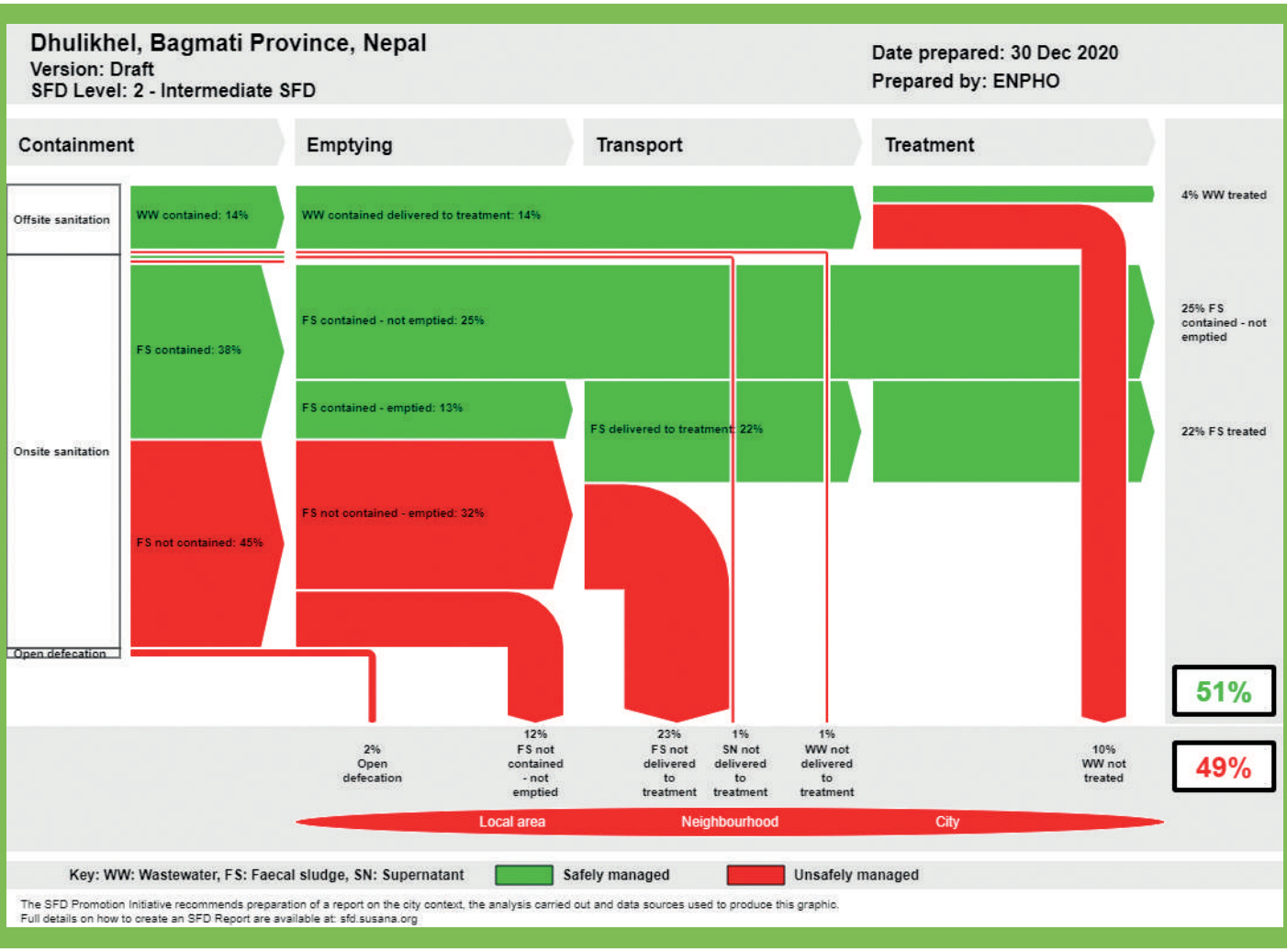
Shit Flow Diagram (SFD)

Report of Dhulikhel Municipality, Nepal



Final Report
2020

Prepared by

Environment and Public Health Organization (ENPHO)

SFD Report Dhulikhel, Nepal, 2020

Produced by: Environment and Public Health Organization, ENPHO

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This Executive Summary and SFD Report are available from:

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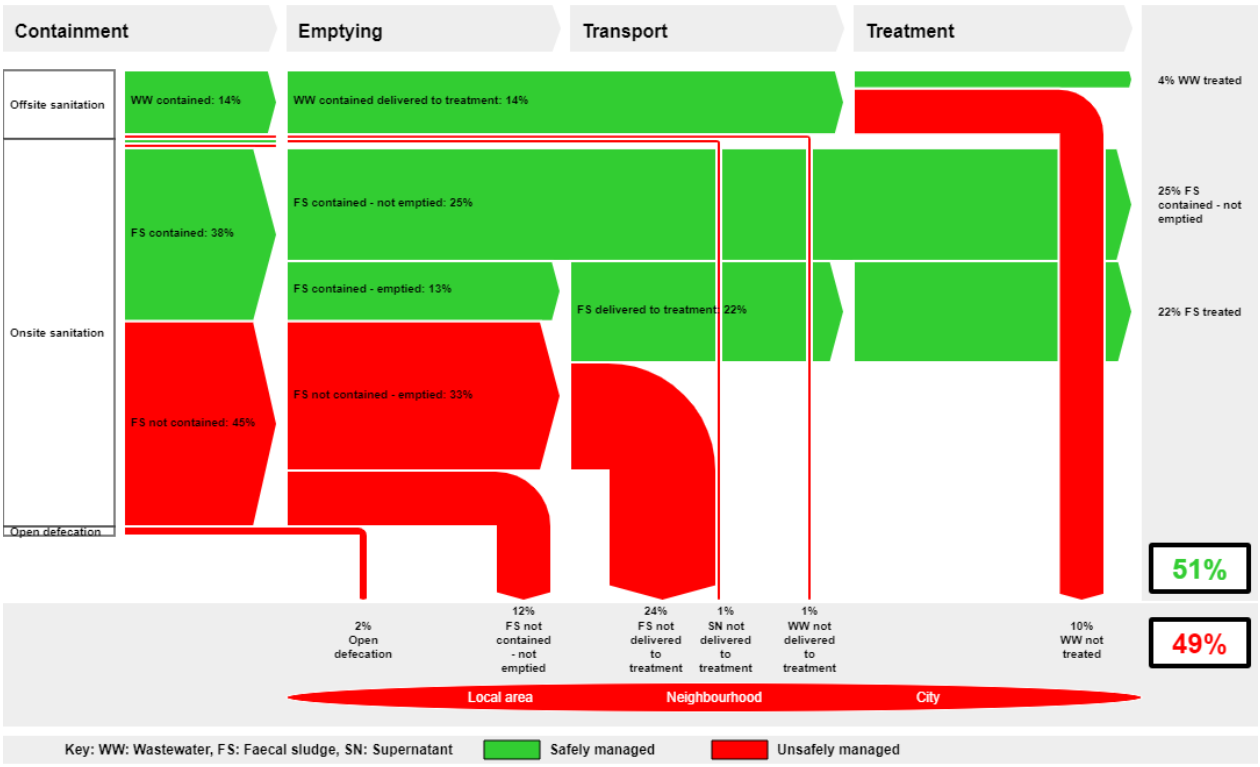
1. The Diagram

Dhulikhel, Bagmati Province, Nepal
Version: Reviewed
SFD Level: 2 - Intermediate SFD

Date prepared: 30 Dec 2020
Prepared by: ENPHO



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:

Intermediate. Level 2 report.

Produced by:

Environment and Public Health Organization (ENPHO)

Collaborating partners:

Dhulikhel Municipality,

Municipal Association Nepal (MuAN),

United Cities and Local Government- Asia Pacific (UCLG- ASPAC)

Status:

Final SFD report.

Date of production:

30/12/2020

3. General city information

Dhulikhel municipality is located in Kavrepalanchok district of Bagmati province, Nepal. The municipality is divided into 12 wards. The municipality is home to 33,981 people as per census 2011. The population growth rate was 0.65% per year from 2001 to 2011.

There are two major highways, B.P highway and Arniko Highway which pass through Dhulikhel. Dhulikhel is located at Eastern rim of Kathmandu Valley, south of Himalayas at 1,550 m above sea level and is situated 30 km southeast of Kathmandu and 74 km southwest of Kodari.

The climate in Dhulikhel is warm and temperate. In winter, there is much less rainfall than in summer. The climate here is classified as Cwb by the Köppen-Geiger system. In Dhulikhel, the average annual temperature is 16.7 °C | 62.1 °F. The rainfall here is around 1,711 mm (Climate data .org, n.d.).

4. Service outcomes

The overview of different sanitation technologies across the sanitation value chain in the municipality is briefly explained in this section.

Containment: The municipality has been declared open defecation free zone. The municipality has few communities, 14% of Households (HHs), connected with sewer networks and majority depends on onsite sanitation systems. At the household level, the majority of houses have installed lined tanks with open bottom and septic tanks while the households at rural areas have installed biogas digesters and lined pits with semi-permeable walls which can be either twin pits or single pits. Also, a significant proportion of the population use unlined pits.

Most of the institutions have been established and operated in the core urban area of the municipality. It was observed that 26.8% of the institutions have systems that consist of either fully lined tanks or septic tanks. While a significant number of institutions also have installed lined tanks with impermeable walls and open bottom (25.9%) and single pits mostly in rural areas (17%).

Dhulikhel Drinking Water and Sanitation Users Committee has been providing drinking water since early 90s in the core traditional urban areas of the municipality. The major source of water is Kharkhola River located 14 km far from the city. Besides this, local springs are tapped and recently, a deep bore has been installed to extract the groundwater.

Emptying and Transportation: Both traditional manual scavenging and mechanical emptying of the containments are practised in the municipality. Septic tanks are being regularly emptied mechanically. The sanitation worker from the municipality revealed that 90% of Faecal Sludge (FS) from the septic tanks and fully lined tanked are pumped by the desludging vehicle.

However, the anaerobic biogas digester has been designed in such way that treated slurry is automatically overflowed from the outlet chamber and used as manure. Thus, the toilet connected to an anaerobic biogas digester has been assumed as regularly emptied.

Treatment and Disposal/ End Use: The FS emptied by the sanitation section of the municipality is disposed of in a landfill site without treatment. However, occasionally, it is fed into biogas digester in Shrikhandpur WasteWater Treatment Plant (WWTP).

5. Service delivery context

Access to drinking water and sanitation has been defined as fundamental rights of 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 billed the Water Supply and Sanitation Law 2018 which has emphasized in 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 placed to accomplish the sanitation need of people. Particularly, NSHMP 2011 has proved as an important strategic document for all stakeholders to develop uniform programs and implementation mechanism at all level. It strengthens institutional set up with the formation of water and sanitation coordination committee at every tier of government to actively engage into sanitation campaign. The document adopted sanitation facilities as improved, basic and limited in line with WHO/UNICEF guideline. The sanitation campaign throughout the country was focused to achieve universal access to improved sanitation.

The draft Sector Development Plan (SDP) has envisioned the delineation of roles and responsibility of federal, provincial and local government in an aim to initiate sustainability of Open Defecation Free (ODF) outcomes from sanitation campaign and way forward to post ODF. It mainly emphasized sector convergence, institutional and legal reforms, and capacity development of the service providers. Together, with a commitment to Sustainable Development Goal (SDG) and promulgation of Total Sanitation Guideline 2017, it assists the service provider with clear indicators and targets to be achieved. The latest outcome, specifically to manage Faecal Sludge Management (FSM) in the country is the Institutional and Regulatory Framework for Faecal Sludge Management. The framework envisaged featuring of FSM on national policies through the federal government and issuing policy directives at the local level along with enhancing the capacity of the service providers. The overall planning, implementation and regulating of FSM service chain have been authorized to local government. In this regard, the local government can develop a partnership with either private sector or water and sanitation user committee for effective service delivery. However, the local government has yet to develop rules and regulations, and standards

to effectively deliver services across the sanitation value chain.

