SFD Report

Birtamod Municipality
Nepal

Final Report

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SFD Report Birtamod Municipality, Nepal, 2026

Produced by:

Asmita Shrestha, ENPHO

Anita Bhuju, ENPHO

Buddha Bajracharya, ENPHO

Jagam Shrestha, ENPHO

Rupak Shrestha, ENPHO

Sabuna Gamal, ENPHO

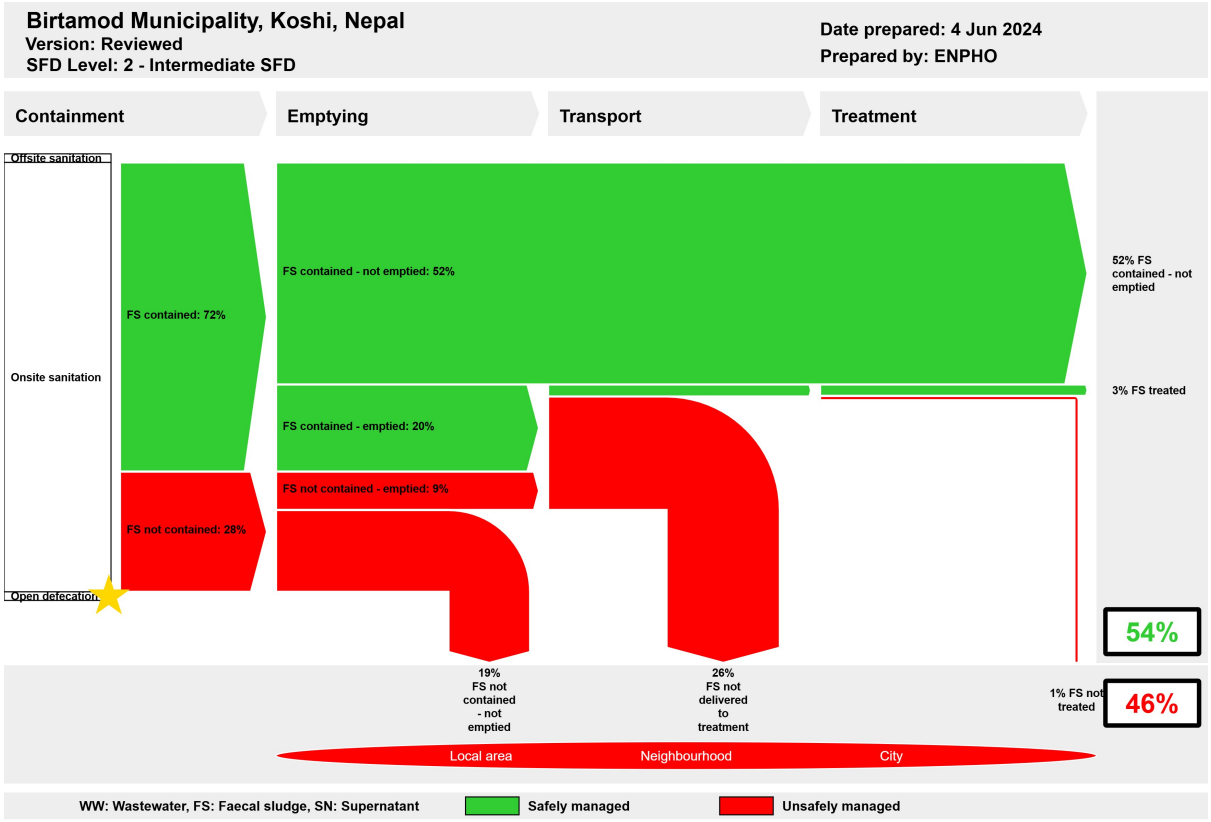
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1. The SFD Graphic



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.
Full details on how to create an SFD Report are available at sfd.susana.org

2. Diagram information

SFD Level:

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3. General city information

Birtamod Municipality, situated in Jhapa District of Koshi Province, Nepal was declared a municipality on May 8, 2014. It was restructured by merging Garamani Village Development Committee (VDC) on March 10, 2017, and comprises 10 political wards.

As of the 2021 Census, its population stands at 116,192 across 29,852 households. The municipality's annual population growth rate is 3.3%, and its population density is 1,485/km². Birtamod enjoys a warm and temperate climate, with an average temperature of 23.1°C and annual precipitation of approximately 2,726 mm. Geographically, it lies on flat Terai land, covering 78.24 square km at an elevation of 163 metres above sea level, and its coordinates are 26°63'79" N latitude and 78°94'59" E longitude.

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). All the households had access to toilet and connected to onsite sanittaion technology.

Containment:

Of the total population of the municipality, 13% of households have a well-designed septic tank for storing faecal sludge from toilets, 43% of households installed fully lined tanks with a single or double chamber, and 2% have biogas built. Additionally, 19% of households have constructed lined tanks with impermeable walls and an open bottom, and 1% used direct pits. Twin pits are installed by 5% of households, while single offset pits were adopted by 18% of households who use pre-cast concrete rings to assemble.

All 39 surveyed institutions in the municipality have access to a safely managed sanitation system: 62% institutional buildings had made fully lined tanks, 3% had lined tanks with impermeable walls and open bottom, 13% had single pit, and 22% had built septic tanks.

Emptying and transportation:

Notably, 33.2% have emptied their containment atleast once after installation due to faecal sludge overflow using mechanical desludging vehicles. About 38.5% of the population opts for mechanical emptying, while a significant 60.4% relies on manual emptying, and 1.1% practiced open emptying in drains.

The municipality has about 4 private desludging service providers with a vehicle of capacity 9,000-litre offering on-demand emptying services and costs varying based on containment shape.

Treatment and Disposal:

There is a treatment plant located in Duhagadhi of Jhapa district which was constructed as part of sanitation innovation under a grant implemented under Asian Development Bank (ADB) supported Third Small Towns Water Supply and Sanitation Sector Project (ADB, 2015) . The treatment plant has a capacity of 27 m^3/day (Charali FSM, n.d.) . The plant is connected in series from one treatment module to the other (Sanitation Plan, n.d.). The private delsudgers including desludgers of Birtamod Municipality don't prefer to dispose the sludge in treatment plant, rather apply it in farmland on demand of farmers (KII-4, 2023). The treatment plant receives mechanically collected sludge more in rainy season, and very less in other seasons (KII-7, 2023). The manually emptied sludge was applied in farmlands or disposed of in open environment untreated.

Risk Assessment:

The survey findings indicated 56.8% of households consumed groundwater as main source of drinking water, 42.5% had private tap in their home, and 0.5% relied on public taps. Likewise, 0.2% dependent on jar water for drinking purpose. Key Informant Interviews (KIIs) indicated that Birtamod Small town WSUO has been providing services since 1995 A.D in all 10 wards covering 9,154 households. The water source is groundwater reservoir distributed through 3 big overhead tanks with a capacity of 450 m^3. It has 1 treatment plant and chlorination unit.

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 54% of the excreta or faecal sludge generated are safely managed while 46% are unsafely managed. The safely managed Faecal Sludge (FS) generated by 52% 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.

The municipality partnered with WUSCs of Charali and Karkarvitta for the operation and management of FSM services through a service level agreement. The Municipality is responsible for regulating FSM services, WUSCs are responsible for the operation and maintenance of the FSTP, and desludging and transportation is outsourced primarily through private operators. (ADB, 2015) . The municipality has even developed a bylaws where construction of septic tank is compulsory while building new houses.

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, Irrigation and Energy
Public Institutions at Local Government	Birtamod Municipality, Birtamod Small town WSUO, Charali FSTP
Non-governmental Organizations	Environment and Public Health Organization (ENPHO)
Private Sector	Public toilet operators, Private desludgers
Development Partners, Donors	MuAN, BMGF, UCLG ASPAC

7. Credibility of data

The data were collected from proportionate stratification random sampling. Altogether, 588 households and 39 institutions were surveyed from 10 wards of the municipality. Primary data on emptying, transportation, and current sanitation practices in the municipality are validated from Key Informant Interviews (KIIs) with private 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 April 23, 2024.

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

SFD Birtamod Municipality, Nepal, 2026

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ABBREVIATIONS

ADB	Asian Development Bank
ABR	Anaerobic Baffle Reactor
AF	Anaerobic Filter
AEPC	Alternative Energy Promotion Centre
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
FSTP	Faecal Sludge Treatment Plant
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
MoH	Ministry of Health
MoHP	Ministry of Health and Population
MoWS	Ministry of Water Supply
MuAN	Municipal Association of Nepal
NGO	Non-Governmental Organization
NPC	National Planning Commission
NSO	National Statistics Office
NUWSSSP	National Urban Water Supply and Sanitation Sector Policy
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
UCLG ASPAC	United Cities and Local Governments Asia Pacific
VDC	Village Development Committee
WASH	Water, Sanitation and Hygiene
WHO	World Health Organization
WSUO	Water Supply and Sanitation User's Organization

1 City context

Birtamod Municipality located in Jhapa District of Koshi Province, is a major commercial center of Nepal and is moving towards urbanization at a rapid pace. It was first announced as the municipality on May 8, 2014, which was again restructured by merging Garamani Village Development Committee (VDC) on March 10, 2017. It is bordered by Arjundhara Municipality in the north, Kankai Municipality and Bahradashi rural Municipality in the west, Mechinagar and Bhadrapur Municipality in the east, and Haldibari Municipality in the south. The municipality is divided into 10 political ward boundaries (Birtamod Municipality , 2024). Figure 1 shows the map of the municipality with its ward boundaries.

