SFD Report

Bedkot Municipality
Nepal

Final Report

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

Date of production: 12/08/2022

Last update: 23/08/2022

SFD Report Bedkot Municipality, Nepal, 2022

Produced by:

Anita Bhuju, ENPHO
Buddha Bajracharya, ENPHO

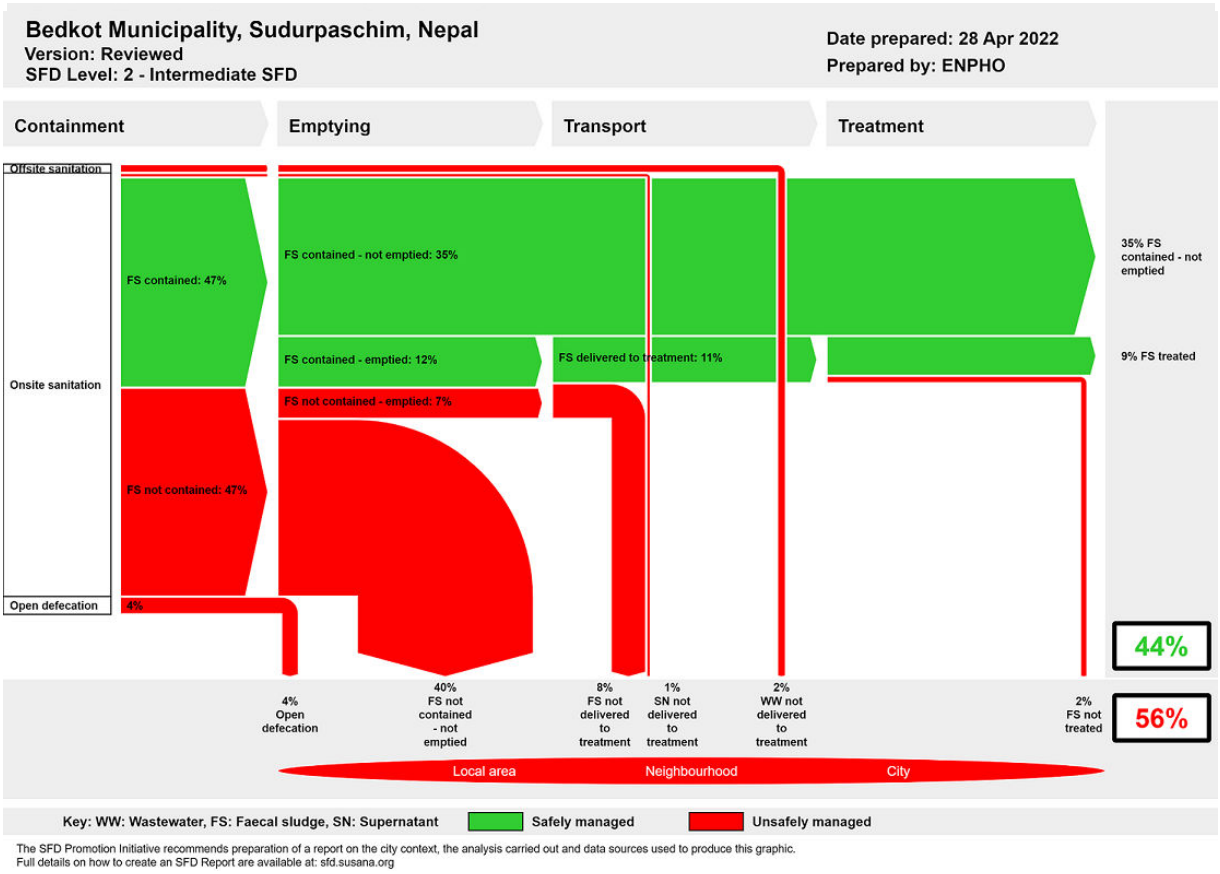
Co-authors:

Jagam Shrestha, ENPHO
Sabuna Gamal, ENPHO
Rupak Shrestha, ENPHO
Shreeya Khanal, ENPHO

This Executive Summary and SFD Report are available from:

www.sfd.susana.org

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:

This SFD is level 2– Intermediate report.