6. Overview of stakeholders

Based on the regulatory framework for FSM, the major stakeholders for effective and sustaining service delivery are presented in Table 1.

Table 1 Overview of Stakeholders.

Key Stakeholders	Institutions / Organizations /
Public Institutions at Federal Government	National Planning Commission, Ministry of Water Supply and Sanitation, Ministry of Environment and Population, Ministry of Federal Affairs and General Administration, Department of Water Supply and Sewerage, Department of Environment, Local Government (Municipal Council)
Public Institutions at local Government	Municipality Dhulikhel Water Supply User's Committee
Non-governmental Organizations	Environment and Public Health Organization (ENPHO)
Development Partners, Donors	MuAN, BMGF,UCLG ASPAC

7. Credibility of data

The major data were collected from a random household sampling. Altogether, 376 households and 159 institutions were surveyed from all the wards of the municipality. The primary data on emptying and transportation were validated with Key Informant Interviews (KIIs) from private entrepreneurs and sanitation section of the municipality. The overall data and findings were shared with the stakeholders of the municipality and validated through a sharing program.

The major limitation during the collection of data was the types of containments: whether it was lined or unlined was based upon the responses from the respondent.

8. Process of SFD development

The data on the sanitation situation were collected through a household survey (ENPHO, 2019). The community mobilizers from the sub-metropolitan were mobilized after providing the orientation on sanitation technologies, objectives of the survey and using a mobile application for the survey. Also, KIIs were conducted with officers form the municipality, water supply system, town development committee and private emptying entrepreneurs to understand the situation across the service delivery chain. For the production of the SFD graphic, initially, a relationship between the sanitation technology used in a questionnaire survey and the SFD-PI methodology was made. Then, data were fed in the graphic generator to produce the SFD graphic.

9. List of data sources

- MoAC. (2011). *Disaster Risk Management Plan: Siraha District.* Kathmandu, Nepal: Ministry of Agriculture and Cooperatives, Government of Nepal.
- MoPE. (2017). *National Population Report 2017.* Singha Dardar, Kathmandu: Ministry of Population and Environment.
- MoWSS. (2016). *Water Service Providers: Capacity Assessment and Benchmarking Data year 2071-72 (2014-15).* Kathmandu, Nepal: Sector Efficiency Improvement Unit (SEIU), Ministry of Water Supply and Sanitation, Government of Nepal.

Dhulikhel, Nepal, 2020

Produced by:

Environment and Public Health Organization

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Buddha Bajracharya, Project Coordinator.

This Executive Summary and the SFD Report are available from: www.sfd.susana.org

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Abbreviations

BGS	British Geological Survey
BMGF	Bill and Melinda Gates Foundation
CBS	Central Bureau of Statistics
DWSS	Department of Water Supply and Sewerage
ENPHO	Environment and Public Health Organization
FS	Faecal Sludge
FSM	Faecal Sludge Management
GON	Government of Nepal
IRF	Institutional and Regulatory Framework
KII	Key Informant Interview
MoAC	Ministry of Agricultural and Cooperatives
MOF	Ministry of Finance
MOFAGA	Ministry of Federal Affairs and General Administration
MOPPW	Ministry of Physical Planning and Works
MOWSS	Ministry of Water Supply and Sanitation
NDWQS	National Drinking Water Quality Standards
NPC	National Planning Commission
NRWSSSP	National Rural Water Supply and Sanitation Sector Policy
NSHMP	National Sanitation and Hygiene Master Plan
NUWSSSP	National Urban Water Supply and Sanitation Sector Policy
ODF	Open Defecation Free
PPE	Personal Protective Equipment
PPP	Public Private Partnership
SDG	Sustainable Development Goal
SDP	Sector Development Plan
SFD	Shit Flow Diagram

SFD-PI	Shit Flow Diagram Promotion Initiative
UCLG ASPAC	United Cities Local Government Asia Pacific
UNICEF	United Nations Children's Education Fund
USAID	United States
VDC	Village Development Committee
WASH	Water, Sanitation and Hygiene
WEDC	Water Engineering and Development Centre
WHO	World Health Organization
WWTP	WasteWater Treatment Plant

1 City context

Dhulikhel is a municipality in Kavrepalanchok District of Nepal. Two major highways, B.P. Highway and Arniko Highway, pass through Dhulikhel. Araniko Highway connects Kathmandu, Nepal's capital city with Tibet's border town of Kodari. Dhulikhel is located at the Eastern rim of Kathmandu Valley, south of the Himalayas at 1,550 m above sea level and is situated 30 km southeast of Kathmandu and 74 km southwest of Kodari. The majority of people in Dhulikhel is Newars, but Brahmin, Chhettri, Tamang and Dalit are also living in the outer area of the town. The geographical map of Dhulikhel municipality is shown in Figure 1.

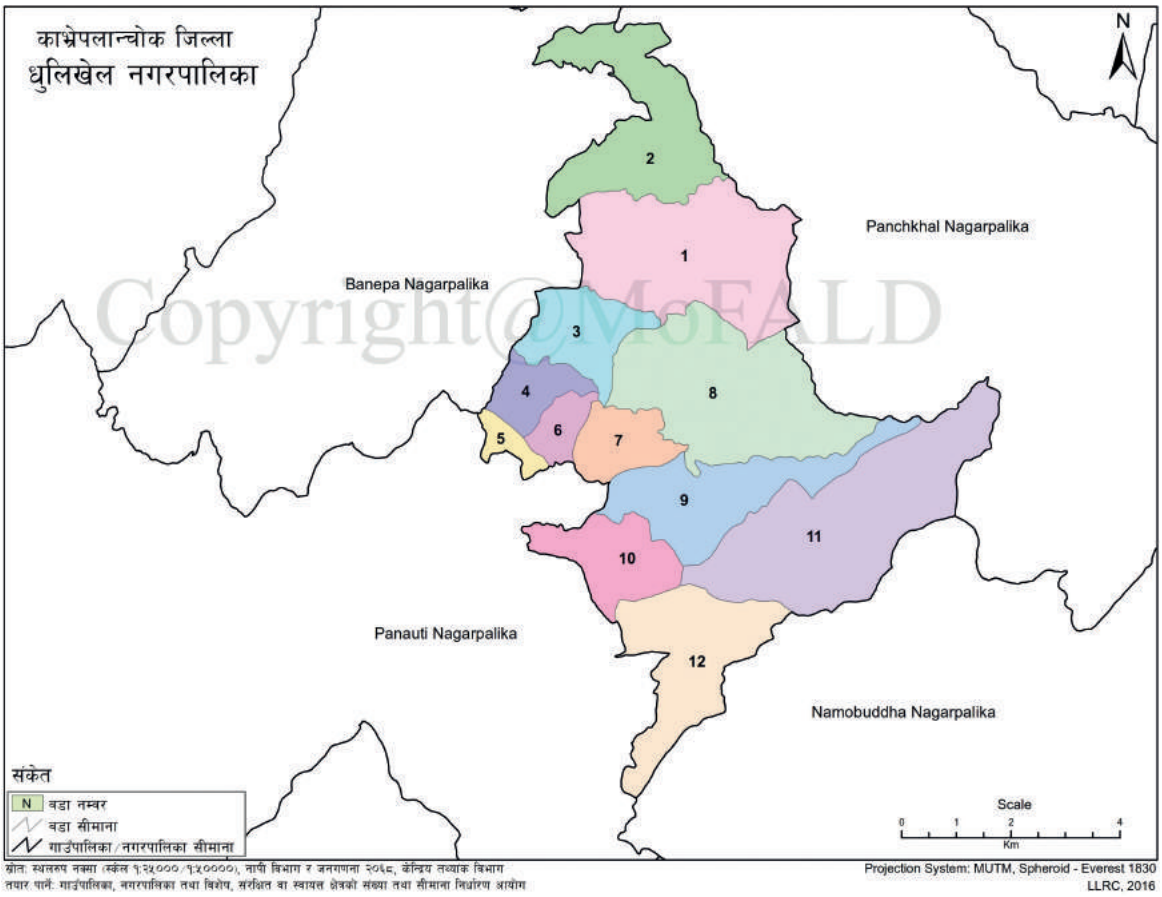

Figure 1: Location map of Dhulikhel municipality.

1.1 Population

As per the figures of Central Bureau of Statistics in 2011, the total population of Dhulikhel municipality is 33,981 with 16,675 male and 17,306 female. However, in total, 31,596 people reside in 6,505 households as per the KII with the head of social development unit in the municipality. The latter figure (31,596) was considered to produce the SFD graphic. The population density is 582 per km^2 with an average growth rate of 0.65. There are 7,039 households with average size of 4.5.

1.2 Geography

Dhulikhel municipality was established on 2043/11/05 (02/17/1987 in Gregorian calendar) constituting 9 wards. It is located 30 km to the east of Kathmandu valley. At present, with the expansion of the area, the municipality consists of 12 wards covering a total area of 54.62 km^2. Dhulikhel is located at the Eastern rim of Kathmandu Valley, south of the Himalayas at 1,550 m above sea level and is situated 30 km southeast of Kathmandu and 74 km southwest of Kodari.

1.3 Climate

The climate in Dhulikhel is warm and temperate. In winter, there is much less rainfall than in summer. The climate here is classified as Cwb by the Köppen-Geiger system. In Dhulikhel, the average annual temperature is 16.7 °C | 62.1 °F. The rainfall here is around 1,711 mm (Climate data .org, n.d.).

2 Service Outcomes

2.1 Overview

The municipality was declared Open Defecation Free Zone in 2018. However, approximately 2% of the households at rural and isolated settlement do not have their own toilet. Majority of households located at the areas recently merged in the municipality have onsite sanitation systems. While, the traditional urban clusters in ward numbers 5, 6 and 7 such as Khadpu, Ekache, Nastole, Lasangko tole, Chochhe, Etole, Dutole, Hospital area, Hurkha, Sarashwati Bajar, Watole, Guthucha, Adda Bajar, Sanjiwani Bazar, Buspark area, Dutole, Watole and so on, are facilitated with municipal sewer networks. Particularly, Decentralized Combined Sewer (DCS) is installed in the ward number 5 which is connected to Shreekhandapur Wastewater Treatment Plant (WWTP). The treatment plant is being managed and operated by community level organization. Similarly, Centralized Combine Sewer (CCS) networks from ward number 6 and 7 are connected to WWTPs located at Thakuri Gaun and Pipal Bot area of the municipality. Both these treatment plants managed by the municipality are defunct and requires major rehabilitation. Moreover, direct discharge of wastewater from toilets into water bodies or open drains were observed in few rural areas.

2.1.1 Household level sanitation system

Household level sanitation technologies vary in urban and rural areas of the municipality. In urban cluster, majority of households are connected to sewer network. While those without access to sewer network have fully lined tanks, lined tanks with impermeable walls and septic tanks. While in rural areas of the municipality, the majority of households have anaerobic biogas digesters and pits. The distribution of the various types of sanitation technologies installed in the households is shown in Figure 2.