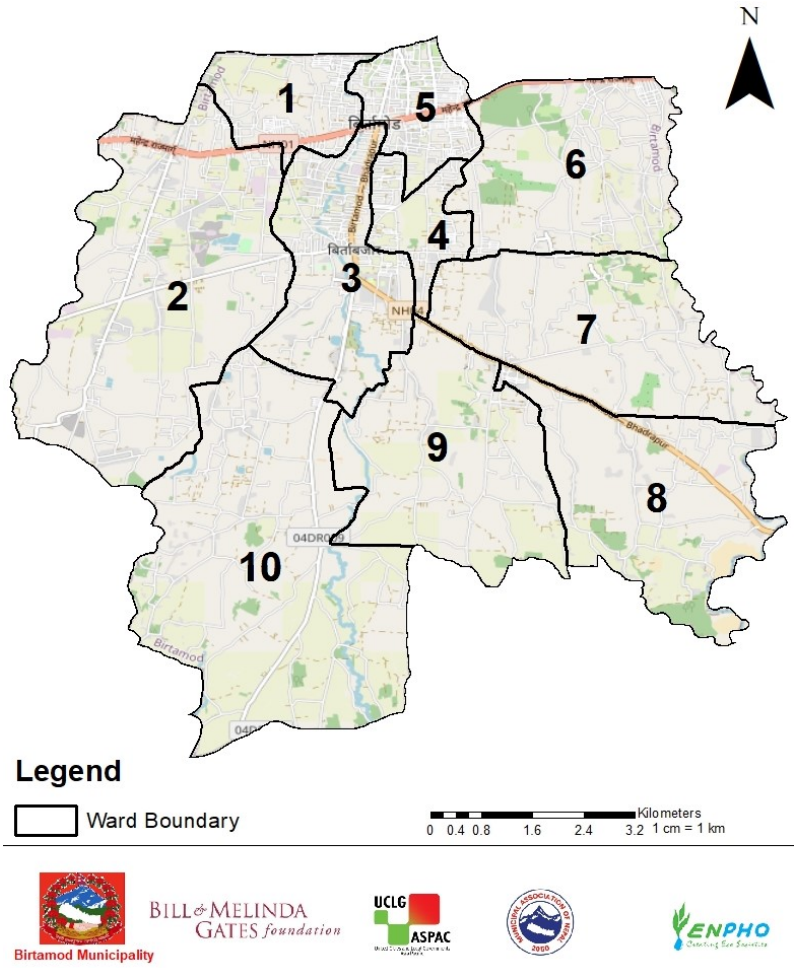


Figure 1: Map of Birtamod Municipality with ward boundaries.

1.1 Population

The municipality's population, according to the 2021 National Population and Housing Census, was 116,192 individuals distributed across 29,852 households. The percentages of male and female populations were 48.3% (56,105) and 51.7% (60,087) respectively. The average household size of the municipality is 3.89 persons per households (NSO, 2021). The municipality has experienced an annual population change of 3.3% per annum, and a population density of 1,485/km² (City Population, Birtamod, 2021).

1.2 Climate

The weather in Birtamod is warm and temperate. It's classified as Cwa according to Köppen-Geiger. The average temperature in the city is recorded as 23.1 °C. The annual precipitation in this location is approximately 2,726 mm | 107.3 inch. The warm and pleasant days of the summer season commence towards the end of June and come to an end in September (Climate Data, 2021) . Figure 2 shows the month-wise weather of Birtamod municipality.

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature °C (°F)	15.9 °C (60.7) °F	18.6 °C (65.4) °F	23 °C (73.4) °F	26 °C (78.8) °F	26.5 °C (79.6) °F	26.7 °C (80.1) °F	26.6 °C (79.9) °F	26.8 °C (80.2) °F	26.1 °C (79) °F	23.9 °C (75.1) °F	20.5 °C (68.8) °F	17.2 °C (63) °F
Min. Temperature °C (°F)	9.9 °C (49.9) °F	12.2 °C (53.9) °F	16.1 °C (61) °F	20.3 °C (68.5) °F	22.5 °C (72.4) °F	24.1 °C (75.4) °F	24.6 °C (76.2) °F	24.5 °C (76.1) °F	23.5 °C (74.2) °F	19.7 °C (67.5) °F	15 °C (59) °F	11.4 °C (52.5) °F
Max. Temperature °C (°F)	21.9 °C (71.4) °F	24.6 °C (76.2) °F	29.3 °C (84.7) °F	31.5 °C (88.6) °F	30.6 °C (87.1) °F	29.8 °C (85.7) °F	29.3 °C (84.7) °F	29.7 °C (85.4) °F	29.2 °C (84.6) °F	28.4 °C (83.2) °F	26.2 °C (79.2) °F	23.3 °C (73.9) °F
Precipitation / Rainfall mm (in)	15 (0)	20 (0)	27 (1)	71 (2)	202 (7)	494 (19)	790 (31)	605 (23)	388 (15)	96 (3)	11 (0)	7 (0)
Humidity(%)	68%	62%	49%	55%	73%	84%	88%	86%	85%	79%	69%	68%
Rainy days (d)	3	3	4	10	18	20	22	22	19	8	2	1
avg. Sun hours (hours)	7.6	8.0	9.4	9.2	8.5	6.8	5.9	6.7	7.0	8.5	8.2	7.7

Figure 2: Weather by Month of Birtamod municipality.

Source: (Climate Data, 2021)

1.3 Topography

Topographically, the Birtamod Bazar and the surrounding area lie on a generally flat land in the Terai (ITECO Nepal (P) Ltd., 2015). The total area of this municipality is 78.24 square km and is located 163 metres above sea level. The area is composed mainly of gravel and boulder along with sand, close to the Aduwa khola, whereas the rest of the area is composed of silty loamy soil, which is highly fertile (ADB, 2015). Birtamod municipality is about 100 km from Biratnagar, the capital of Koshi Province and about 12 km from Bhadrapur (district headquarters) on the East West highway. This municipality is spread between 26°63’79" North latitude and 78°94’59" East longitude (Birtamod Municipality , 2024).

2 Service Outcomes

2.1 Overview

The country has made significant progress towards achieving its current sanitation status. On September 30, 2019, the Government of Nepal declared the nation free of open defecation, marking universal access to improved sanitation facilities nationwide. Meanwhile, Birtamod Municipality achieved Open Defecation Free (ODF) status on 24 August 2018, initiating a new phase of sanitation management to address the challenges of treating faecal sludge (Birtamod Municipality, 2019) . The data on sanitation situation were collected through household and institutional surveys (ENPHO, 2023). To assess the sanitation status across the entire sanitation service chain, a household survey was conducted in 588 sampled households using a proportionate sampling across the 10 wards of 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, and Key Informant Interviews (KIIs) are presented in this section.

2.1.1 Sanitation Systems in household buildings

The findings from this survey in 2024 revealed that all sampled households have 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) . All the households having access to toilets have connected their toilets to onsite sanitation technology.

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 13% of households have a well-designed septic tank for storing faecal sludge from toilets, 42% of households have fully lined tanks with a single or double chamber, and 2% have biogas built. Additionally, 19% of households have constructed lined tanks with impermeable walls and an open bottom, and 1% used direct pits. Twin pits are installed by 5% of households, while single offset pits were adopted by 18% 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 different onsite sanitation technologies installed at households with different types of containments in Birtamod 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	2%	Fully lined tank	44%
Fully Lined tank	Cemented brick/stone walls or concrete wall	PCC or plaster	One or two	NA	42%		
Septic tank	Cemented brick/stone walls or concrete wall	PCC or plaster	Two or more than two	NA	13%	Septic tank	13%
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	19%	Lined tank with impermeable walls and open bottom	19%
Single Pit	Concrete rings in piled up form	Soiling or nothing	NA	One	18%	Lined pit with semipermeable walls and bottom	24%
Twin Pits	Concrete rings in piled up form	Soiling or nothing	NA	Two	5%		
Direct Pit	Concrete rings in piled up form	Soiling or nothing	NA	One	1%		
						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, 2% of households have installed biogas digesters. When creating SFD graphics, biogas is reclassified as SFD containment, considering it as a fully lined tank.

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 Birtamod Municipality, about 13% have installed a properly designed septic tank in their homes, mostly in urban ward (ward 5, 4 and 3).

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, 42% of households have fully lined tanks (mostly built in urban areas as seen in GIS map, Figure 3).

