chaudhary	Gulariya-04	volunteer	9848916845				21/M
11.	Saroj Kumar Yadav	Gulariya-03	volunteer	9822425232				22/M
12	Sapana Tharu	Gulariya-5	Balapur	9808363607				32/M
13	Nagma Manihar	Gulariya-8	Bhansar	9822564174				29/M
14	Deepa K.C.	Gulariya-7	Vaunter	9864739414				26/F
15	Ajay Kumar Pasi	Gulariya-9	Volunteer	9842718793				25/F
16.	Rijwan Khan	Gulariya-11	volunteer	9815500806				28/F
17.	Gangadhar Sigdel	Gulariya Munic office		9848036978				27/M
18	Ram Kisun Chaudhary	Gulariya	का.स.	9819550558				20/M

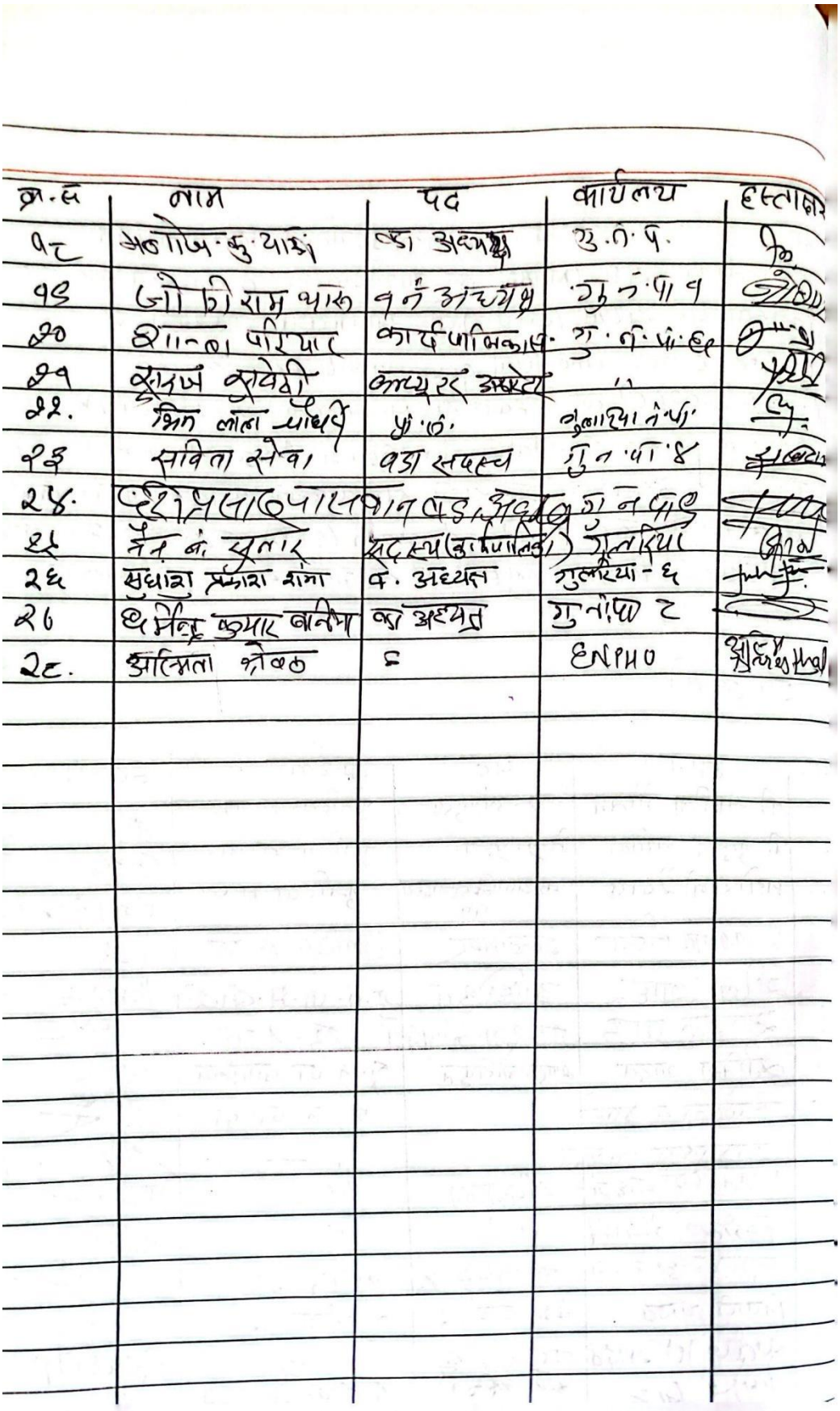
7.3 Appendix 3:List of Participants present in Sharing and Validation meeting of SFD