Produced by:

Environment and Public Health Organization (ENPHO).

Collaborating partners:

Bedkot Municipality, Municipal Association of Nepal (MuAN), United Cities and Local Government- Asia Pacific (UCLG- ASPAC).

Status:

Final SFD report.

Date of production: 12/08/2022

3. General city information

Bedkot Municipality is in Kanchanpur District of Sudurpaschim Province, Nepal with an area of 158.5 sq. km. The proposed area of the municipality is formed by merging former Suda Village Development Committee (VDC) and Daiji Village Development Committee in 10 wards. It lies at 28.57° N latitude and 80.1348° E longitude spreading over Northern Terai and Siwalik range.

A population of 49,479 is residing in the municipality with a growth rate 1.7%. The climatic condition of the Municipality is Tropical Savannah with mean annual air temperature above 26°C and mean annual precipitation within the range of 1,800-2,000mm.

4. Service outcomes

Kanchanpur district was declared Open Defecation Free (ODF) on December 22, 2018. Still, Bedkot Municipality of the district has 4.02% of people practising open defecation. Of the households with toilets, 99.44% have onsite sanitation system and 0.56% have offsite sanitation system in the municipality.

Containment:

In the municipality, most households have connected their toilet to a lined tank with impermeable walls and open bottom followed by a fully lined tank and lined pit with semipermeable walls and open bottom (single pit and twin pit), respectively. Few households have connected their toilet to biogas digester, septic tank and unlined pit.

The institutions of Bedkot municipality only have onsite sanitation systems such as lined tanks with impermeable walls with open bottom and lined pits with semipermeable walls and open bottom (single pit and twin pit).

A public toilet, located at Daiji local market, was constructed by the municipality and bazar samiti. It gets an average users of 5 people per day. The toilet consist of twin pits and has not been emptied.

Emptying:

Among the households with onsite sanitation system, only 22.19% have emptied their containment at least once. Most households practice manual emptying instead of mechanical emptying. Those practising manual emptying contact traditional labours or opt for self-emptying whereas private desludgers are contacted for mechanical emptying.

Transport, Treatment and Disposal/Reuse:

The toilets connected to a biogas digester treats generated Faecal Sludge (FS) at household level. FS from the remaining containments that are emptied manually or mechanically ends up in farmlands, disposed of in the open environment, dig and dumped, disposed of in sewerage, drain and water bodies without any treatment.

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 billed the Water Supply and Sanitation Law 2018 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 places 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 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 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.

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 and Sewerage Management
Public Institutions at Local Government	Bedkot Municipality Drinking-Water Supply and Sanitation User's Committee
Non-governmental Organizations	Environment and Public Health Organization (ENPHO)
Development Partners, Donors	MuAN, BMGF, UCLG ASPAC

7. Process of SFD development

Data on sanitation situation were collected through household and institutional survey. 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, Key Informant

Interviews (KIIs) were conducted with officers and engineer of municipality, Nepal Water Supply Corporation and Water Supply and Sanitation Division Office 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 in SFD graphic generator to produce the SFD graphic.

8. Credibility of data

The major data were collected from random household sampling. Altogether, 373 households and 40 institutions were surveyed from 10 wards of Bedkot municipality. Primary data on emptying, transportation and current sanitation practices in the municipality were validated from KII with public toilet management, sanitation and environmental section and water service providers. The overall data and findings were shared with the stakeholders of the municipality and validated through sharing program.