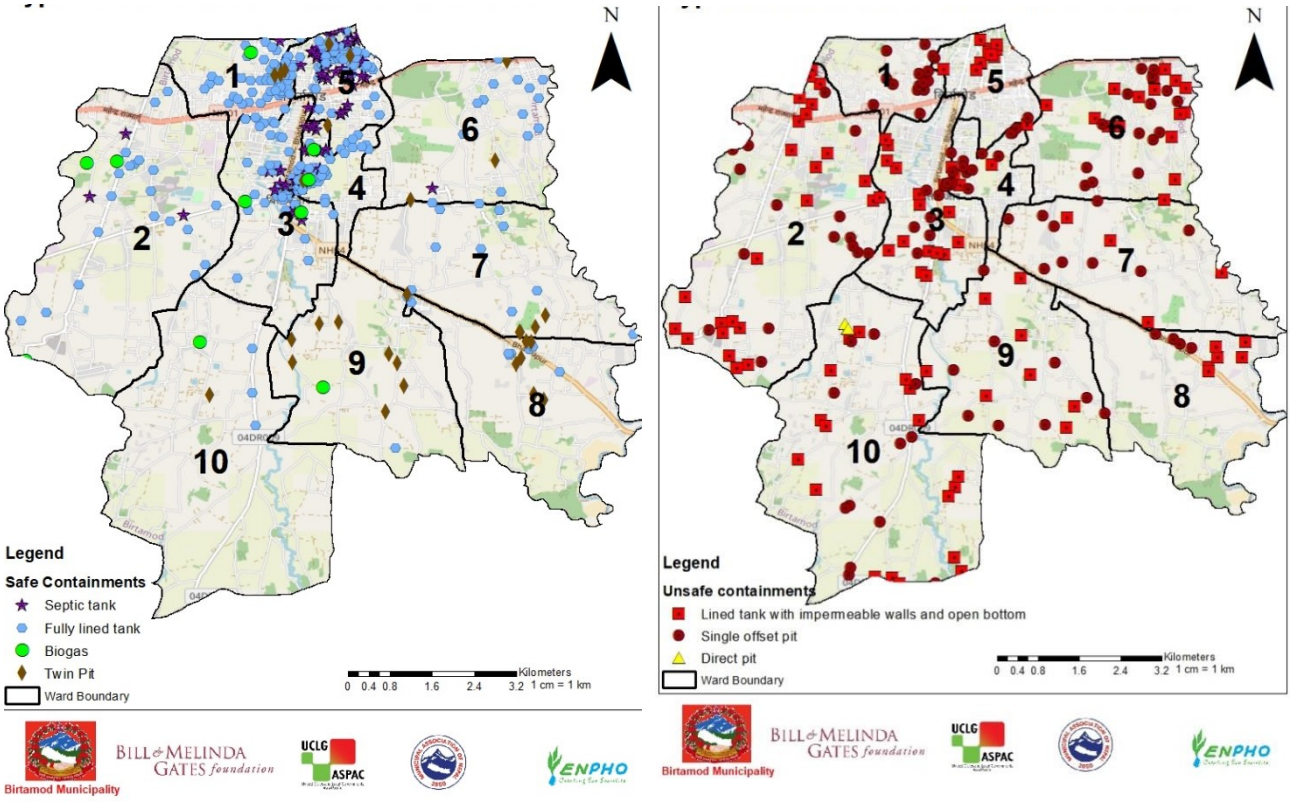


Figure 3: GIS map showing safe (left) and unsafe(right) containments in sampled households.

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, 19% 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 1.2 metres. Both pits are connected through a diversion box. However, these pits will function as pits with semi-permeable walls and open bottoms if twin pits installed by households do not adhere to the proper design. 5% of the households have twin pits installed in their house.

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, 18% of households have single pits.

Direct Pit: These are holes dug into the ground just beneath the toilet to store faecal sludge. The population residing in 1% of households with access to toilets in their houses have built direct pit. The walls are made of concrete ring or concrete walls and bottoms have soiling or nothing, such containments were found in ward 10 (Figure 4). When creating a SFD graphics, direct pit is reclassified, considering it as a lined pit with semipermeable walls and open bottom. Figure 4 shows direct pit constructed in a household of municipality.



Figure 4: Pictures demonstrating direct pit installed in sampled households.

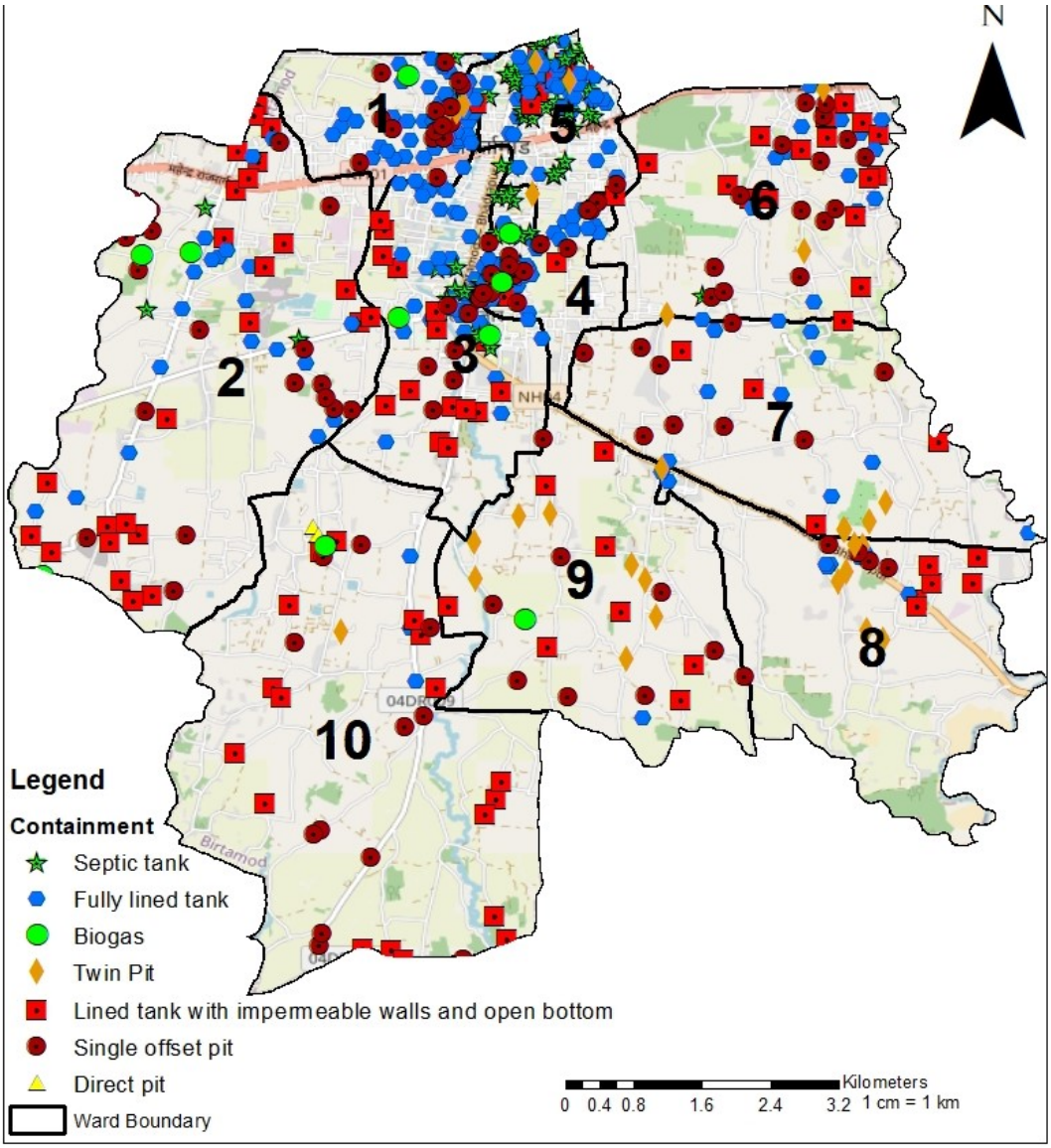


Figure 5: Map locating different types of containment in Birtamod Municipality.

2.1.2 Sanitation System in Institutional Buildings

All the surveyed 39 institutions had access to a safely managed sanitation system in the municipality. Different educational institutes, government and non-government offices, health care centres and hotels with lodging facilities were surveyed.

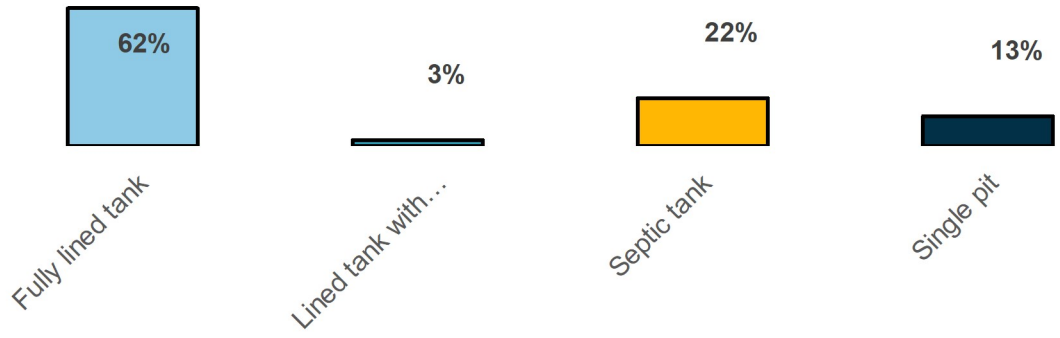


Figure 6: Containments used in institutional buildings.

The findings showed that 62% of institutional buildings had made fully lined tanks, 3% had lined tanks with impermeable walls and open bottom, 13% had single pit, and 22% had built septic tanks. The proportion of different types of sanitation technologies are shown in Figure 6.

2.1.3 Public Toilets

During the study period, it was explored there are 4 public toilets constructed in different areas where there is increased flow of people. One of the public toilets was visited during the field visit and the information based on KII is provided below.