आज मिति २०८० साल साउन २६ गतेको दिन नेपाल नगरपालीका संघ (MuAN) को आयोजनामा वातावरण र जनस्वास्थ्य संस्था (Enpho) को प्राविधिक सहयोग र United cities and local government Asia Pacific (UCLG ASPAC) को सहकार्यमा Municipalities Network Advocacy on Sanitation in South Asia (MuNASS-II) कार्यक्रम अन्तर्गत गुलरीया नगरपालीकामा दिसाजन्य लेदो व्यवस्थापन र Shit Flow diagram (SFD) सम्बन्धी अन्तरक्रिया कार्यक्रममा निम्न अनुसारको सहभागीहरुको उपस्थिती रहेको छ।

उपस्थिती

स.स.	नाम	पद	कार्यलय	हस्ताक्षर
१.	श्री सावित्रा गौतम	नगर-उपप्रमुख	गुलरिया न.पा.	
२.	श्री मुकुन्द अर्याल	वि.प्र.प्र.अ.	गुलरिया न.पा.	
३.	मनोरानी रैदास	कार्यपालिका सदस्य	गुलरिया न.पा.	मनोरानी
४.	ई.विशाल पोडल	इन्जिनियर	गुलरिया न.प	
५	शीला शाह	अधिकृत	गु.न.पा.मे.बो.रो	
६	सौगत पाण्डे	प्रशासन अधिकृत	गु.न.पा	
६	सुनिता यादव	शाखा अधिकृत	गु.न.पा कार्यालय	
८	[illegible]		गु.ने.पो.गा.	
९	[illegible]		" — "	
१०	काली किं चौधरी	कार्यपालीका	"	काली किं
११	निर्मला मेनाली	"	"	
१२	सुम बहादुर मल्ल	वडा अध्यक्ष	वार्ड नं	
१३	तिवारी पाण्डे	वडा सदस्य, २	गुलरिया, २	तिवारी
१४	[illegible]	[illegible]	"	[illegible]
१५	[illegible]	[illegible]	गु.न.प.३ गुलरिया	
१६	तारा बहादुर [illegible]	कार्यपालिका सदस्य	गुलरिया न.पा.	
१७	[illegible]	"	गु.न.पा.	



क्र.सं	नाम	पद	कार्यालय	हस्ताक्षर
१८	मनोज कुमार यादव	का अध्यक्ष	गु.न.पा.	
१९	जी.पी. राम थारु	१ नं अध्यक्ष	गु.न.पा १	
२०	शान्ता परियार	कार्यपालिकाका	गु.न.पा.६	
२१	सुरज कुमार चौधरी	कार्यपालिका अध्यक्ष	"	
२२.	मिना लाला चौधरी	प्र.अ.	गुलरिया नं.प.	
२३	सविता सेवा	वडा सदस्य	गु.न.पा.४	
२४.	[illegible]	[illegible]	गु.न.पा.६	
२५	नैन नं. सुनार	सदस्य(कार्यपालिका)	गुलरिया	
२६	सुधारा प्रसाद शर्मा	न. अध्यक्ष	गुलरिया-६	
२७	धनेन्द्र कुमार बनिया	का अध्यक्ष	गु.न.पा.८	
२८.	अस्मिता केवट	८	ENPHO	

7.4 Appendix 4: Glimpses of KIIs

KII with board members of Khairapur WSUC

SFD Gulariya Municipality, Nepal, 2024

Produced by:

Asmita Shrestha, ENPHO
Jagam Shrestha, ENPHO
Buddha Bajracharya, ENPHO
Sabuna Gamal, ENPHO
Rupak Shrestha, ENPHO
Anita Bhuju, ENPHO

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SFD Promotion Initiative