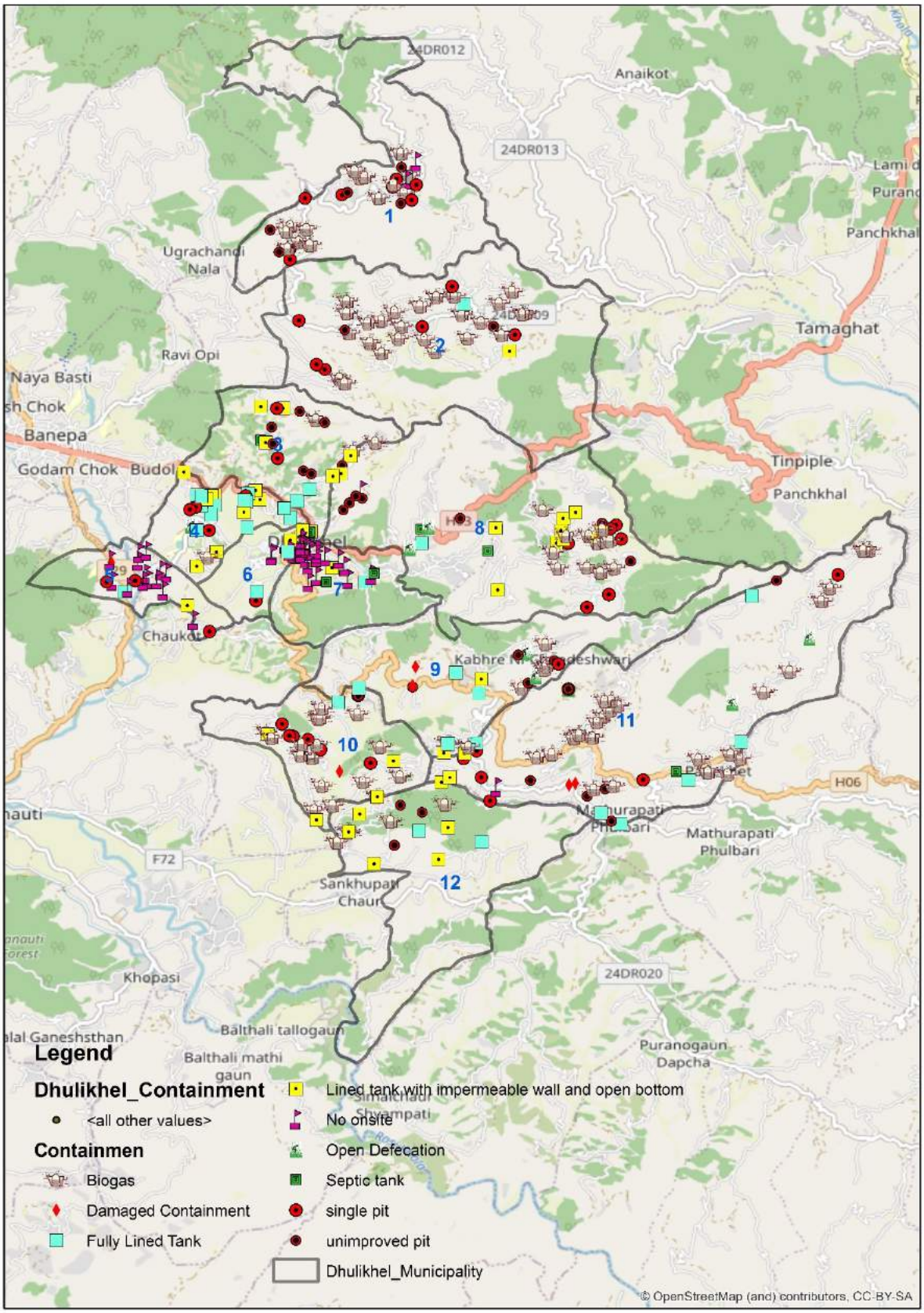

Figure 2: Distribution of various types of sanitation technologies installed in households in Dhulikhel municipality.

2.1.2 Institutional level sanitation system

Majority of institutions are located in the core urban area of the municipality. These institutions have direct access to centralized sewer network and thus 26.7% of institutions have toilets connected to sewer network. While, 25.9% have toilets connected to lined tanks with impermeable walls and open bottom, 26.8% have toilets connected to either septic tanks or fully lined tanks. Also, institutions in rural area have single pits. Whereas, approximately 11.6% of institutions operating in rented buildings do not know the type of containments in the building (ENPHO, 2019).

The distribution of various types of sanitation technologies in institutional buildings in Dhulikhel municipality is shown in Figure 3.

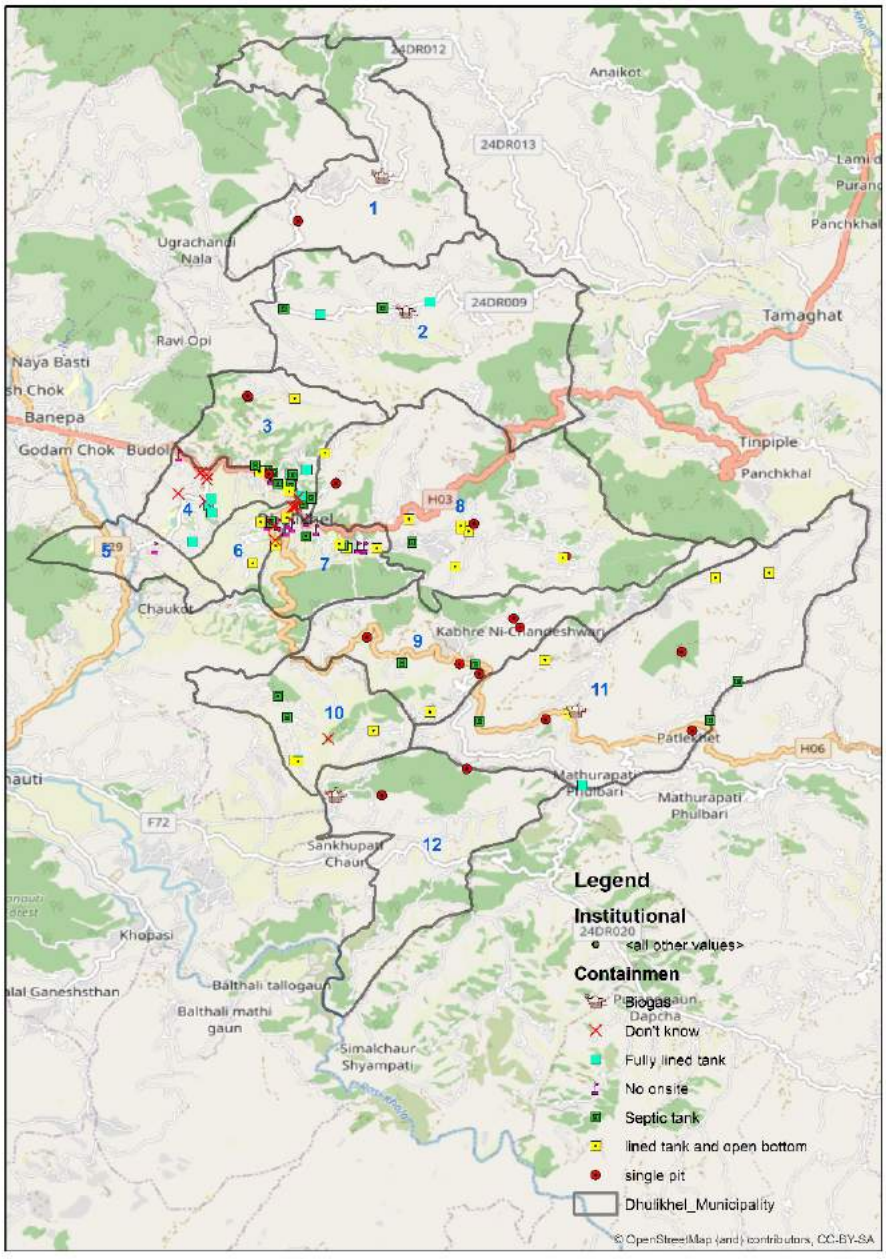

Figure 3: Distribution of various types of sanitation technologies in institutional buildings in Dhulikhel municipality.

The various types of sanitation technologies selected for the SFD graphic generator is shown in the SFD selection grid, as shown in Figure 4.

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	T1A1C1		T1A1C3		Significant risk of GW pollution Low risk of GW Pollution	T1A1C6				Not Applicable
Septic tank	T1A2C1				T2A2C5 T1A2C5	T1A2C6			T1A2C9	
Fully lined tank sealed	T1A3C1				Significant risk of GW pollution T1A3C5			T1A3C8		T1A3C10
Lined tank with impermeable walls and open bottom	Significant risk of GW pollution T1A4C1	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 T1A4C5			T1A4C8		Significant risk of GW pollution T1A4C10
Lined pit with semi-permeable walls and open bottom	Not Applicable									T2A5C10 T1A5C10
Unlined pit										T2A6C10 T1A6C10
Pit (all types), never emptied, 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 pit latrine) failed, damaged, collapsed or flooded									T1B10 C7 TO C9	
No toilet Open defecation	Not Applicable								T1B11 C7 TO C9	Not Applicable

Figure 4: SFD selection grid for Dhulikhel municipality.

2.2 SFD matrix

Figure 5 shows the SFD matrix of Dhulikhel municipality with the proportion of Faecal Sludge (FS) in septic tanks, fully lined tanks and open bottom tanks and pits. Also, it shows the proportion of the population using the different types of sanitation systems and information on the proportion of faecal sludge emptied, transported and treated. The proportion of FS in septic tanks, fully lined tanks and lined tanks with open bottom/all types of pits (step two of the graphic generator) was set to 80%, 99% and 99%, respectively, as per the guidance given in the Frequently Asked Questions (FAQs) in the Sustainable Sanitation Alliance (SuSanA) website.

Dhulikhel, Bagmati Province, Nepal, 30 Dec 2020. SFD Level: 2 – Intermediate SFD
Population: 31596
Proportion of tanks: septic tanks: 80%, fully lined tanks: 99%, lined, open bottom tanks: 99%

System Label	Pop	W4a	W5a	W4b	W5b	W4c	W5c	F3	F4	F5	S4d	S5d	S4e	S5e
System description	Proportion of population using this type of system	Proportion of wastewater in sewer system, which is delivered to centralised treatment plants	Proportion of wastewater delivered to centralised treatment plants, which is treated	Proportion of wastewater in sewer system, which is delivered to decentralised treatment plants	Proportion of wastewater delivered to decentralied treatment plants, which is treated	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	Proportion of supernatant in sewer system, which is delivered to treatment plants	Proportion of supernatant in sewer system, that is delivered to treatment plants	Proportion of supernatant in open drain or storm sewer system, which is delivered to treatment plants	Proportion of supernatant in open drain or storm sewer system that is delivered to treatment plants which is treated
T1A1C1 Toilet discharges directly to a centralised combined sewer	10.0	100.0	0.0											
T1A1C3 Toilet discharges directly to a decentralised combined sewer	4.0			100.0	100.0									
T1A1C6 Toilet discharges directly to open drain or storm sewer	1.0					0.0	0.0							
T1A2C1 Septic tank connected to a centralised combined sewer	1.0							0.0	0.0	0.0	0.0	0.0		
T1A2C5 Septic tank connected to soak pit	1.0							67.0	0.0	0.0				
T1A2C6 Septic tank connected to open drain or storm sewer	1.0							90.0	0.0	0.0			0.0	0.0
T1A2C9 Septic tank connected to 'dont'know where'	1.0							90.0	0.0	0.0				
T1A3C1 Fully lined tank (sealed) connected to a centralised combined sewer	1.0							0.0	0.0	0.0	0.0	0.0		
T1A3C10 Fylly lined tank (sealed), no outlet or overflow	8.0							39.0	0.0	0.0				
T1A3C5 Fully lined tank (sealed) connedted to a sak pit	1.0							0.0	0.0	0.0				
T1A3C8 Fully lined tank (sealed) connected to open ground	31.0							90.0	80.0	100.0				
T1A4C1 Lined tank with impermeable walls and open bottom, connected to centralised combined sewer	1.0							0.0	0.0	0.0	0.0	0.0		
T1A4C10 Lined tank with impermeable walls and open bottom, no outlet or overflow	7.0							48.0	0.0	0.0				
T1A4C5 Lined tank with impermeable walls and open bottom, connected to a soak pit	2.0							63.0	0.0	0.0				
T1A4C8 Lined tank with impermeable walls and open bottom, connected to open ground	2.0							43.0	0.0	0.0				
T1A5C10 Lined pit with semi-permeable walls and open bottom, no outlet or overflow	8.0							32.0	0.0	0.0				
T1A6C10 Unlined pit, no outlet or overflow	8.0							30.0	0.0	0.0				
T1B10 C7 TO C9 Containment (Septic tanks, fully fined tanks, partially lined tanks and pits, and unlined pits) failed, damaged, collapsed or flooded - connected to water bodies, or open ground or 'don't know where'	2.0							0.0	0.0	0.0				
T1B11 C7 TO C9 Open defection	2.0													
T2A2C5 Septic tank connected to soak pit, where there is a 'significant risk' of groundwater pollution	1.0							0.0	0.0	0.0				
T2A5C10 Lined pit with semi-permeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	4.0							45.0	0.0	0.0				
T2A6C10 Unlined pit, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	3.0							30.0	0.0	0.0				

Figure 5: SFD matrix of Dhulikhel municipality.