Public Toilet in Krisi Bajar

There is a public toilet constructed in Krisi thok built in 2021 built by Krisi Bajar Byabasthapan Samiti. It has separate sections for male and female. The toilet was kept clean and well-maintained. The water source for the toilet was being managed from a nearby tubewell and a 1,000-liter tank. There's a service charge of Rs. 5 (USD 0.03) for urination and Rs. 10 (USD 0.06) for defecation. In average there were about 40-50 service users per day. The excreta of toilet were connected to a holding tank, which are usually emptied in the interval of every 2-3 years (KII-6, 2023).



Figure 7: Public Toilet in Krisi thok.

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, 33.2% emptied their containment due to faecal sludge overflow.

The findings indicated for emptying the faecal sludge, 38.5% of the population opts mechanical emptying, while a significant 60.4% relies on manual methods, and 1.1% practiced open emptying in drains. 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-4, 2023).

Transportation services

The municipality has a private desludging service available inside the municipality. There are about 4 private desludging service providers available: Jhapa Septic tank desludging service, Purbanchal Septic tank desludging service and 2 more desludging service operators from ward 3 (name-not known). Furthermore, the desludging services are also provided from nearby municipalities, 3-4 desludging vehicles comes from Surunga and some from Mechinagar Municipality. The picture of one of the desludging vehicles is shown in Figure 8. The information obtained from KII is provided below (Table 2):

Table 2: Details on private desludging vehicles.

	Jhapa septic tank desludging services	Purbanchal septic tank desludging services
Service started from	2010 A.D (2066 B.S)	2023
Capacity of vehicle	9,000 litre	9,000 litre
Number of Vehicles	3 (2 running in Birtamod Municipality, 1 in Damak Municipality)	1
Service Charge	Rectangular tank- Rs. 3,000-Rs. 3,500 (USD 20-24) Ring tank-Rs. 2,000-Rs.2,500 (USD 13-17)	Rectangular tank- Rs. 3,500-Rs. 4,000 (USD 24-27) Ring tank-Rs. 2,000-Rs.2,500 (USD13-17)
Service Areas	Birtamod Municipality, Damak Municipality	Birtamod Municipality, Neighboring municipality – on demand
Average trip per month	70-80	20-25
Disposal Practices	Mostly farmland: on demand of farmers, Charali FSTP during rainy season	



Figure 8: Private desludging vehicle in Birtamod Municipality.

2.1.5 Treatment and Disposal/Reuse of Faecal Sludge

The faecal sludge treatment plant located in Duhagadhi of Jhapa district was constructed as part of sanitation innovation under a grant implemented by the Asian Development Bank (ADB) supported by Third Small Towns Water Supply and Sanitation Sector Project (ADB, 2015). The 3 local governments (Mechinagar Municipality, Birtamod Municipality and Buddhashanti Rural Municipality) partnered with WUSCs of Charali and Karkarvitta for the operation and management of Faecal Sludge Management (FSM) services through a service level agreement. The Municipality is responsible for regulating FSM services, WUSCs are responsible for the operation and maintenance of the FSTP, and desludging and transportation is outsourced through private operators (ADB, 2015).

The treatment plant has a capacity of 27 m^3/day (Charali FSM, n.d.). The plant is connected in a series from one treatment module to the other. First, FS is passed through a screen chamber to remove solid debris and then to a planted drying bed where solids are retained. The resulting effluent from the drying bed then passes through an Anaerobic Baffle Reactor (ABR), Anaerobic filter (AF), planted gravel filter and finally to a polishing pond. The dewatered sludge from the planted drying bed undergoes stabilization in the bed and on complete filling of the drying beds with a sludge, a retention time of 6 months is provided before it is removed (Figure 9) (Sanitation Plan, n.d.).

There is a desludging vehicle owned by Charali small town WSUC which provides the average 30 trips per month, which is not sufficient as per the capacity of treatment plant. Since the location is located far from town, approximately 20 km from the main highway road, and the tipping fee of Rs. 500 (USD 3.5) is charged, the private delsudgers including desludgers of Birtamod Municipality do not prefer to dispose of the sludge in treatment plant rather apply it in farmland on demand of farmers (KII-4, 2023). The mechanically collected sludges are disposed in FSTP predominantly during the rainy season (KII-7, 2023).



Figure 9: Charali faecal sludge treatment plant.

Those who practiced the manual emptying, most individuals adopted the practice of digging new pits and dumping the old ones, and only a few practices composting method. Additionally, sludge was directly applied to farms and thrown to water bodies which cannot be considered safe as it possess direct risks to environment and public health (Figure 10).

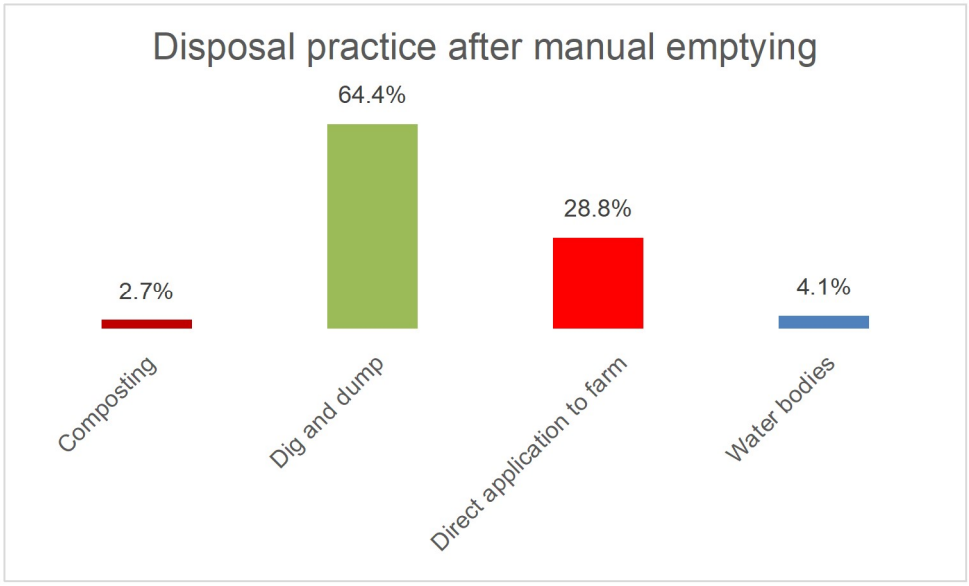


Figure 10: Disposal of sludge after manual emptying.

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, 56.8% of households consumed groundwater as their main source of drinking water, 42.5% had private tap in their home, and 0.5% relied on public taps. Likewise, 0.2% dependent on jar water for drinking purposes. Key informant interviews (KII-3, 2023; KII-5, 2023) findings indicated that Birtamod Small town WSUO has been providing

services since 1995 A.D. It provides its services to all 10 wards, covering 9,154 households. The source of water is groundwater reservoir distributed through 3 big overhead tanks with capacity of 450 cubic metres. It has 1 treatment plant and chlorination unit, where the water consumption records at 1.5 crore (10^7) litre per day (KII-5, 2023).

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

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 tanks 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; whereas 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 11 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, 24% of households have installed lined pits with semi-permeable walls and an open bottom. Among these, 20% of households use groundwater as a source of drinking water, and it was found that 80% of these households are at high risk of groundwater contamination. 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 16% (calculated as 24% x 86% x 80% = 16%).

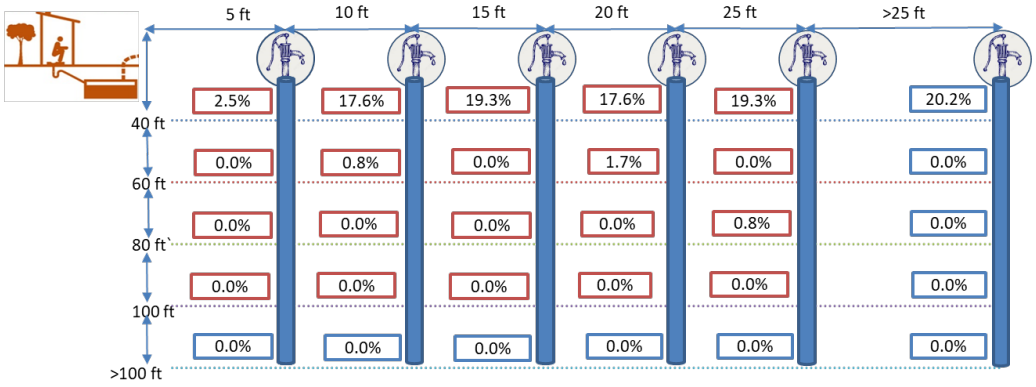


Figure 11: Depth of hand pumps and lateral spacing of it with containment types: lined pit with semi-permeable walls and open bottom.

Figure 12 illustrates the depth of hand pumps and their horizontal distance from lined tanks with impermeable walls and an open bottom. Specifically, 19% of households have installed lined tanks with impermeable walls and an open bottom, of which 15% rely on groundwater for drinking. Among these households, it was revealed that 81% 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 11 % (calculated as 19% x 77% x 81% = 11%).