9. List of data sources

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

- CBS, 2022. Multiple Indicator Cluster Survey 2019, s.l.: Central Bureau of Statistics and United Nations Children's Fund.
- DWSSM, 2009. National Urban Water Supply and Sanitation Sector Policy. Kathmandu, Nepal: Department of Water Supply and Sewerage Management, Ministry of Water Supply, Government of Nepal.
- GoN, 2015. Constitution of Nepal: Goverment of Nepal.
- MoWS, 2017. Institutional and Regulatory Framework for Faecal Sludge Management in Urban Areas of Nepal, Kathmandu, Nepal: Ministry of Water Supply.
- MoWS, 2022. Draft National Water, Sanitation and Hygiene Policy, s.l.: Ministry of Water Supply.

SFD Bedkot Municipality, Nepal, 2022

Produced by:

Anita Bhuju, ENPHO

Buddha Bajracharya, ENPHO

Co-authors:

Jagam Shrestha, ENPHO
Sabuna Gamal, ENPHO
Rupak Shrestha, ENPHO
Shreeya Khanal, ENPHO

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

Table of Content

List of Tables

List of figures

Abbreviations

DWSSM	Department of Water Supply and Sewerage Management
DUDBC	Department of Urban Development and Building Construction
ENPHO	Environment and Public Health Organization
FAO	Food and Agriculture Organization
FS	Faecal Sludge
FSM	Faecal Sludge Management
GoN	Government of Nepal
HH	Household
IRF	Institutional and Regulatory Framework
JMP	Joint Monitoring Programme
KII	Key Informant Interview
KM	Kilometre
MDG	Millennium Development Goal
mm	Millimetre
MoEST	Ministry of Education, Science and Technology
MoFAGA	Ministry of Federal Affairs and General Assembly
MoH	Ministry of Health
MoHP	Ministry of Health and Population
MoUD	Ministry of Urban Development
MoWS	Ministry of Water Supply
MTEF	Medium Term Expenditure Framework
MuAN	Municipal Association of Nepal
NPC	National Planning Commission
NSHCC	National Sanitation and Hygiene Coordination Committee
NUWSSP	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
SCEIS	Sector Coordination and Efficiency Improvement Section
SDP	Sector Development Plan
SEIU	Sector Efficiency Improvement Unit

SFD	Shit Flow Diagram
SFD PI	Shit Flow Diagram Promotion Initiative
SN	Supernatant
UCLG ASPAC	United Cities and Local Governments Asia Pacific
UNGA	United Nations General Assembly
UNICEF	United Nations Children's Education Fund
VDC	Village Development Committee
WASH	Water, Sanitation and Hygiene
WASH-CC	Water, Sanitation and Hygiene Coordination Committee
WHO	World Health Organization
WSP	Water Supply Providers
WSUC	Water Supply and User's Committee
WW	Wastewater

1 City context

Bedkot Municipality is in Kanchanpur District of Sudurpaschim Province, Nepal. The municipality share its boundary with Shuklaphata Wildlife Sanctuary, Arjuni Post (Jhalari Pipladi Municipality) on the east, Bhimdatta Municipality on the west, Chure Range (Dadeldhura District) on the north and Shuklaphata Reserve on the south. The area of the municipality is formed by merging former Suda Village Development Committee (VDC) and Daiji Village Development Committee. It has 10 wards (Bedkot Municipality, 2022). Figure 1 shows the boundary map of Bedkot Municipality.