2.2.1 SFD matrix explanation

The sanitation technologies and the corresponding percentage of the population using those systems in the municipality are shown in Table 1.

Table 1: Sanitation technologies with SFD reference variable and percentage of the population using each type.

	Sanitation Technologies	SFD Reference Variable	Percentage of Population
1	Toilet discharges directly to centralized combined sewer	T1A1C1	10%
2	Toilet discharges directly to decentralized combined sewer	T1A1C3	4%
3	Toilet discharges directly to open drain or storm sewer	T1A1C6	1%
4	Septic tank connected to a centralized combined sewer	T1A2C1	1%
5	Septic tank connected to soak pit	T1A2C5	1%
6	Septic tank connected to open drain or storm sewer	T1A2C6	1%
7	Septic tank connected to 'don't know where'	T1A2C9	1%
8	Fully lined tank (sealed) connected to centralized combined sewer	T1A3C1	1%
9	Fully lined tank (sealed), no outlet or overflow	T1A3C10	8%
10	Fully lined tank (sealed) connected to soak pit	T1A3C5	1%
11	Fully lined tank (sealed) connected to open ground	T1A3C8	31%
12	Lined tank with impermeable walls and open bottom, connected to centralized combined sewer	T1A4C1	1%
13	Lined tank with impermeable walls and open bottom, no outlet or overflow	T1A4C10	7%
14	Lined tank with impermeable walls and open bottom, connected to soak pit	T1A4C5	2%
15	Lined tank with impermeable walls and open bottom, connected to open ground	T1A4C8	2%
16	Lined pit with semipermeable walls and open bottom, no outlet or overflow,	T1A5C10	8%
17	Unlined pit, no outlet or overflow	T1A6C10	8%
18	Containment (septic tanks, fully lined tanks, partially lined tanks and pits, and unlined pits) failed, damaged, collapsed or flooded – connected to water bodies, or open ground or 'don't know where'	T1B10C7 to C9	2%
19	Open defecation	T1B11C7 To C9	2%
20	Septic tank connected to soak pit, where there is a significant risk of groundwater pollution	T2A2C5	1%
21	Lined pit with semipermeable walls and open bottom, no outlet or overflow, where there is a significant risk of groundwater pollution	T2A5C10	4%
22	Unlined pit, no outlet or overflow where there is a significant risk of groundwater pollution	T2A6C10	3%

Sanitation technologies referred as T1AxCy and T2AxCy, where Ax represents the type of sanitation system such as septic tank, fully lined tank and so on, and Cy represents the connection of effluents such as soak pit, sewer network, no outlet and so on. Here, sanitation technologies under T1 represent the technologies which have low risk towards potential groundwater contamination. While T2 types of sanitation technologies have a high risk of groundwater contamination in the given geographical context and types of water sources used for drinking purposes.

14% of the population has toilets connected directly to either centralise combined sewer or decentralised combined sewer systems while 1% have toilets connected to open drain. The technically appropriate installation of a septic tank is used by 5% of the population in the municipality. However, only 1% of these have the effluent connected to a soak pit with low risk of groundwater contamination. Similarly, 41% of the population use a toilet connected to a fully lined tank, where 31% corresponds to anaerobic biogas digesters in which treated effluent is discharged into open land. The anaerobic biogas digester is assumed to be a fully lined tank which is emptied regularly and capable of self-treatment of the sludge.

Figure 6: Fully lined tank at household in Dhulikhel municipality.

The people living in the newly constructed buildings in emerging urban areas without access to sewer system use lined tanks with impermeable walls and open bottom. In an aggregate, 16% of the population use lined tanks with impermeable walls and open bottom among which, only 4% has high risk towards potential groundwater contamination. Whereas, the people living in rural area use single pits either lined pits constructed from concrete rings or unlined pits.

Figure 7: A concrete single pit installed at households in Dhulikhel municipality.

2.2.2 Risk of groundwater pollution

The risk of groundwater pollution is assessed according to the following explained criteria.

i. Sources of Drinking Water and Water Production

Dhulikhel Drinking Water and Sanitation Users Committee has been providing drinking water since early 90s in the core traditional urban areas of the municipality. The major source of water is Kharkhola River located 14 km far from the city. Water is treated in a well-established water treatment plant and supplied water maintaining WHO guideline (Devkota K., 2018). Currently, 2,762 private taps are connected in its service area serving 29,600 people. The scheme consists of a horizontal roughing filter, slow sand filter and chlorination unit for disinfection. The quality of treated water, as citied by a report published by network of water technology in Asia and pacific from K, Raut, is in compliance with National Drinking Water Quality Standards (NDWQS) as shown in Table 2 (NewTap, 2016).

Table 2: Raw water and treated water quality of the drinking water treatment plant.

Parameters	Unit	Raw water	Treated water	NDWQS 2005
pH	-	7.5 (at 19.5°C)	8.2 (at 18.5°C)	6.5-8.5
Electrical conductivity	µS/cm	205	212.5	1,500
Turbidity	NTU	<1	<1	5
Total hardness	mg/L as $CaCO_3$	121	116	500
Fluoride	mg/L	<0.5	<0.5	0.5-1.5
Iron	mg/L	<0.05	<0.05	0.3
Manganese	mg/L	<0.05	<0.05	0.2
Ammonia	mg/L	<0.05	<0.05	1.5
Nitrate	mg/L	1.4	1.2	50
Total *Coliform*	MPN/100mL	190	0	0
E.Coli	MPN/100mL	80	0	0

NTU: Nephelometric Turbidity Unit
MPN: Most Probable Number

Besides, many water users committee such as Deurali (Sisnekhola), Aaiselu Jhyang, Chisapani, Dhulodhungya, Jukay khola, Kalodhungye, Kavrebhanjyang, Mathilo Kuttal, and Naya gaun Drinking Water Supply schemes supplies piped drinking water in the remaining service areas of the municipality.

The survey carried out in 2019 showed that almost 93% of the households have access to piped drinking water supply services through either a private household tap or public taps operated by the water user's committee. While remaining households rely on tube wells and unprotected spring sources which are considered to have risk of contamination.

2.2.3 Emptying of faecal sludge

Emptying is one of the major components of the sanitation value chain since it ensures proper functioning of containment. For a septic tank, it functions well until the volume of sludge is one-third of the total volume of the tank. Also, in other containments, regular emptying prevents overflow of the sludge and blockages. However, the anaerobic biogas digester has been designed in such way that treated slurry is automatically overflowed from the outlet chamber which is used as manure. Thus, the toilet connected to anaerobic biogas digester has been assumed as regularly emptied.

Both traditional manual scavenging and mechanical emptying of the containments are practised in the municipality (Figure 8). Septic tanks are being regularly emptied mechanically. The sanitation worker from the municipality revealed that 90% of Faecal Sludge (FS) from the septic tanks and fully lined tanks is pumped by the desludging vehicle. Thus, in an overall, the portion of FS emptied (variable F3) for septic tanks connected to soak pit (T1A2C5) is 67% and for open drain and unknown connection (T1A2C6 and T1A2C9) is 90%. The portion of FS from anaerobic biogas digester considered as fully lined tank (sealed) connected to open ground (T1A3C8) is 90% which is delivered to treatment (variable F3 set to 90%).

While only 80% of FS from other containments are emptied and the portion of FS (variable F3) remained below 50% as shown in Table 3.

Figure 8: Containment being emptied mechanically and manually in Dhulikhel municipality.

Table 3: Sanitation technologies and and proportion of faecal sludge emptied.

S.N.	Sanitation Technology	SFD Reference Variable	Percentage of Emptied containment	Emptied Portion of FS	Actual Proportion of emptied FS (Variable F3)
1	Septic tank connected to soak pit	T1A2C5	74%	90%	**67%**
2.	Septic tank connected to open drain or storm sewer	T1A2C6	100%	90%	**90%**
3.	Septic tank connected to 'don't know where'	T1A2C9	100%	90%	**90%**
4.	Fully lined tank (sealed), no outlet or overflow	T1A3C10	43%	90%	**39%**
5.	Fully lined tank (sealed), to open ground	T1A3C8	100%	90%	**90%**
6.	Lined tank with impermeable walls and open bottom, no outlet or overflow	T1A4C10	60%	80%	**48%**
7.	Lined tank with impermeable walls and open bottom, connected to soak pit	T1A4C5	54%	80%	**43%**
8.	Lined pit with semipermeable walls and open bottom, no outlet or overflow	T1A5C10	40%	80%	**32%**
9.	Unlined pit, no outlet or overflow	T1A6C10	37%	80%	**30%**
10.	Lined pit with semipermeable walls and open bottom, no outlet or overflow, where there is a significant risk of groundwater pollution	T2A5C10	56%	80%	**45%**
11.	Unlined pit, no outlet or overflow where there is a significant risk of groundwater pollution	T2A6C10	37%	80%	**30%**

2.2.4 Transportation, Treatment and Disposal/Reuse of Faecal Sludge

The FS emptied by the sanitation section of the municipality is disposed into landfill site without treatment as shown in Figure 9. However, occasionally, it is fed into the biogas digester in Shrikhandpur WWTP.

Around 80% of the FS emptied from anaerobic biogas digester considered as fully lined tank (sealed) connected to open ground (T1A3C8) is considered to be transported to treatment (variable F4 set to 80%) and all FS from these biogas digesters is assumed to be treated as it is used as manure in agriculture. Thus, variable F5 for this system is set to 100%.

Variables F4, F5, S4d, S4e, S5e and S5d for the rest of the systems are assumed to be 0%.

Figure 9: Disposal site at solid waste landfill site in Dhulikhel municipality.

2.3 SFD graphic

The SFD graphic for Dhulikhel (Figure 10) shows that 51% of the FS and Wastewater (WW) is being safely managed. Out of which 4% of WW is being treated in decentralized WWTP and 22% of FS is treated in household anaerobic biogas digester. The remaining 25% is safely stored in containment without any risk to groundwater contamination. In the medium- to long- term, this practise may not be sustainable and faecal sludge management improvements may be required.

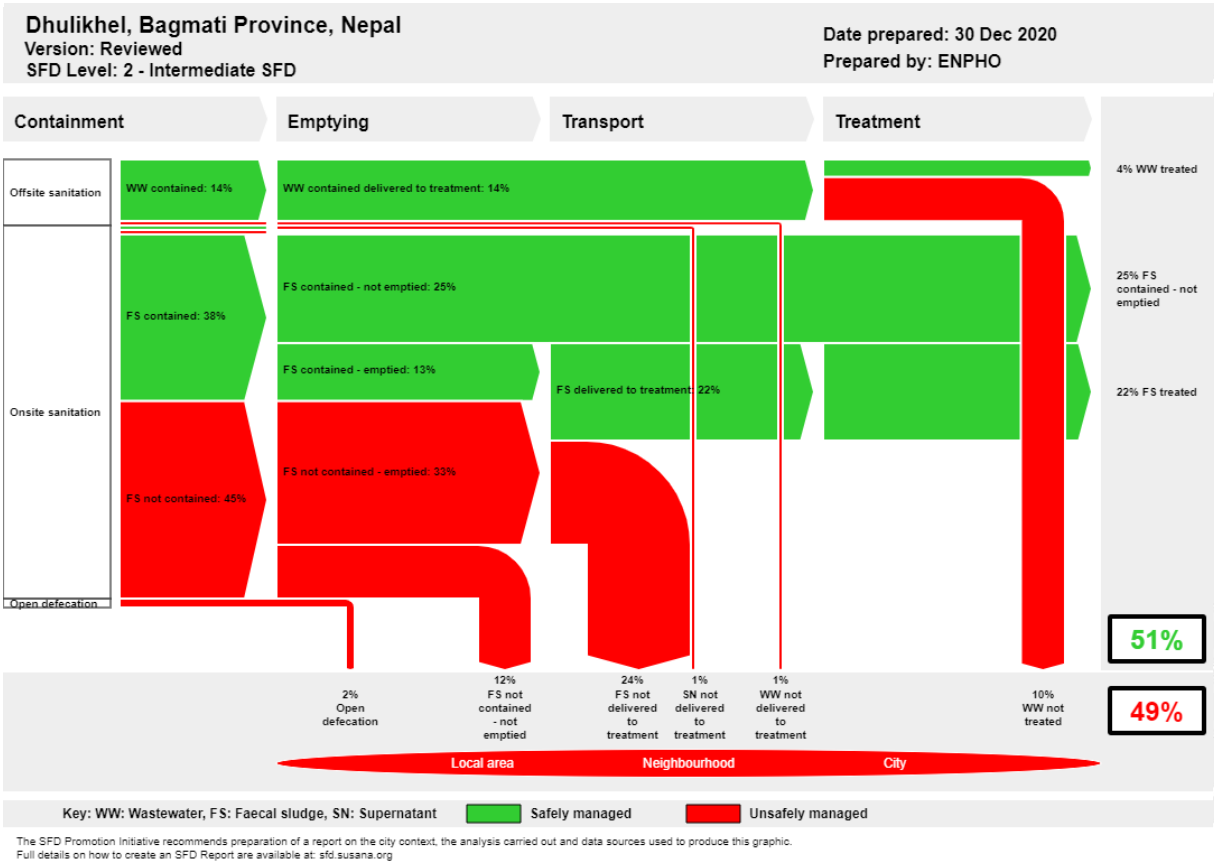

Figure 10: SFD graphic of Dhulikhel municipality.