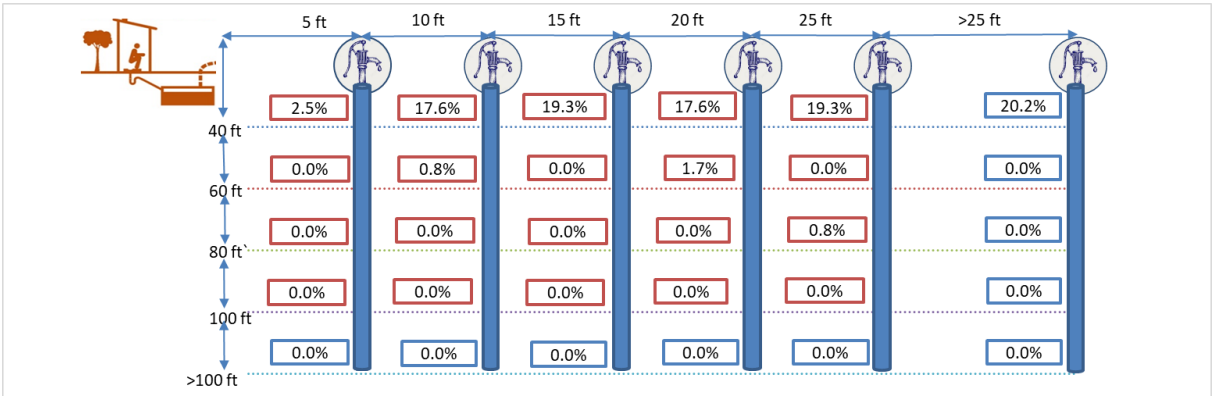


Figure 12: Depth of hand pumps and lateral spacing of it with containment types lined tank with impermeable walls and open bottom.

2.2 SFD Selection Grid

The SFD grid consists of different containment technology used in list A and its connection in list B. Sanitation technologies selected in the SFD grid in Birtamod Municipality are shown in Figure 13. The vertical column on the left side of the SFD selection grid has a list of technologies to which the toilet is connected to. 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, twin pits,

and direct pits constructed by assembling pre-cast concrete rings on top of each other, are collectively referred to as lined pits with semi-permeable 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 13.

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					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									Not Applicable

Figure 13: SFD selection grid for Birtamod Municipality.

A brief explanation of terms used to indicate different frames selected in the SFD selection grid is explained in Table 3.

Table 3: Explanation of terms used to indicate frame selected in the SFD selection grid.

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.

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 proportions 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 14 illustrates the SFD matrix of the municipality.

Birtamod, Koshi, Nepal, 4 Jun 2024. SFD Level: 2 - Intermediate SFD
Population: 116192
Proportion of tanks: septic tanks: 100%, fully lined tanks: 100%, lined, open bottom tanks: 1

Containment				
System type	Population	FS emptying	FS transport	FS treatment
	Pop	**F3**	**F4**	**F5**
System label and description	Proportion of population using this type of system (p)	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
T1A2C5 Septic tank connected to soak pit	13.0	7.0	0.0	0.0
T1A3C10 Fully lined tank (sealed), no outlet or overflow	44.0	30.0	17.0	95.0
T1A4C10 Lined tank with impermeable walls and open bottom, no outlet or overflow	7.0	22.0	10.0	95.0
T1A4C8 Lined tank with impermeable walls and open bottom, connected to open ground	1.0	28.0	0.0	0.0
T1A5C10 Lined pit with semi-permeable walls and open bottom, no outlet or overflow	8.0	58.0	3.0	95.0
T2A4C10 Lined tank with impermeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	11.0	6.0	40.0	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	16.0	50.0	0.0	0.0

Figure 14: SFD Matrix of Birtamod Municipality.

2.3.2 Proportion of faecal sludge Emptied (F3)

The column labelled "Population (Pop)" in figure 14 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 undergoes 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-4, 2023).

According to findings from household surveys and Key Informant Interviews (KII-4, 2023), approximately 85% 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 15% of the FS in the containment, characterized by high thickness and poor water solubility, remains un-removed during emptying, as reported from KII-4 with desludger information. The calculation of the emptied proportion of FS is adjusted accordingly as follows (Table 4).

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

Table 4: Sanitation technologies and proportion of emptied faecal sludge (ENPHO, 2023[1]; KII_4, 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	8%	85%	7%
2	Fully lined tank (sealed), no outlet or overflow	T1A3C10	35%	85%	30%
3	Lined tank with impermeable walls and open bottom, no outlet or overflow (High Risk)	T2A4C10	7%	85%	6%
4	Lined tank with impermeable walls and open bottom, no outlet or overflow	T1A4C10	26%	85%	22%
5	Lined tank with impermeable walls and open bottom, connected to an open ground	T1A4C8	33%	85%	28%
6	Lined pit with semi-permeable walls and open bottom, no outlet or overflow	T1A5C10	68%	85%	58%
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	59%	85%	50%

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

Some proportions of mechanically emptied sludge were treated in Charali faecal sludge treatment plant, and operational biogas systems are classified as treated (F5). In the provided SFD matrix, 44% of fully lined tanks, including 2% with functioning household biogas digesters, are considered treated, F4=100% with F5=95%. The sludge transported to the treatment plant is considered treated with efficacy 95 % based on KII information.

2.4 Summary of Assumptions

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.
- ✓ The emptied FS from septic tanks connected to soak pits (system T1A2C5) is 7% (F3 = 7%) but no FS is delivered to treatment nor treated in the FSTP (F4 = 0% and F5 = 0%).
- ✓ The emptied FS from fully lined tanks, no outlet or overflow (system T1A3C10) is 30% (F3 = 30%) out of which 17% is delivered to treatment and 95% is treated in the FSTP (F4 = 17% and F5 = 95%).
- ✓ The emptied FS from lined tanks with impermeable walls and open bottom, connected to open ground (system T1A4C8) is 28% but no FS is delivered to treatment and treated in the FSTP (F4 = 0% and F5 = 0%).
- ✓ The emptied FS from lined tanks with impermeable walls and open bottom, no outlet or overflow (system T1A4C10) is 22% (F3 = 22%) out of which 10% is delivered to treatment and 95% is treated in the FSTP (F4 = 10% and F5 = 95%).
- ✓ 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 6% (F3 = 6%) out of which 40% is delivered to treatment and 95% is treated in the FSTP (F4 = 40% and F5 = 95%).
- ✓ 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 50% (F3 = 50%) out of which 3% is delivered to treatment and 95% is treated in the FSTP (F4 = 3% and F5 = 95%).
- ✓ The emptied FS from lined pits with semi-permeable walls and open bottom, no outlet or overflow (system T1A5C10) is 58% (F3 = 58%) but no FS is delivered to treatment (F4 = 0% and F5 = 0%).

2.5 SFD Graphic

Figure 15 presents diagrammatic representations of the shit flow within Birtamod 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 by 54% of the population is safely managed, represented by "Green" arrowheads, indicating FS stored in containment without significant risk to groundwater. Conversely, FS from 46% of the population is unmanaged, represented by "Red" arrowheads. This signifies FS that are not safely conatined and openly dumped in environment without any treatment, both considered unsafe. The diagram illustrates four different factors across the sanitation value chain, arranged from left to right.

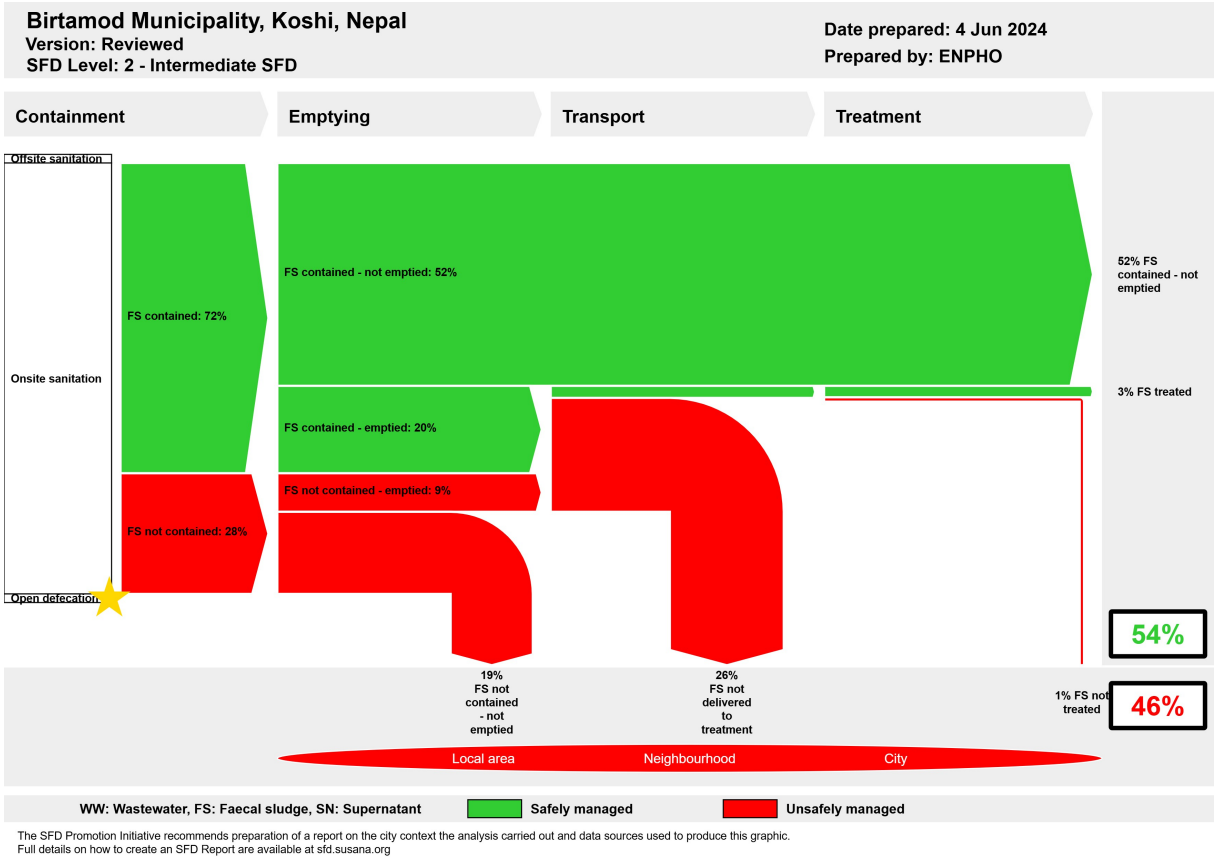


Figure 15: SFD Graphic of Birtamod Municipality.