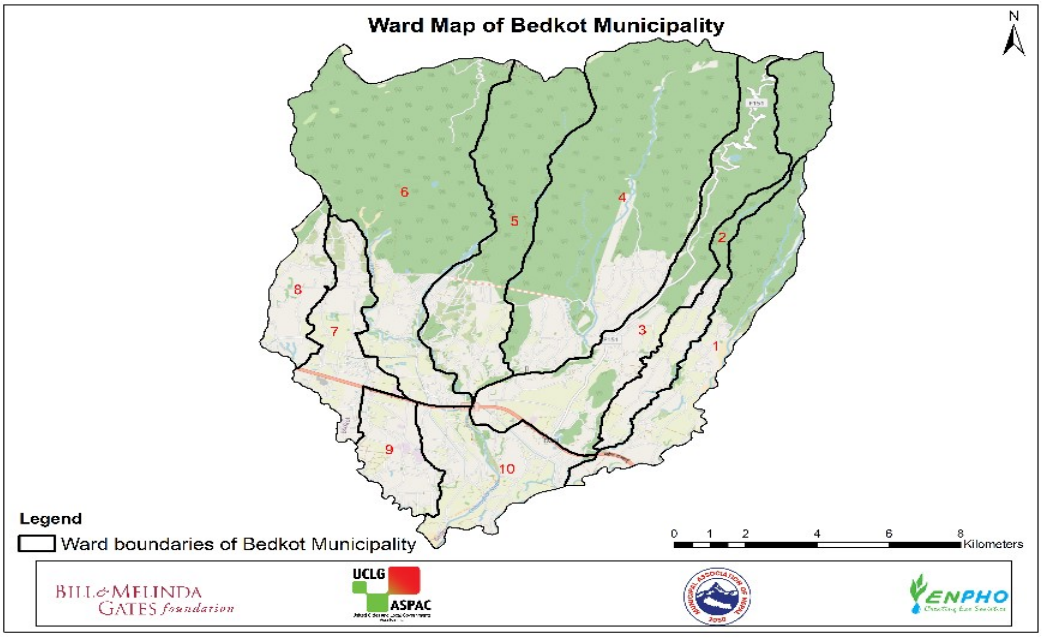


Figure 1: Ward boundary map of Bedkot Municipality.

1.1 Population

The municipality has total population of 49,479 with 23,492 male population and 25,987 female population residing in 9,219 households (HHs). The population growth rate of the municipality is 1.35% (National Census, 2021) (MoFAGA, 2017).

1.2 Topography and Geography

The municipality lies at 28.57° N latitude and 80.1348° E longitude. The elevation of the municipality ranges from 192 m to 1,401 m above mean sea level (Dahal & Timalsina, 2020). It spreads over 158.5 sq. km. (Bedkot Municipality, 2022) . It lies on Northern Terai and Siwalik range with geological structure consisting of boulders, pebbles, cobbles and coarse (Dahal, 2006).

1.3 Climate

The climatic condition of Bedkot Municipality is Tropical Savannah based on the Köppen–Geiger classification with mean annual air temperature above 26°C and mean annual precipitation within the range of 1,800-2,000mm (Karki, et al., 2015).

2 Service Outcomes

2.1 Overview

Sanitation is defined as infrastructures, facilities or services provided for safe management of human excreta emanating from toilet while handling, storage, and treatment onsite or offsite conveying it safely to the end use or disposal to protect human health and environment (Affam & Ezechi, 2021). Sanitation system in which the user interface is transported directly to a sewer network, storm water drainage or open drainage without being contained in the place where it is generated is called offsite sanitation system. Onsite sanitation system is defined as a toilet system where faeces or sewage is handled or treated at its source rather than transporting to another location (Affam & Ezechi, 2021).

2.1.1 Sanitation Status

a Household Level Sanitation Status

Kanchanpur district was declared Open Defecation Free (ODF) on December 22, 2018 (DWSSM, 2020). The status of ODF indicates accessibility to basic sanitation. But 4.0% of Bedkot Municipality of Kanchanpur district still have no toilets. The households without toilet either opt for open defecation, neighbour's toilet, or community toilet.

Among the households with toilet, 0.6% of households have their toilet connected to water resources or directly to open environment. The excreta disposed directly to open environment or water body without any treatment is one of the causes of disease transmission. 99% have onsite sanitation system. Percentage of households using onsite and offsite sanitation is shown in Figure 2.