The portion of unsafely managed excreta and wastewater (49%) accounts to:

i. Toilet connected to non-functional centralized sewer (10%) and wastewater connected to open drain (1%).
ii. The portion of supernatant from septic tanks which is not delivered to treatment plant (1%).
iii. The emptied portion of FS -not contained and not delivered to treatment (24%).
iv. FS not contained and not emptied from systems located in areas of high risk of groundwater pollution (12%).
v. Open defecation (2%).

Offsite and Onsite Sanitation System

A sanitation system in which excreta are collected and transported away from the plot where they are generated is defined as an offsite sanitation system. It relies on sewer technology for transport. Nepal Demographic and Health Survey reported that 6.9% of the urban population in the country have offsite sanitation systems connected to piped sewer networks (MoH, Nepal, New ERA and ICF, 2017).

In Dhulikhel municipality, 14% of population has access to sewer networks. These sewers networks are connected to two centralized wastewater treatment plants (located in Thakurigaun and Pipalbot) and one decentralized wastewater treatment plant located in

Shrikhandapur. While approximately 1% of the population has connected their toilet wastes directly into open drains and stromwater drains.

A sanitation technology or sanitation system in which excreta are collected, stored, emptied from or treated on the plot where they are generated is termed as an onsite sanitation system. Almost 84% of the population has onsite sanitation systems.

The proportion of FS contained and FS contained - emptied

FS contained is defined by SFD-PI regarding WHO as faecal sludge stored in a sanitation technology and or system which ensures a safe level of protection from excreta, i.e. pathogen transfer to the user or general public is limited. Thus, faecal sludge stored in septic tanks connected to soak pit, fully lined tanks (sealed), lined tanks with impermeable walls and open bottom without significant risk of groundwater pollution and lined/unlined pits without significant risk of groundwater pollution is considered FS contained. Thus, the proportion of FS contained in Dhulikhel municipality is 38%. The proportion of FS emptied (variable F3) from these FS contained sanitation technologies is shown in Table 3. Thus, the sum of the resultant proportion of FS contained - emptied is 13% as shown in Table 4. The sum of FS contained but not emptied, primarily due to never emptied sanitation technologies and the remaining FS during the emptying process is 25%, which is considered safely stored.

Table 4: Sanitation technologies and proportion of FS contained and FS emptied.

Sanitation technologies	SFD Reference Variable	The proportion of FS contained	The proportion of FS emptied (Variable F3)	Proportion FS-contained emptied
Septic tank connected to soak pit	T1A2C5	1%	67%	0.53%
Fully lined tank (sealed), no outlet or overflow	T1A3C10	8%	39%	3.08%
Fully lined tank (sealed) connected to soak pit	T1A3C5	1%	0%	0%
Lined tank with impermeable walls and open bottom, no outlet or overflow	T1A4C10	7%	48%	3.32%
Lined tank with impermeable walls and open bottom, connected to soak pit	T1A4C5	2%	63%	1.24%
Lined pit with semipermeable walls and open bottom, no outlet or overflow	T1A5C10	8%	32%	2.53%
Unlined pit, no outlet or overflow	T1A6C10	8%	30%	2.37%
Septic tank connected to a centralized combined sewer	T1A2C1	1%	0%	0%
Fully lined tank (sealed) connected to centralized combined sewer	T1A3C1	1%	0%	0%
Lined tank with impermeable walls and open bottom, connected to centralised combined sewer	T1A4C1	1%	0%	0%
Total		**38%**		**13.07%**

The proportion of FS not contained and FS not contained-emptied

FS stored in the inappropriate sanitation technologies where the transmission of the pathogen to the user and the general public is higher is considered as FS not contained. The portion of FS – not contained stored in the inappropriate sanitation technologies with a high risk to pathogen transmission directly or through groundwater pollution is 45% as shown in Table 5. Also, the resultant proportion of FS not contained – emptied is around 33% as shown in Table 5 as well.

Table 5: Description of the percentages of FS not contained –emptied.

Sanitation technologies	Variable	The proportion of FS not contained	The proportion of FS emptied (Variable F3)	Proportion FS not contained – emptied
Septic tank connected to open drain or storm sewer	T1A2C6	1%	90%	0.72%
Septic tank connected to 'don't know where'	T1A2C9	1%	90%	0.72%
Fully lined tank (sealed) connected to open ground	T1A3C8	31%	90%	27.62%
Lined tank with impermeable walls and open bottom, connected to open ground	T1A4C8	2%	43%	0.85%
Containment (septic tanks, fully lined tanks, partially lined tanks and pits, and unlined pits) failed, damaged, collapsed or flooded –connected to water bodies, or open ground or “don’t know where”	T1B10C7 to C9	2%	0%	0%
Septic tank connected to soak pit, where there is a significant risk of groundwater pollution	T2A2C5	1%	0%	0%
Lined pit with semipermeable walls and open bottom, no outlet or overflow, where there is a significant risk of groundwater pollution	T2A5C10	4%	45%	1.78%
Unlined pit, no outlet or overflow where there is a significant risk of groundwater pollution	T2A6C10	3%	30%	0.89%
Total		**45%**		**32.58%**

The total portion of supernatant from containment connected to sewer system is assumed at 1%; Moreover, wastewater not delivered to treatment plant is 1%.

FS emptied but not delivered to the treatment plant

The municipality does not have a faecal sludge treatment plant. Thus, the FS emptied from either FS contained or FS not contained sanitation technologies is disposed without any treatment. The FS emptied and transported by the municipal sanitation service is disposed of at the solid waste landfill site. In aggregate, 24% of FS emptied is not delivered to treatment and possess a potencial high risk of transmission of pathogens to the general public.

The portion of FS not contained and emptied primarily from anaerobic biogas digesters (system T1A3C8) is assumed to be delivered to treatment and treated. However, only 80% of such systems is functioning well, thus the portion of FS emptied from those systems is 28% and FS delivered to treatment plant and treated is 80% (variable F4 set to 80%) of it, which accounts to 22%. Hence, 22% of FS is shown treated and safely managed.

Open Defecation

Despite declared as an Open Defecation Free zone, approximately 2% of the population practise open defecation in the nearby jungles, rivers and open spaces.

3 Service delivery context description

3.1 Policy, legislation and regulation

3.1.1 Policy

The constitution of Nepal 2015 has envisioned access to drinking water and sanitation as fundamental rights of the citizens that would be delivered and managed by federal, provincial and local governments in mutual coordination (GON, 2015) . GON through its Ministry of Water Supply (MoWS) has billed Water Supply and Sanitation Law 2018 in its federal parliament to respect, protect, promote, fulfil and implement the provisions in the constitution. It has envisioned every citizen a right to quality sanitation services and prohibited the direct discharge of wastewater and sewage into water bodies or public places directly against the prescribed standard in section 38. Also, it has a provision of imprisonment for a term ranging from three months to one year or a fine of up to NPR 500,000 (US$ 4,390) or both to the offender (MoWS, 2018).

Beside current developments in laws and policies, earlier National Sanitation Policy (1994) was the first sanitation specific policy that provided guidelines for the planning and implementation of sanitation programs. An unofficial revised version was produced in 2002, however, it was not ratified by GON. Instead, National Rural Water Supply and Sanitation Sector Policy (NRWSSSP) was approved in 2004 (WEDC, 2005). The policy was formulated to provide a basic level of water supply to all people such that development of water supply and sanitation services supports the social and economic development of the nation and improves the health status. It mainly focused on the participatory approach and community leadership project development with emphasize given on optimization of local resources and installation of locally appropriate technology (DWSS, 2004) . Similarly, the GON approved National Urban Water Supply and Sanitation Policy (NUWSSSP) in 2009. The policy uses Water and Sanitation Hygiene (WASH) services as a tool for poverty reduction. Output-Based Aid Approach was adopted for supporting the construction of household toilets along with cost recovery principles and decentralized waste management in urban areas (DWSS, 2009) . A Unified National Water Supply and Sanitation Sector Policy (NWSSSP) was approved in 2014 by the GON to resolve existing inconsistent and incoherent in rural and urban sanitation policies. The NWSSSP aimed to grab many opportunities like new technologies and knowledge, and service delivery approaches emerged in the sector. Remarkably, NWSSSP was the first official document that recognized discharge of untreated wastewater and dumping of septic sludge heavily polluted into surface water sources in urban areas. Further, it pinpointed that densely located onsite sanitation facilities in urban and rural localities have been posing a risk of groundwater pollution. The policy set strategy to develop and enforce wastewater quality standards for discharging all kinds of wastewater into natural water bodies and agricultural lands. Reuse options with appropriate treatment were highly prioritized and mandatory provisions were set for constructing onsite treatment facilities in hospitals, industries and commercial buildings (DWSS, 2014).

Based upon these policies, National Sanitation and Hygiene Master Plan (NSHMP) 2011 was formulated and implemented by the GON. Coordination among various stakeholders and local leadership was highly emphasized to develop participatory integrated sanitation programs. It focused on universal access to sanitation through the construction of household

toilets and declaration of Open Defecation Free zones. It has set ODF as a basic indicator to universal access on improved sanitation with due consideration on sustainable changes in hygiene behaviours including proper use of toilet and waste management practices in the urban and rural areas. It provided strategic direction for all the concerned stakeholders to formulate an enabling environment for harmonizing the efforts of stakeholders, maintaining uniformity and standards and developing institutional arrangement at all levels of government (NPC, 2011) . It strengthens institutional set up with the formation of water and sanitation coordination committee at every tier of government in a participatory approach. Also, it defined what sanitation facility should be promoted to achieve universal access to improved sanitation.

The national sanitation coverage after the implementation of NHSMP 2011 is 95.5% until March 2018 (MoWS, 2018) . Thus, upon achieving good progress towards the sanitation coverage, the GON has drafted Nepal Water Supply, Sanitation and Hygiene Sector Development Plan (SDP 2016-2030) in 2016 emphasizing sector convergence, institutional and legal reforms, capacity development of the sector institutions and establishing coordination and harmonization. The draft SDP has classified service system and delineated roles and responsibilities accordingly for effective and sustainable service delivery as shown in Appendix 1.

Together, with a national commitment to pursuing and achieving the Sustainable Development Goals (SDGs) by 2030, National Planning Commission (NPC) formulated targets and indicators for coordinated efforts to achieve the goals in 2017. Similarly, Total Sanitation Guideline 2017 has envisioned sustaining ODF outcomes and initiating post-ODF activities through integrated water, sanitation and hygiene plan at every local level. It has set various indicators and remarkably 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 the hygienic environment and promote public health (NPC, 2017).