2.5.1 Onsite Sanitation

All the population in Birtamod Municipality utilizes onsite sanitation technologies. Among them, FS from 72% of the population is appropriately stored in technically effective containment, as depicted by "FS contained" in the SFD graphic. FS from the remaining 28% 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 72% of the population is contained. The value of FS contained (72%) 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 28% of the population is not contained.

The value of FS not contained (28%) 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 52% is obtained from the proportion of the population using sanitation systems where the FS is contained and have not emptied their containment. However, this 52% 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 20% 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 9% 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. 26%, 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 plants. 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 3% which comes from the FS contained -emptied. The FS which is transported via mechanical desludging is taken to treatment plant.

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 the 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 rays. It provides the mechanism for appointing environmental inspectors 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 citizens to easy access on clean and quality drinking water, sanitation services and management of sewage and wastewater. It defines sewerage and wastewater management as construction of sewer networks and treatment plants to preserve sources of water. It is 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 tanks in the households are 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 the 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 the 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 a 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, 2019) however, the target of 90% households with toilets connected to sewer system or proper FSM is yet to be achieved.

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 policies, plans and programs. It supports, facilitates, and coordinates with federal, provincial, and local governments 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 16.

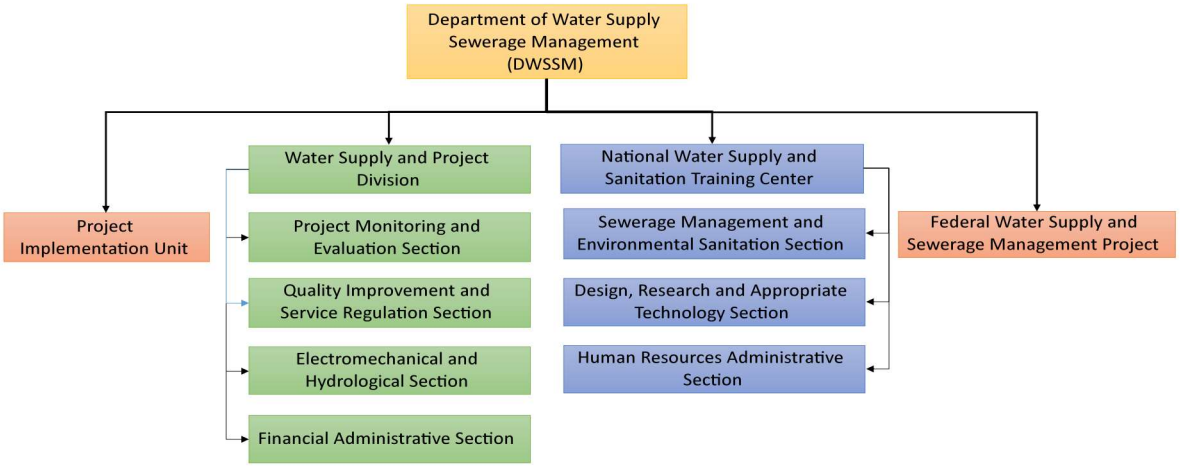


Figure 16: Organizational Structure Department of Water Supply and Sewerage Management (DWSSM).

At Provincial Government

Ministry of Water Supply, Irrigation and Energy: Ministry of water supply, Irrigation and Energy in Koshi 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: There is no dedicated sanitation section in the municipality. Instead, the sanitation related works are managed under the environment and disaster management unit. During study period, there was no formal registration system for private desludgers to provide FSM services in the municipality. Following figure 17 shows the organogram of the Birtamod Municipality.

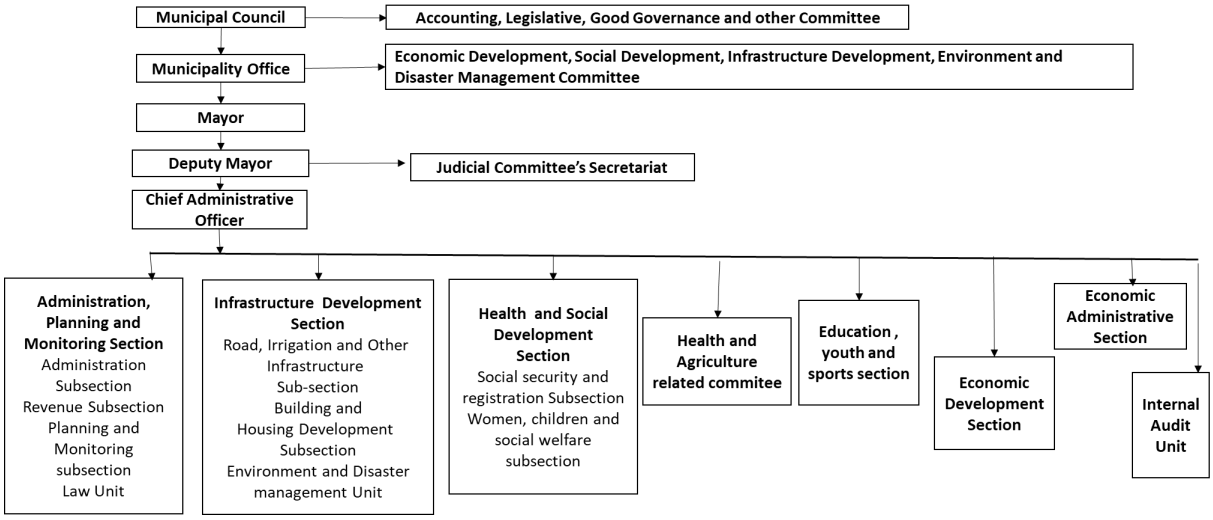


Figure 17: Organogram of Birtamod Municipality (Source: Birtamod Municipality).

3.1.3. Service provision

Urban Water Supply and Sanitation Policy 2009 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 allocated WASH focal person. It has managed faecal sludge treatment plant jointly with Buddhashanti and Mechinagar Municipality (UN habitats, 2021). There is a WASH plan procedure and guidelines. The local governments partnered with WUSCs of Charali and Karkarvitta for the operation and management of FSM services through a service level agreement. The Municipality is responsible for regulating FSM services, WUSCs are responsible for the operation and maintenance of the FSTP, and desludging and transportation is done through private operators (ADB, 2015). There is no formal registration system available for private desludgers within municipality.

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 5. However, FSM specific standards have yet to be developed and implemented.

Table 5: 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 Birtamod Municipality. The objective was to obtain a comprehensive understanding of current sanitation service practices. Ms. Pabitra devi Mahatara, Mayor and Mr. Nagendra Prasad Sangroula, Deputy Mayor of Birtamod municipality, was interviewed specifically regarding sanitation service practices, covering technical, institutional, and financial aspects. Additional interviews were conducted with Mr. Meghnath Bastola, Chairperson, and Khadka Raj Giri, Submanager of Birtamod small town Water Sanitation Users Committee. Furthermore, Mr. Rajkumar Shrestha, owner of the Jhapa septic tank desludging service, was interviewed to gain insights into faecal sludge (FS) emptying, disposal practices and treatment plant. 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. The details are provided in Table 6.

Table 6: List of Key Informant Interviewed personnel.

S.N.	Name	Designation	Organization/ Company	Purpose of KII	Date
1.	Pabitra Devi Mahatara (KII-1)	Mayor	Birtamod Municipality	Sanitation status, Ongoing projects on Sanitation, Policies and plan for Sanitation development	21 March, 2024
2.	Nagendra Prasad Sangroula	Deputy Mayor	Birtamod Municipality	Sanitation status, Ongoing projects on Sanitation, Policies and plan for Sanitation development	21 March, 2024
3.	Meghraj Bastola	Municipal staff, and Chairperson, of Birtamod Small town WSUO	Birtamod Municipality	Sanitation status, Ongoing projects on Sanitation, Policies and plan for Sanitation development	19 March, 2024
4.	Rajkumar Shrestha (KII-2)	Propreitor, Jhapa septic tank desluging service	Birtamod Municipality	Emptying practices, finances, requirement, disposal and treatment	20 March, 2024
5.	Khadka Raj Giri (KII-3)	Submanager	Birtamod Small town WSUO	Water supply services	19 March, 2024
6.	Arati Malik (KII-6)	Caretaker	Public toilet, Birtamod	Sanitation status of toilet	19 March, 2024
7.	Mr. Tanka Kumar Rijal (KII-7)	Focal Person	Charali faecal sludge treatment Plant	Functioning status and details of treatment plant	19 March, 2024

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. Ms. Pabitra Devi Mahatara, the mayor of the municipality, provided encouragement and motivated the enumerators before the survey. The pictures below depict the enumerators practicing Kobotoolbox for data collection and a group photo featuring the SFD team members and enumerators (Figure 18).