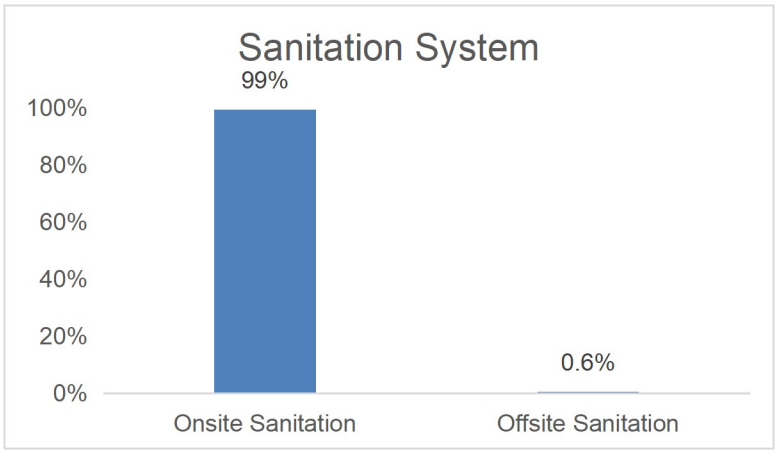


Figure 2: Household sanitation status of Bedkot.

Types of Offsite Sanitation

Figure 3 shows the outlet of offsite sanitation system showing toilet discharge to water body and open environment.

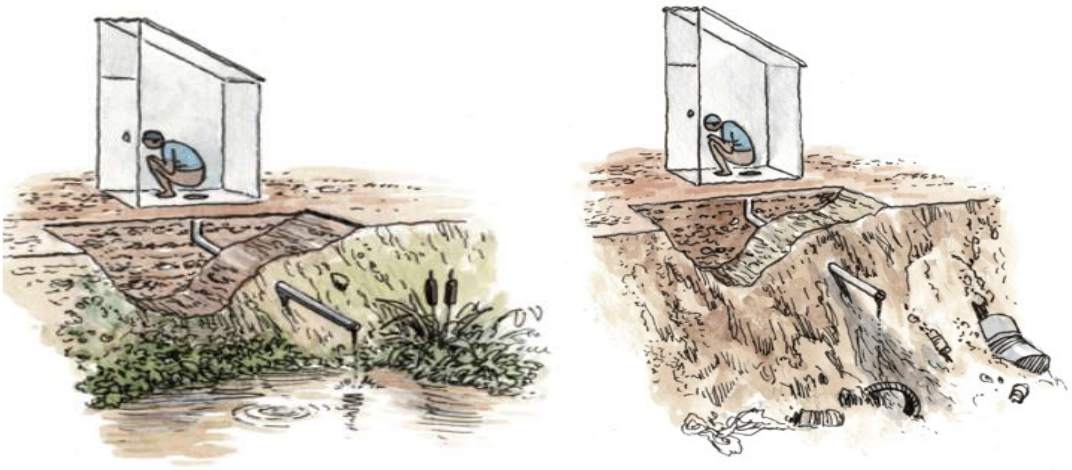


Figure 3: Toilet discharges directly to water body (left) and Toilet discharges directly to open ground (right).

Types of Onsite Sanitation System

Biogas digester is a waste-to-energy conversion technology designed to treat household organic waste and Faecal Sludge (FS) to generate biogas. 6% of households with onsite sanitation technologies have built biogas digester in their houses (Figure 4). Alternative Energy Promotion Centre (AEPC) has promoted biogas technology at households in 75 districts of Nepal. The installation of biogas at households has supported in improving situation of health status and sanitation status in Nepal (AEPC, 2018).

Figure 4: Toilet connected to Biogas digester.

1.7% have septic tanks, a rectangular onsite sanitation technology which is parted into two or three parts for better storage and stabilization of FS. The technology is properly sealed and the effluent is discharged into a soak pit. Figure 5 demonstrates visual representation of a septic tank connected to open drain or storm sewer and a septic tank connected to open ground.

Figure 5: Septic tank connected to open drain or storm water (left) and Septic tank connected to open ground (right).

22% have fully lined tanks, a rectangular onsite sanitation technology which is used to safely store faecal sludge. There is no outlet or overflow to discharge the effluent. The walls and bottom of the tank is totally lined and sealed. Figure 6 demonstrates visual representation of a fully lined tank with no outlet or overflow.