All these above-mentioned policies and guideline states Faecal Sludge Management (FSM) as a component of the sanitation system. Lack of concrete policies, guidelines and indicators on FSM was felt in the sector for effective planning, implementation and service delivery. Thus, through in-depth discourses on FSM, Ministry of Water Supply and Sanitation (MOWSS) through its Department of Water Supply and Sewerage (DWSS) articulated and endorsed Institutional and Regulatory Framework for Faecal Sludge Management in Urban Areas of Nepal in 2017.

The main objective of the FSM framework is to define the specific roles and responsibilities of key institutions for the effective management and regulation of FSM. It is framed upon existing laws such as Environmental Protection Act and Rules 1997, Self-Local Governance Act and Rules 1999, Environmental Standards on Effluent Discharge 2000, Nepal National Building Code 2003, and Land Acquisition Act amendment 2010 (MOWS, 2017). 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 Water and Sanitation

Users Committee (WSUC) in the framework reflects a participatory approach that would help in sustaining the interventions.

3.1.2 Institutional roles

At the federal government, the National Planning Commission (NPC) is responsible for planning the national sanitation programs in coordination with the respective ministry. Department of Water Supply and Sewerage under Ministry of Water Supply and Sanitation (MOWS) is a leading authoritative agency for development and implementation of sanitation policy and programs. Earlier, the sanitation programs were implemented through its regional offices at the local level. The policies formulated had to be channelized through Ministry of Federal Affairs and General Administration (MOFAGA), a ministry at federal government accredited with the role of coordination, cooperation, facilitation and monitoring and evaluation of activities undertaken by local governments; regulation and management of the civil service in the country. The schematic diagram as shown in Figure 11 illustrates roles and responsibilities for effective management of faecal sludge at the federal government.

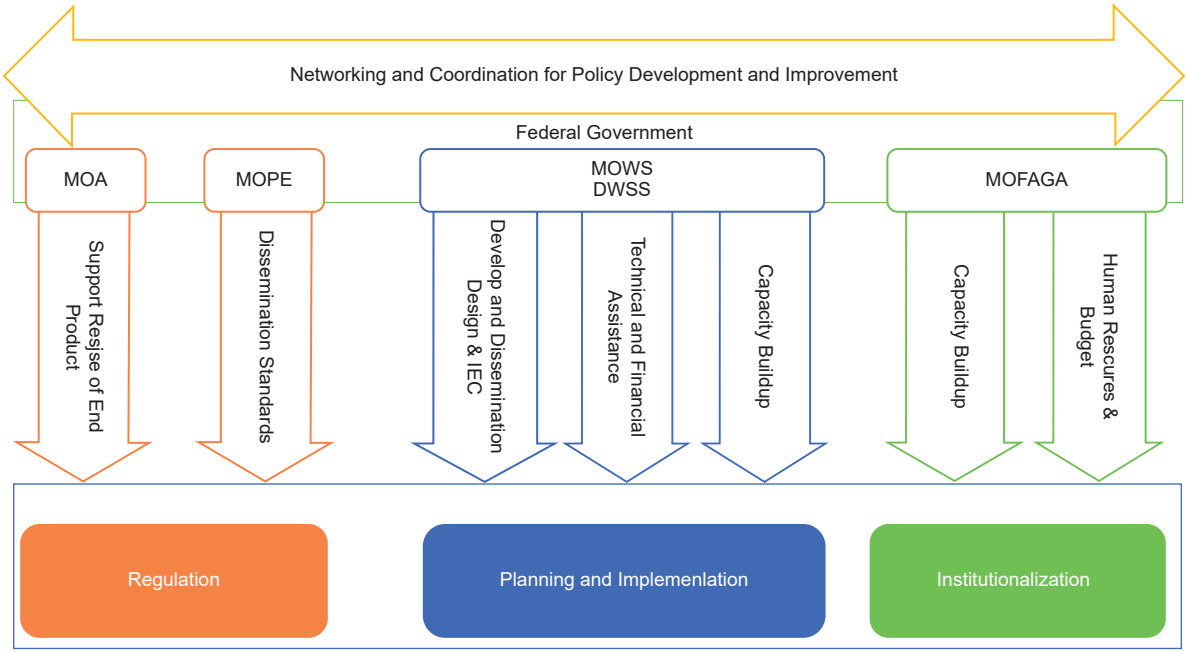

Figure 11: Institutional arrangements and their responsibility for FSM at the federal government.

Ministry of Physical Infrastructure and Development is entitled with authority for water supply and sanitation programs at the provincial government. The draft SDP has envisioned the role of the provincial government as roles of regulation and surveillance on small scale sanitation systems implemented by the local government whereas it is responsible to undertake implementation program of medium to mega-scale sanitation interventions in coordination with federal and local government.

The Constitution of Nepal 2015 and Local Government Operation Act 2017 enabled the local government to implement sanitation interventions to enhance public health and living standards. Generally, local government in coordination and partnership with Water and Sanitation User Committee (WSUC) and developing agencies have been implementing water

supply and sanitation programs. The IRF for FSM has delineated the roles and responsibility of local government across all sanitation values chain as presented in Figure 12.

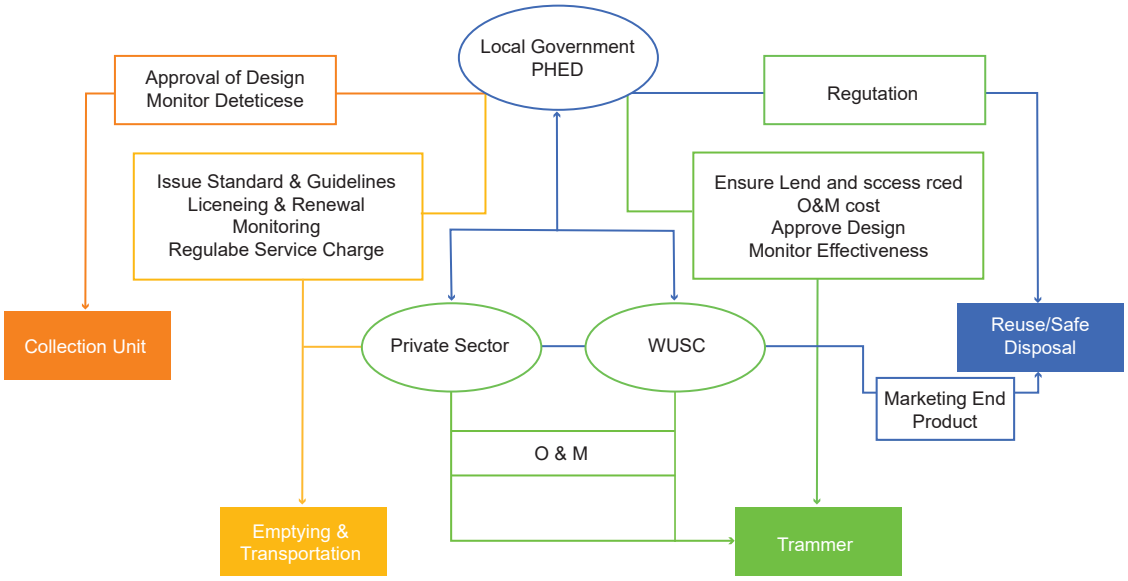

Figure 12: Roles and responsibility of local government (municipality) for FSM.

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 (MOPPW, 2009). Also, Public-Private Partnership Policy 2015 encourages private sector investment in the development and operation of public infrastructure services for comprehensive socio-economic 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).

Dhulikhel Drinking Water and Sanitation Users Committee has been providing drinking water since early 90s in the core traditional urban areas of the municipality. The major source of water is Kharkhola River located 14 km far from the city. Water is treated in a well-established water treatment plant and supplied water maintaining WHO guideline (Devkota K., 2018). The municipality has been providing desludging services from its sanitation section. It owned the desludging vehicle with a capacity of 4,000 litres. Currently, in average, 2 trips of faecal sludge are being emptied a week (KII2, 2019).

3.1.4 Service standards

The sanitation service standards have been proposed in the draft Nepal Water Supply, Sanitation and Hygiene Sector Development Plan (2016-2030). It has classified sanitation services as high, medium and basic based on knowledge and facilities in place. The sanitation service levels with indicators are shown in Table 6. However, FSM specific standards have yet to be developed and implemented.

Table 6: 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 greywater	✓	✓	✓
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	✓	✓	✓

Source: MoWSS, 2017

4 Stakeholder Engagement

4.1 Key Informant Interviews (KIIs)

The KIIs and the sharing of the objective of the study were conducted with the major stakeholders in the sanitation sector in the municipality. Staff from the sanitation section of the municipality were interviewed on the current sanitation services. Also, sanitation workers from sanitation unit of the municipality were interviewed on emptying practices in the municipality.

4.2 Household survey

A random household survey was conducted in all wards of the municipality through the mobilization of volunteers selected by the municipality. The household survey was conducted using a mobile application “KOBOCOLLECT” after orientation. A two-day orientation training was conducted to make volunteer understand the objective of the survey, technical terms regarding sanitation, the use of the mobile application and how to conduct a random sample survey, as shown in Figure 13.

Figure 13: Mayor of Dhulikhel municipality addressing the local volunteer during orientation program on questionnaire survey.

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 $n_o = \frac{Z^2pq}{e^2}$ and its finite population correction for the proportion $n = \frac{n_0}{1+\frac{(n_0-1)}{N}}$.

Where,

Z^2	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 since 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 size required in each ward is calculated as

$n_h = \frac{N_h}{N} \times n$, where, N_h is a total population in each stratum.

Thus, 364 households were sampled from a total of 6,505 households distributed in 12 wards with proportionate stratification random sampling, as shown in Appendix 5.

4.2.2 Direct observation

Various sanitation technologies in the households in all the wards were observed and visual references were kept. Also, observation of the emptying and transportation of the FS from the containments was carried out. The disposal site of the FS emptied from both the municipality and the private entrepreneur was observed during the the field observations.

4.2.3 Sharing and validation of data

The sharing and validation of findings on the sanitation status were conducted in the municipality hall participated by the mayor, ward chairpersons, general members of the municipal council and other relevant stakeholders, as shown in Figure 14. The participants responded that the findings of this study reflected the current sanitation situation of the municipality. The program was also participated by the executive director of a Municipal Association Nepal (MuAN) and it was suggested to develop a FSM plan and effectively implement it to provide with sustainable sanitation services in the municipality. The list of participants with their designation is attached in Appendix 1.

Figure 14: Sharing and validation of findings of a household survey in Dhulikhel municipality.

5 Acknowledgements

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7 Appendix

7.1 Appendix 1: Roles and responsibility of various tiers of governments delineated in drafted SDP 2016 - 2030

Table 7: Roles and responsibility of various tiers of governments delineated in draft 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: Number of institutions sampled in the survey

Table 8: Number of surveyed institutions.

Ward	Financial Institutions	Hotel/ Home Stay	Commercial Buildings	Educational Institutions	Government /Non-government Office	Community Buildings	Health Care Centre	Total
1		2		8	1			11
2				3	2			5
3	2			4	1		4	11
4				5				5
5				2	1		2	5
6				2				2
7	2	4	4	2	5	2	1	20
8	1	1		5	1			8
9				1		1		2
10				3	1	1	2	7
11	2			1	1			4
12	1			3	1	1	1	7
13				4	2			6
14				4	4		1	9
15				5			1	6
16				5	1		1	7
17	1			5	2	1	1	10
18				7		3	1	11
19				4				4
20				2				2
21				4	2		2	8
22				3	1			4
23					1	1	1	3
24				4	1		1	6
Total	9	7	4	86	28	10	19	163

7.3 Appendix 3: Stakeholder identification

Table 9: Stakeholder identification.