Figure 18: 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 588 households were sampled from 29,852 households distributed in 10 wards with proportionate stratification random sampling. The household samples surveyed in the municipality is shown in Figure 19.

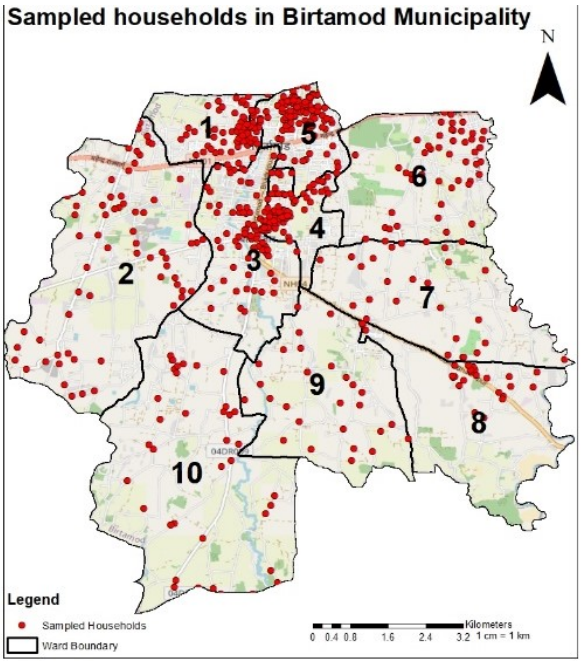


Figure 19: Distribution of sampling points in different wards of Birtamod Municipality.

4.3 Direct observation

Various sanitation technologies installed in the households of different wards were observed and visual references were kept. Furthermore, observation of containment emptying process and transportation of faecal sludge were carried out. The SFD team members observed the different containments during the field practice done by enumerators (Figure 20-left).

4.4 Sharing and validation of data

The Shit Flow Diagram (SFD) Sharing and Validation workshop was conducted in the municipality to share the findings of the sanitation situation survey and receive the suggestions from municipal stakeholders. Figure 20 (right picture) demonstrates the SFD team members presenting the SFD graphics to municipal stakeholder. Altogether 18 participants including the deputy mayor, ward chairpersons and other members from the 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 3.





Figure 20: Observation during field visit(left) and discussion on SFD in validation sharing program (right).

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 and Local Governments 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: Ms. Pabitra Devi Mahatara - Mayor, Mr. Nagendra Prasad Mahatara - Deputy Mayor of Birtamod Municipality for continuous support in the study. We would also like to thank Mr. Jayram Timsina - focal person of the municipality for facilitating the enumerators and continuous support throughout the study.

We would like to appreciate Dr. Roshan Raj Shrestha, Deputy Director of Bill and Melinda Gates Foundation (BMGF), Dr. Bernadia Irawati Tjandradewi, Secretary General of UCLG ASPAC. Similarly, we are very much obliged to Mr. Bhim Prasad Dhungana, President of MuAN and Co. President of UCLG ASPAC, and Mr. Kalanidhi Devkota, Executive Director of 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: Ms. Samjhana Baraily B.K, Sukmaya Chamling Rai, Sonu Mardi, Dhanbir Rajbanshi, Gita Silwal, Nischal Basnet, Dinesh Khadka, Sumitra Ghatraj, Subhadra Dhakal, Hima Devi Acharya for their support during the survey.

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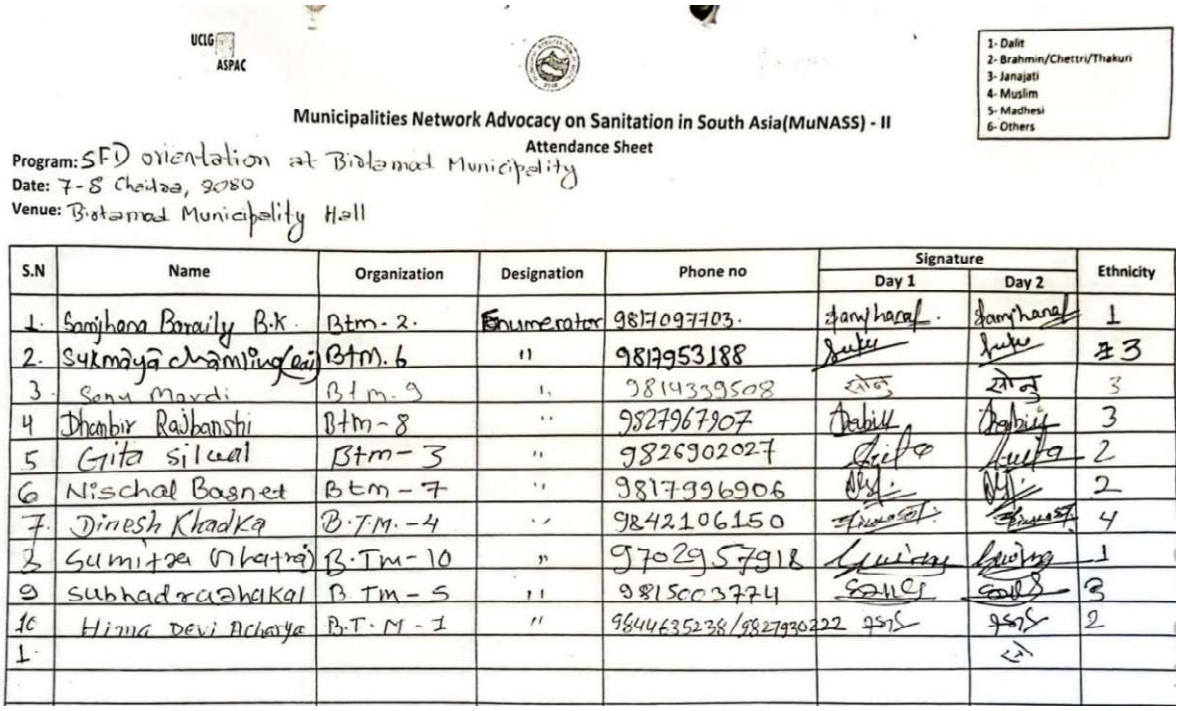
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7 Appendix

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

Appendix 2: List of enumerators in SFD orientation



UCLG ASPAC

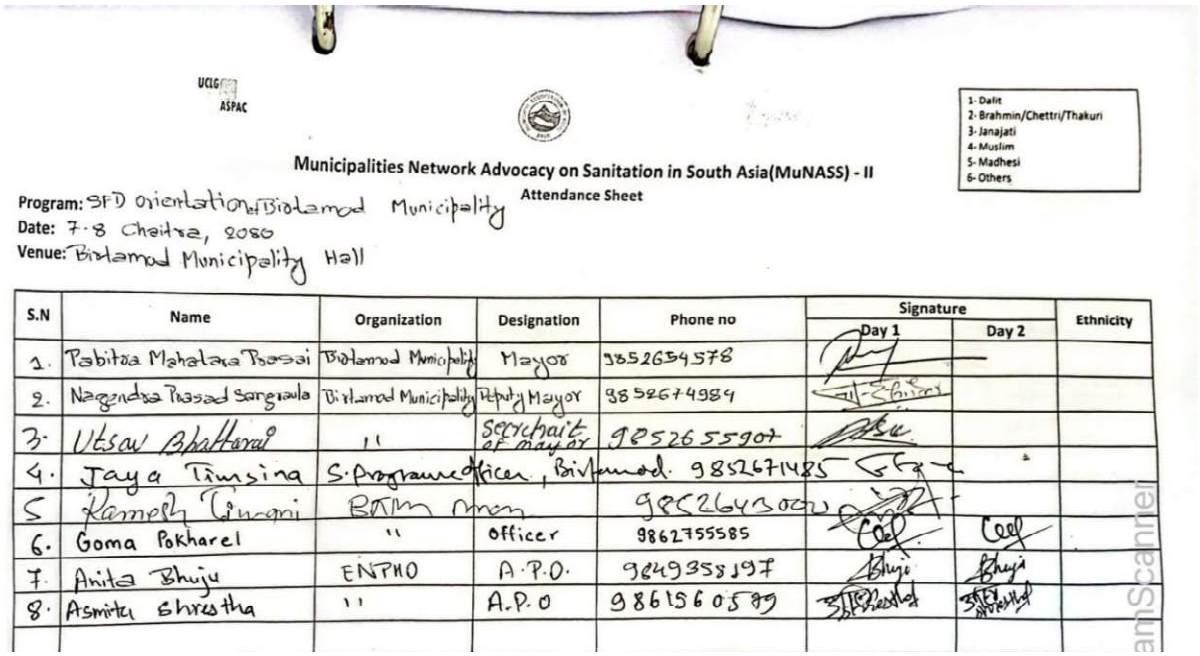
1- Dalit
2- Brahmin/Chettri/Thakuri
3- Janajati
4- Muslim
5- Madhesi
6- Others

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

Attendance Sheet

Program: SFD orientation at Birtamod Municipality
Date: 7-8 Chaitra, 2080
Venue: Birtamod Municipality Hall

S.N	Name	Organization	Designation	Phone no	Signature Day 1	Signature Day 2	Ethnicity
1.	Samjhana Baraily B.K.	Btm-2.	Enumerator	9817097703.			1
2.	Sukmaya Chamling Rai	Btm. 6	"	9817953188			3
3.	Sony Mardi	Btm-9	"	9814339508			3
4	Dhanbir Rajbanshi	Btm-8	"	9827967907			3
5	Gita Silwal	Btm-3	"	9826902027			2
6	Nischal Bagnet	Btm-7	"	9817996906			2
7.	Dinesh Khadka	B.TM.-4	"	9842106150			4
8	Sumitra Khatri	B.Tm-10	"	9702957918			1
9	Subhadra Dahal Kal	B Tm-5	"	9815003774			3
10	Hima Devi Acharya	B.T.M-1	"	9844635238/9827990222			2
1.							