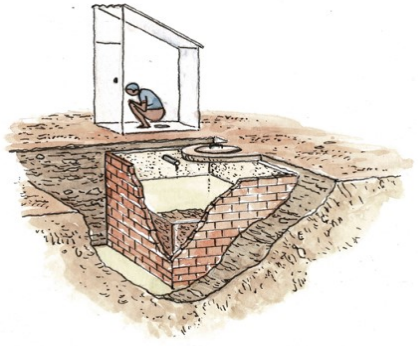


Figure 6: Fully lined tank (sealed), no outlet or overflow.

52% have lined tanks with impermeable walls and open bottom which are rectangular onsite technologies where the walls of the tank are lined and the bottom of tank is not lined. The facility allows infiltration of effluents which could contaminate groundwater (Peal, et al., 2020). Figure 7 demonstrates visual representation of connection of lined tank with impermeable walls and open bottom with no outlet or overflow, connected to an open drain or storm sewer and connected to open ground.

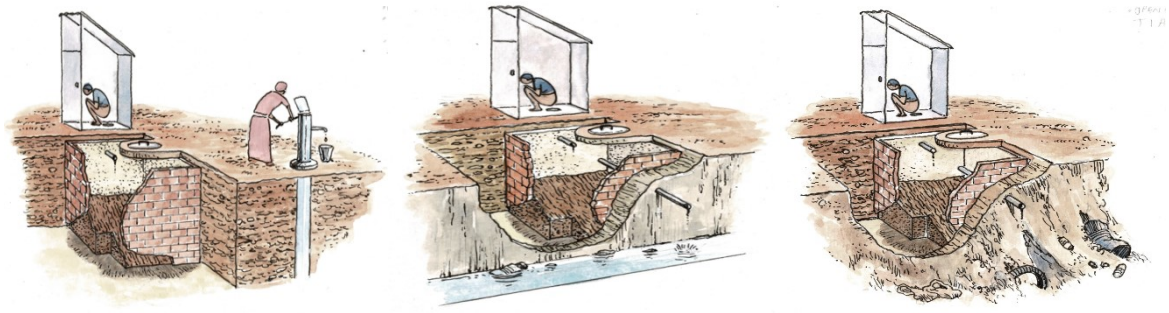


Figure 7: Lined tank with impermeable walls and open bottom, no outlet or overflow (left), Lined tank with impermeable walls and open bottom, connected to an open drain or storm sewer(middle), Lined tank with impermeable walls and open bottom, connected to open ground (right).

1.1% have twin pits which are circular onsite sanitation technologies that consists of two sets of concrete rings. Each pit is used alternatively after filled. FS is left to decompose after the pit is filled. Twin pits effectively treat FS if there is no exfiltration of water (Saxena & Den, 2022). 13% have single pits, which are circular onsite technologies made from concrete rings. There is no lining done between two rings and allows infiltration of effluents from walls and bottom. 3.9% have unlined pits which are a hole dug just beneath the toilet to store FS onsite. Figure 8 demonstrates visual representation of connection of lined pits with semi-permeable walls and open bottom with no outlet or overflow and unlined pits with no outlet or overflow. Figure 9 shows a toilet connected to lined pit with semi-permeable walls and open bottom at a household.

Figure 8: Lined pit with semi-permeable walls and open bottom, no outlet or overflow (left) and Unlined pit, no outlet or overflow (right).

Figure 9: Toilet connected to lined pit with semi-permeable walls and open bottom at a household.

Among the surveyed HHs, 30% have safely collected excreta. Biogas digester, septic tanks and fully lined tanks are considered as safer containments regarding public health perspective and groundwater contamination (Jayathilake, et al., 2019). Figure 10 depicts the ward map of Bedkot municipality with different types of containments in households.