S.N.	Stakeholder group	In Dhulikhel Municipality context
1	Municipal Council	Municipal Council, Dhulikhel Municipality
2	Ministry in charge of water supply and sanitation	Department of Water Supply and Sewerage Management
3	Ministry in charge of environmental protection	Department of Environment
4	Service provider for drinking water	Nepal Water Supply Corporation
4	Service provider for solid waste management	Sanitation Section of Dhulikhel Municipality
5	Service provider for construction of onsite sanitation	Local masons
6	Service providers for emptying and transportation	Sanitation section of Dhulikhel Municipality
7	Service provider for operation and maintenance of treatment infrastructure	N/A
8	Market participants practising end-use of FS end products	N/A
9	Service provider for disposal of FS (sanitary landfill)	Sanitation section of Dhulikhel Municipality
10	External agencies associated with FSM services	Municipal Association of Nepal, Environment and Public Health Organization

7.4 Appendix 4: Tracking of engagement

Table 10: Tracking of stakeholder engagement.

S.N.	Name of Organization	Person	Designation	Date of Engagement	Purpose of Engagement
1	Dhulikhel Municipality	Ashok Kumar Byanju	Mayor	10th May 2019	KII (1)
2	Sanitation Section, Dhulikhel Municipality	Shree Bikram Byanju	Focal Person	13th May 2019	KII (2)
3	Sanitation Section, Dhulikhel Municipality	Hari Deula	Desludging Vehicle Driver	24th May 2019	KII (3)
4	Dhulikhel Municipality		Local Volunteers	15 to 24 May 2019	Household survey

7.5 Appendix 5: Number of households in each ward and sampled number of households

Table 11: Number of total households in each ward and sampled households.

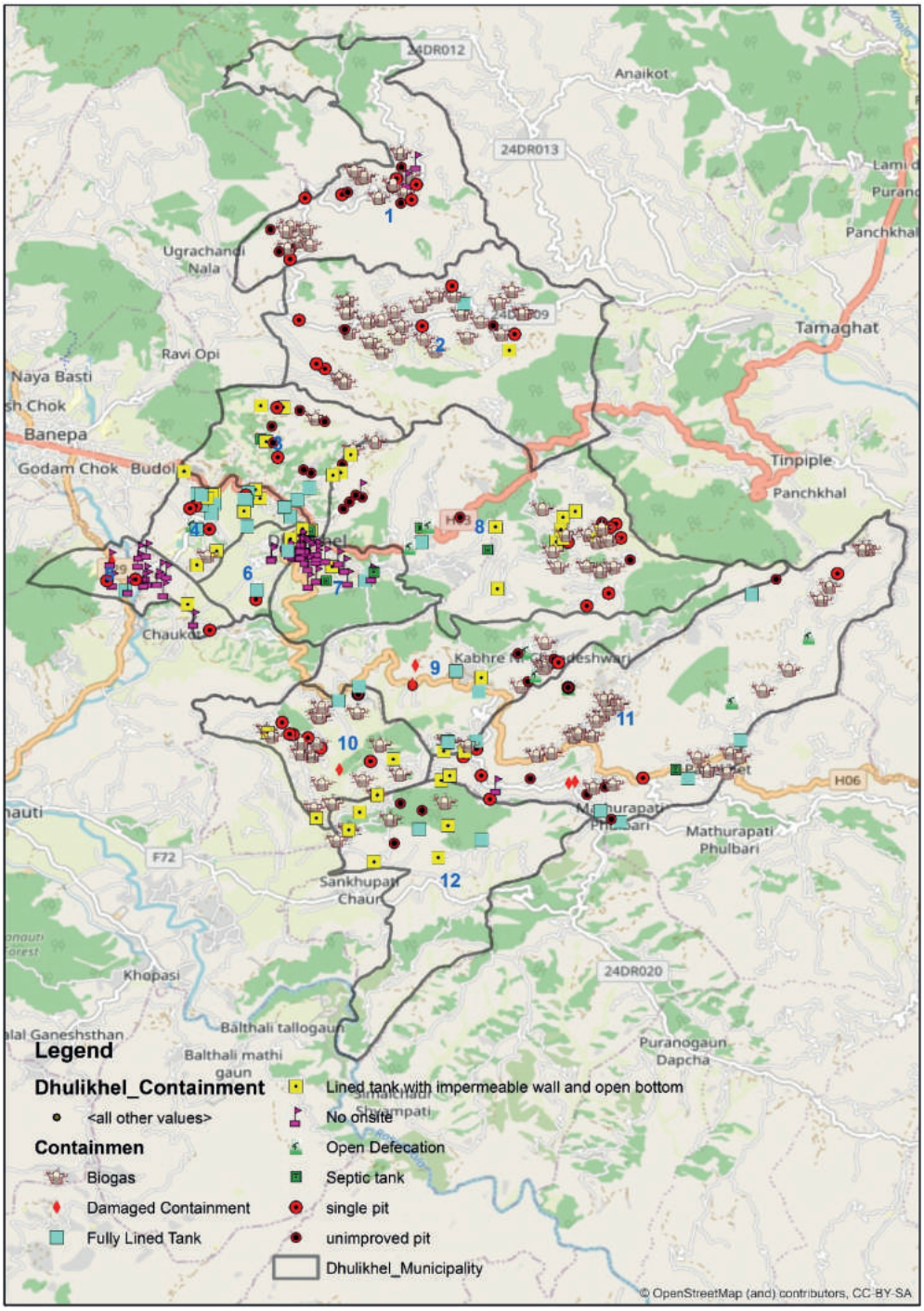
Ward	Households	Sample
1	534	29
2	617	35
3	466	27
4	498	28
5	354	20
6	362	21
7	497	28
8	667	38
9	732	41
10	349	20
11	833	47
12	596	30
Total	6,505	364

Appendix 6: Questionnaire for household survey

हामी नगरपालिकाबाट संचालित स्वयमंसेवक हौं।नगरपालिका, नेपाल नगरपालिका संघ र एन्फोको सहकार्यमा यस नगरपालिकामा दिसाजन्य लेदो सम्बन्धि घरधुरी सर्वेक्षणका लागि हामी आएका हौं। यसका लागि हजुरसँग अर्न्तवार्ता लिन चाहान्छौ , जुन करिब २० मिनेट लाग्नेछ। के म अर्न्तवार्ता सुरु गरौ ? (We are working as volunteer from ENPHO in collaboration with Municipal Association of Nepal (MuAN) and municipality to conduct survey on faecal sludge management. We would like to talk to you about sanitation and faecal sludge management practices. The interview will take about 20 minutes.
D 1. वडा (Ward)
D 2. टोल (Tole)
D 4. उत्तर दिने व्यक्तिको नाम (Name of respondent)
D5. उत्तर दिने व्यक्तिको लिङ्ग (Gender of Respondent)
D6.के हजुर घरमूली हुनुहुन्छ ? (Is the respondent head of the HH?)
D7. घरमूलीको नाम उल्लेख गर्नुहोस् (Name of household owner)
D8. यो घरमा, कति परिवार संख्या बस्नुहुन्छ ? (How many families are there in this building?) non rented family
D9. पुरुष (Male)
D10. महिला (Female)
D11. बालबालिका संख्या (६ बर्ष भन्दा मुनि) (Children (less than 6 year))
D12. के यो घरमा भाडामा बस्ने कोही हुनुहुन्छ? (Is there a tenant living in this house?)
D13. यदी हुनुहुन्छ भने, कति जना उल्लेख गर्नुहोस् (If yes, how many tenants (in total) are there?
पानीका प्रयोग सम्बन्धि (Water Use)
W14. खानेपानीको मुख्य स्रोत कुन हो ? ? (What is major source of the drinking water?)
W15. खानेपानी का लागि के व्यवस्था गरिएको छ ? What mechanism is developed for drinking water in your house?
W15.1. जमिनमुनि कति गहिराईवाट पानी तानेको छ? How deep is the water level in the well nearby?) (in feet)
W17.दैनिक कति लिटर पानी खपट हुन्छ ? What volume of water in consumed per day?
S18. तपाईको घरमा शौचालय छ ? Do you have toilet in your house?
S19. यदि छैन भने, तपाई र परिवारका सदस्यहरु कहाँ दिसा गर्नुहुन्छ ? Where you and your family go for defecation?
S19.1 कति घरधुरीले प्रयोग गर्छ ? How many households use it?
S19.2 कुन स्थान (ठाउँमा) छ ? Where is it located?
S19.3 कस्ले व्यवस्थापन गर्छ ? Who manage it?
S19.4 Specify Others:
S19.5 महिला पुरुषलाई छुटै शौचालयको व्यवस्था गरिएको छ ? Is there separate male and female compartment?
S19.6 पुरुषलाई कति वटा शौचालयको व्यवस्था गरिएको छ ? How many male compartment?
S19.7 महिलालाई कति वटा शौचालयको व्यवस्था गरिएको छ ? How many female compartment?
S19.8. तपाई र तपाइको परिवार प्रयाजसो खुला दिसा गर्न कहाँ जानुहुन्छ ? Where do you and your family go for open defecation frequently?
S20. कतिवटा चर्पीहरु (प्यान/ कमोद) छन् ? (How many toilets (pans/commodes) are there?)
S21. चर्पी कुन प्रकारको प्यान प्रयोग गर्नु भएको छ ? What type of pan is used in toilet?(observation)
S22. कस्तो खालको फ्लसीङ्ग प्रणाली छ ? (What type of flushing system is used? (Observation+Interview)
S23. पानी खन्याएर फ्लस गर्न र सफाइ गर्न कति पानी लाग्छ ? (लिटरमा) In an average what volume of water is used for flushing (liters)?
S24. यान्त्रिक फ्लस प्रणालीको क्षमता कति पानी हो ? (लिटरमा) What is capacity of cistern flush in liters?
25. चर्पी प्रयोग गरेपछि दिसा सफाइ गर्न के प्रयोग गर्नु हुन्छ ?What is used for anal cleansing after while using toilet?
S26. चर्पीमा ककस्ता ठोस फोहरहरु चर्पीमा फालिन्छ ?What solid wastes gets thrown(intentionally or unintentionally) in your toilet?
S26. चर्पीमा ककस्ता ठोस फोहरहरु चर्पीमा फालिन्छ ?What solid wastes gets thrown(intentionally or unintentionally) in your toilet?/स्याम्पु गुटकाका प्याकेट shampoo packets/ tobacco packets
S26. चर्पीमा ककस्ता ठोस फोहरहरु चर्पीमा फालिन्छ ?What solid wastes gets thrown(intentionally or unintentionally) in your toilet?/रेजर बेलेट razor
S26. चर्पीमा ककस्ता ठोस फोहरहरु चर्पीमा फालिन्छ ?What solid wastes gets thrown(intentionally or unintentionally) in your toilet?/स्यनिटरी प्याड sanitary pads
S26. चर्पीमा ककस्ता ठोस फोहरहरु चर्पीमा फालिन्छ ?What solid wastes gets thrown(intentionally or unintentionally) in your toilet?/परिवार नियोजनका साधन family planning materials
S26. चर्पीमा ककस्ता ठोस फोहरहरु चर्पीमा फालिन्छ ?What solid wastes gets thrown(intentionally or unintentionally) in your toilet?/अन्य others
S27. अन्य हो भन्ने उल्लेख गर्नु होस । Specify other
S28. नियनित चर्पी सफाइको लागि केको प्रयोग गर्नु हुन्छ ? What cleaning products do you use in toilet?
S29. सामान्यतया कति अन्तरालमा चर्पी सफा गरिन्छ ? How often do you clean your toilet?
S30. चर्पीको निकास कहाँ जोडिएको छ ? (Where is toilet connected to ?) (observation)
S30.1. उल्लेख गर्नुहोस् (Specify (Other) Where does your toilet connection go ?)
S31. ट्याङ्कीबाट निस्कने पानी (फोहोरपानी) कहाँ जान्छ ? (Where does the effluent or overflow from the tank go?)
S32. कस्तो खालको ढल छ ? (What is the type of sewerage system?)
S33. ढल प्रशोधन केन्द्र छ ? Is there treatment plant ?
S33.1.यदि छ भन्ने तपाईको सेप्टिक वा ढल त्यसमा जोडिएको छ ? if yes, Is your sewer/ effluent from septic connected to it?
S33. तपाईको पिट/ट्याकीमा भान्छाको फोहोरपानी जोडिएको छ ? Is grey water connected to your containment?
S34.चर्पीको अवस्था कस्तो छ ? (What is the current physical status of toilet?) (Observation+Interview)