UCLG ASPAC

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

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

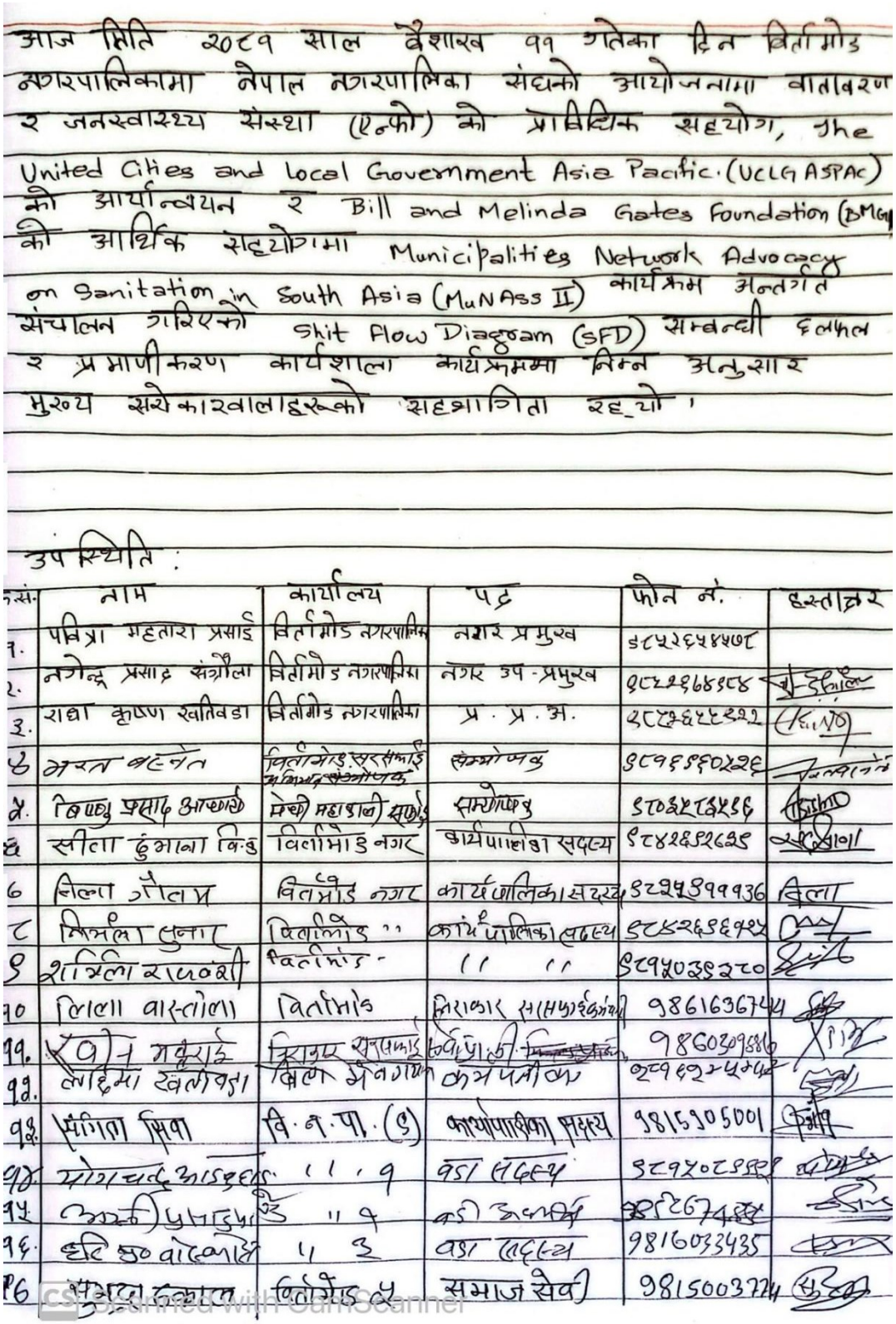
Attendance Sheet

Program: SFD orientation of Birtamod Municipality
Date: 7-8 Chaitra, 2080
Venue: Birtamod Municipality Hall

S.N	Name	Organization	Designation	Phone no	Signature Day 1	Signature Day 2	Ethnicity
1.	Pabitra Mahatara Parsai	Birtamod Municipality	Mayor	9852654578			
2.	Nagendra Prasad Sangraula	Birtamod Municipality	Deputy Mayor	9852674984			
3.	Utsav Bhattarai	"	Secretary of mayor	9852655907			
4.	Jaya Timsina	S. Programme Officer, Birtamod		9852671485			
5	Ramesh Timsina	BATM Mem		9852643007			
6.	Goma Pokharel	"	Officer	9862755585			
7.	Anita Bhuju	ENPHO	A.P.O.	9849358197			
8.	Asmita Shrestha	"	A.P.O	9861560589			

CamScanner

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



आज मिति २०८१ साल वैशाख ११ गतेका दिन बिर्तामोड नगरपालिकामा नेपाल नगरपालिका संघको आयोजनामा वातावरण र जनस्वास्थ्य संस्था (एन्फो) को प्राविधिक सहयोग, The United Cities and local Government Asia Pacific (UCLG ASPAC) को आर्थान्वयन र Bill and Melinda Gates Foundation (BMGF) को आर्थिक सहयोगमा Municipalities Network Advocacy on Sanitation in South Asia (MuNAss II) कार्यक्रम अन्तर्गत संचालन गरिएको Shit Flow Diagram (SFD) सम्बन्धी दलहल र प्रमाणीकरण कार्यशाला कार्यक्रममा निम्न अनुसार मुख्य सरोकारवालाहरूको सहभागिता रहेको ।

उपस्थिति :

क्र.सं.	नाम	कार्यालय	पद	फोन नं.	हस्ताक्षर
१.	पवित्रा महतारा प्रसाई	बिर्तामोड नगरपालिका	नगर प्रमुख	९८५२६५४५७८	
२.	नगेन्द्र प्रसाद संग्रौला	बिर्तामोड नगरपालिका	नगर उप-प्रमुख	९८५२६८४९८४	
३.	राधा कृष्ण खतिवडा	बिर्तामोड नगरपालिका	प्र. प्र. अ.	९८५२६५८२२२	
४	भरत बहेनेत	बिर्तामोड उरसल्लाई [illegible]	संयोजक	९८५६९६०५२६	
५.	विष्णु प्रसाद आचार्य	मेची महाकाली खानेपानी	सदस्य	९८०३५८३५१६	
६	सीता कुमारी विष्ट	बिर्तामोड नगर	कार्यपालिका सदस्य	९८४२६९२६३९	
६	निला गौतम	बिर्तामोड नगर	कार्यपालिका सदस्य	९८२५९९९९३६	
८	मिर्मला पुनार	बिर्तामोड "	कार्यपालिका सदस्य	९८६२६९६४५५	
९	शर्मिला राजवंशी	बिर्तामोड-	" "	९८९५०३९३८०	
१०	लिला वास्तोला	बिर्तामोड	निराकार सामाजिक संस्था	९८६१६३६५५५	
११.	[illegible]	[illegible]	[illegible]	९८६०३०९६८८	
११.	लक्ष्मी खतीवडा	बिर्तामोड नगरपालिका	कार्यपालिका	९८५६२५५५८२	
१२.	संगिता मिश्र	वि.न.पा. (९)	कार्यपालिका सदस्य	९८१५९०५००१	
१३.	योगचन्द्र आइहस	" " ९	वडा सदस्य	९८५२०८९९९९	
१४	[illegible]	" ९	वडा अध्यक्ष	९८१८६७४९९	
१६.	हरि प्र० वोल्होरे	" ३	वडा सदस्य	९८१६०३३४३५	
१६	[illegible]	बिर्तामोड ५	समाज सेवी	९८१५००३७५५	

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क्र.सं	नाम	कार्यालय	पद	फोन नं.	हस्ताक्षर
18.	रमेश तिवारी	बिर्तामोड नगर.	प्रमुख कार्यकारी	9842382000	
19.	पुष्पकुमार पौडेल	वार्ड नं.3 - 9	अनौपचारिक (नगरी)	9842382488	
20.	राजेन्द्र श्रेष्ठ	ENPHO	P.D.	9851042148	
21.	बुद्ध वज्राचार्य	"	P.C.	9849132020	
22.	अनिता भुजू	"	A.P.O.	9849358197	

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Appendix 4: Glimpses of KIIs









SFD Birtamod Municipality, Nepal, 2026

Produced by:

Asmita Shrestha, ENPHO

Anita Bhuju, ENPHO

Buddha Bajracharya, ENPHO

Jagam Shrestha, ENPHO

Rupak Shrestha, ENPHO

Sabuna Gamal, ENPHO

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