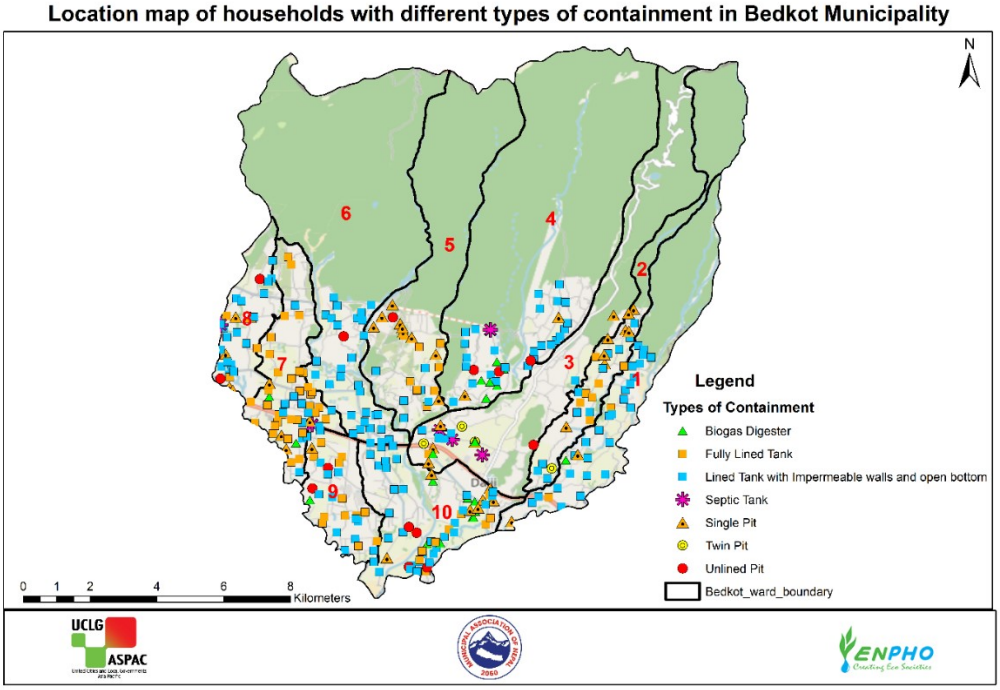


Figure 10: Ward map of Bedkot municipality with different types of containments in households.

b Institutional Level Sanitation System

100% of surveyed institutions have sanitation service with an onsite sanitation system. The sanitation data of institutions of Bedkot Municipality were obtained from sample institutions including educational, government and non-government offices and health care centres. All types of institutions have an onsite sanitation system which were connected to different types of containments.

Among the types of containment in institutions, 93% have lined tanks with impermeable walls and open bottom, 5.0% have single pits and 2.0% have twin pits. Figure 11 shows the different types of onsite sanitation and its percent at institutions of Bedkot municipality. Figure 12 shows the ward map of Bedkot municipality with types of containments in institutions.