गोवरग्याँस Biogas
S34. गोवरग्याँस को आयतन कति हो? (What is the volume of Biogas Digester?)
S35.गोबर ग्यासमा चर्पीको दिसा वाहेक के हाल्नुहुन्छ ? What is added to digester other than human excreta from the toilet?
S36. अन्य Others specify
S36. गोबर ग्यासको लेडो कहाँ जान्छ ? Where does the slurry from the digester go?
S37. अन्य के हो ? Others specify
S38. बायोग्यास रियाकटरको भौतिक अवस्था कस्तो छ? What is physical condition of biogas digester?
S39.बायोग्यास फोटो खिच्नु । Photo if Bio gas
ईकोसान ECOSAN
S40.ईकोसान चर्पी कहिले निर्माण भएको हो? (साल)When was ECOSAN constructed?
S41. ईकोसान फोटो Photo of ECOSAN
नोट: माथिका प्रश्नहरुले नओगतेका केही नयाँ जानकारी छन् भने कृपया यहाँ उल्लेख गर्नुहोस् (Note (If you want to add any detail/data, which was not covered in above questionnaire, then please write it here))
S 42.Photo. चर्पी भित्रको तस्बिर लिनुहोस्। (Take photo of the inside of the toilet)
C1. भण्डारण ट्याङ्की / खाल्डो कहाँ छ ? (Where is the containment located?) (observation+Interview)
C2. भण्डारण ट्याङ्की कहिले बनाइएको हो ? (When was the containment constructed?)
C3. भण्डारण ट्याङ्कीमा कहाँ– कहाँको फोहोरपानी जान्छ ? (From where wastewater goes in containment?) (Multiple Choice)
C3.1. उल्लेख गर्नुहोस् (Specify (Other) From where wastewater goes in containment?)
C4. भण्डारण ट्याङ्कीको आकार कस्तो छ ? (What is the shape of containment?)
C5. भण्डारण ट्याङ्कीको पर्खाल के ले निर्माण गरिएको छ ? What is type of lining in containment?
C6. भण्डारण ट्याङ्कीमा कति खण्ड छन् ? (Number of chambers in the septic/holding tank)
C7. भण्डारन ट्याकीको भईमा के गरिएको छ ? What is type of base flooring?
C8. भण्डारण ट्याङ्की प्लास्टर गरिएको छ ? (Is your containment sealed?)
C9.भण्डारण ट्याङ्की सजिलै खोल्न–बन्द गर्न मिल्ने ढकनी छ ? (Is there a proper man hole or access port for each tank/pit?) (observation)
C10. भण्डारण ट्याकीको भुईमा कस्तो प्रकारका निर्माण कार्य गरिएको छ ? What type of flooring is constructed above the containment?
C11. अन्य (Other) Specify
C 12. भण्डारण ट्याकी भरिएपछि, भुई फुटाउनु परेमा फुटाउन सकिन्छ ? Are you willing to break it, when containment required emptying?
C13. कुन प्रकारको पिट प्रयोग गर्नु हुन्छ ? What type of pit do you use?
C 14. प्रत्येक खाल्डो भरिन कति समय लाग्छ ? How long does it take to fill each pit? (Year)
C15. भण्डारण ट्याकीदेखि पानीको स्रोत कति टाढा छ ? How far is source of drinking water from your containment?
C16. नाप (फिटमा) (Dimensions of septic tank) (Observation+Measurement)
C16.1.लम्बाइ (फिटमा) (Length in feet))
C16.2. चौडाइ (फिटमा) (Width in feet)
C16.3. गहिराई (फिटमा) (Depth in feet)
C16.4. गहिराई (फिटमा) (Depth in feet)
C16.5. व्यास (फिटमा) (Diameter in feet))
C 17.के तपाई संग थप भण्डारण ट्याकी छ? Do you have additional containment?
C18.कति वटा थप भण्डारण ट्याकी छ? How many additional containment?
C19. माथि उल्लेख गरिएको नाप (Dimension noted on previous questions are)
C20. हजुरको सेप्टिक ट्याङ्की/ खाल्डोको अवस्था कस्तो छ ? (What is the current physical status of septic tank/pit?)
C21. सेप्टिक ट्याङ्की/ खाल्डोको फोटो लिनुहोस् । (Photograph of the tank/pit's location) (If there is a manhole, then manhole should be visible in picture.)
नोट: माथिका प्रश्नहरुले नओगतेका केही नयाँ जानकारी छन् भने कृपया यहाँ उल्लेख गर्नुहोस् (Note (If you want to add any detail/data, which was not covered in above questionnaire, then please write it here))
EMPTYING
E1. के तपाईले अहिलेसम्म सेप्टिक ट्याङ्की / खाल्डो खाली गर्नुभएको छ ? (Have you ever emptied your containment?)
E2. हजुरले अहिलेसम्म सेप्टिक ट्याङ्की / खाल्डो किन खाली नगर्नु भएको ? (Why haven't you emptied your containment ?)
E3.उल्लेख गर्नुहोस् (Specify (Other) Why haven't you emptied your containment?)
E4.सेप्टिक ट्याङ्की/ खाल्डो भरिएपछि के गर्नुहुन्छ ? (What will you do after the containment get filled?)
E5. उल्लेख गर्नुहोस् (Specify (Other) What will you do after the tank/pit get filled?)
E6. हजुरको सेप्टिक ट्याङ्की / खाल्डो खाली गर्ने निकायलाई कति शूल्क तिर्न इच्छुक हुनुहुन्छ ? (How much are you willing to pay for emptying the septic tank/Pit Latrine)
E7. सेप्टिक ट्याङ्की / खाल्डो खाली गर्नुको कारण के थियो ? (What was the reason for emptying ?)
E8. उल्लेख गर्नुहोस् (Specify (Other) What was the reason for emptying ?)
E9. हजुरको सेप्टिक ट्याङ्की/ खाल्डो कहिले खाली गर्नुभएको थियो ? (When was the septic tank/pit last emptied?)
E10. कति अन्तरालमा ट्याङ्की खाली गर्नुहुन्छ /भरिन्छ ? (At what time interval is the septic tank/pit emptied?)
E11. सेवा दिने निकायको थिए ? (Who empties the septic tank/pit?)
E12. उल्लेख गर्नुहोस् (Specify (Other) Who empties the septic tank/pit?)
E13. सेवा दिने निकायले (वा आफैले) कसरी खाली गर्छन् ? (How they emptied tank/pit ?)
E14 .यदी हातले गर्नुहुन्छ भने, मेसिनको प्रयोग नगरी हातले किन खाली गर्नुहुन्छ ? (Why do you practice manual emptying service?)
E15. उल्लेख गर्नुहोस् (Specify (Other) Why do you practice manual emptying service?)

E16. हातले खाली गरिसकेपछि दिसाजन्य लेदो कहाँ बिर्सजन/ फ्याल्नु हुन्छ ? (Where do you dispose your faecal sludge after manually emptying your pit or septic tank?) (Multiple Choice)
E17. उल्लेख गर्नुहोस् (Specify (Other) Where do you dispose your faecal sludge after manually emptying your pit or septic tank?)
E18. बिर्सजन गरिएपछि/ फ्यालिएपछि, त्यसको नराम्रो पक्ष के भोग्नुपर्छ (What are the ill-effects that you observe during / after manual disposal?) (Multiple Choice)
E19. उल्लेख गर्नुहोस् (Specify (Other) what are the ill-effects that you observe during / after manual disposal?)
E20. सेप्टिक ट्याङ्की /खाल्डो खाली गर्ने क्रममा कति पानी प्रयोग भएको थियो ? (How much water was used during emptying the septic tank/pit?)
E21. मेसिनको प्रयोग नगरी खाली गर्ने क्रममा कति आयतनको बाल्टिन प्रयोग गरिएको थियो ? (What was the size of bucket used for manual emptying?)
E22. कति टिप गरिएको थियो ? (बाल्टिनको प्रयोग गर्दा) (How many trips did they make for manual emptying?)
E23. कस्तो प्रकारको मेसिन /ट्याकर प्रयोग भएको थियो ?What is type of vehicle used for mechanical emptying?
E24. मेसिनले खाली गर्ने भाँडोको आयतन कति थियो ? (What was the size of container used for mechanical emptying?)
E25. कति टिप गरेका थिए (मेसिनले खाली गर्ने क्रममा) (How many trips did they make for mechanical emptying?)
E26. मेसिनको प्रयोगले खाली गर्ने क्रममा केही समस्या व्यहोर्न परेको थियो ? (Were there any problems during mechanical emptying of septic tank/ pit?) (Multiple Choice)
E26. मेसिनको प्रयोगले खाली गर्ने क्रममा केही समस्या व्यहोर्न परेको थियो ? (Were there any problems during mechanical emptying of septic tank/ pit?) (Multiple Choice)/घरबाट गाडी राख्ने ठाँउको पहुँच टाढा थियो (Access or distance for suction truck to house)
E26. मेसिनको प्रयोगले खाली गर्ने क्रममा केही समस्या व्यहोर्न परेको थियो ? (Were there any problems during mechanical emptying of septic tank/ pit?) (Multiple Choice)/टायल फुटाल्नु परेको थियो (Break floor tiles to access septic tank)
E27. उल्लेख गर्नुहोस् (Specify (Other) problem during mechanical emptying)
E28. मेसिन ट्याकरवाट खाली गराउदा कति बाकी थियो ? How much portion is left in containment after emptying
सेवा निकायको विशेषता (Characteristics of Service Provider)
SP1.के हजुरको समाजमा सेप्टिक ट्याङ्की/ खाल्डो खाली गर्ने निकाय / व्यक्ति छन् ? (Do you have service provider or person for emptying your pit/septic tank in the locality?)
SP2. यदि छन् भने कति ? (How many service provider are there in this locality?)
SP3. सेवा दिने निकायलाई कसरी सम्पर्क गर्नुभयो ? (How did you contact service provider?) (Multiple Choice)
SP4. उल्लेख गर्नुहोस् (Specify (other)how did you contact service provider?)
SP5. सम्पर्क गरेपछि कति समय पछि आउँछन् ? (How much time do service provider take to arrive?)
SP6. के हजुर उनीहरुको सेवाबाट सन्तुष्ट हुनुहुन्छ ? (Are you satisfied with the emptying services?)
SP7. यदि हुनुहुन्छ भने, कुन पक्षमा सन्तुष्ट हुनुहुन्छ ? (What aspects of the service are you satisfied with?) (Multiple Choice)
SP8. उल्लेख गर्नुहोस् (Specify (Other) what aspects of the service are you satisfied with?)
SP9. यदि हुनुहुन्न भने, यस्तो सेवा सुधार्न के गर्न सकिन्छ ? (What may be the ways of improving this service?) (Multiple Choice)
SP10. उल्लेख गर्नुहोस् (Specify (Other) What may be the ways of improving this service?)
SP11. सेप्टिक ट्याङ्की / खाल्डो खाली गर्ने त्रममा, सेवा दिने निकायले के–के सुरक्षाका सामाग्री प्रयोग गर्छन् ? (Which safety measures do service provider used during emptying?) (Multiple Choice)
SP12. उल्लेख गर्नुहोस् (Specify (other) safety measure)
नोट: माथिका प्रश्नहरुले नओगतेका केही नयाँ जानकारी छन् भने कृपया यहाँ उल्लेख गर्नुहोस् (Note (If you want to add any detail/data, which was not covered in above questionnaire, then please write it here))
सम्पर्क नम्बर (घरधनी /घरको फोन नम्बर) (Contact No. (Household owner/LAN line No.))
GPS
सेप्टिक टंकी / खाल्डो खाली गर्ने साधन बिसौने ठाउँको फोटो लिनुहोस् (Photograph of the parking area for the desludging truck)
स्वयंसेवकको नाम (Name of enumerator)
स्वयम्सेवकको सर्वेक्षण गरेको अनुभवमा कुनै प्रतिक्रिया (Feedback of Enumerator based on observation)



For further information

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