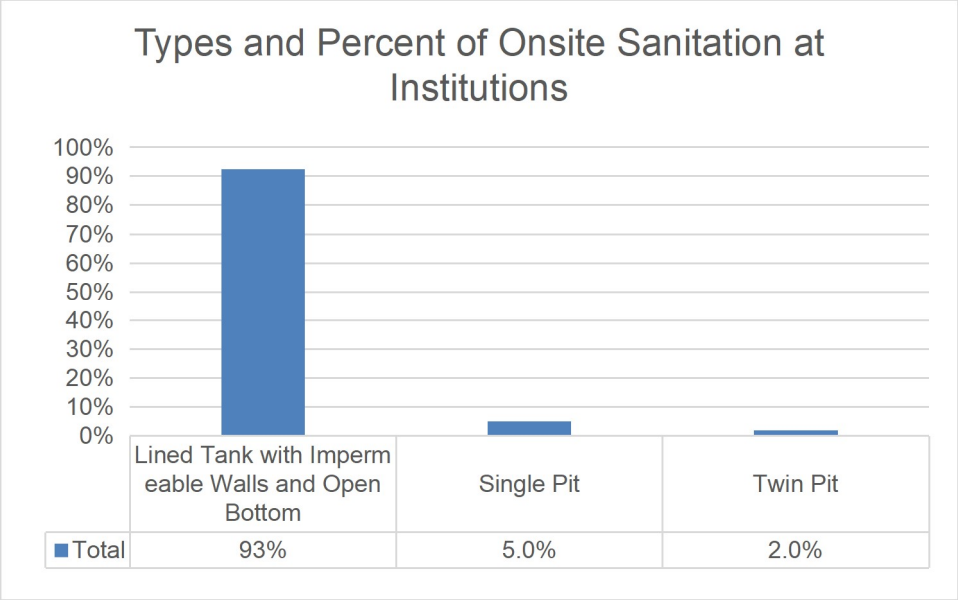


Figure 11: Different types of onsite sanitation and its percent at institutions of Bedkot Municipality.

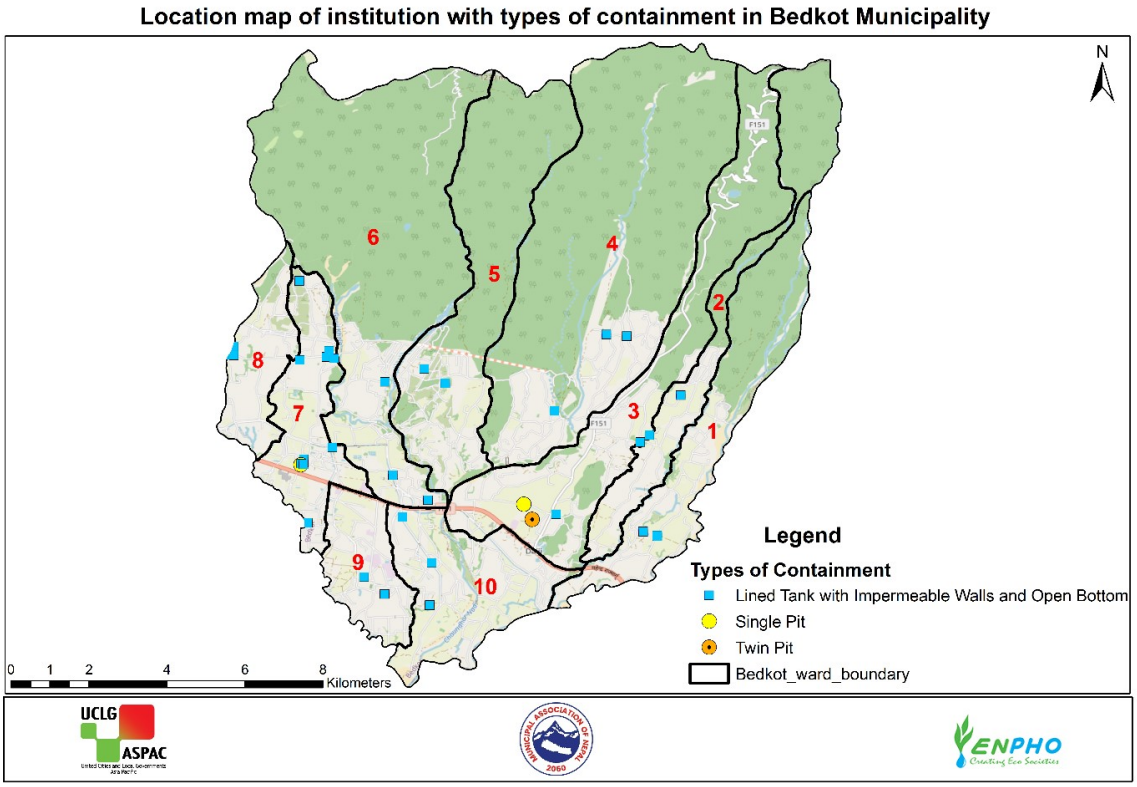


Figure 12: Ward map of Bedkot municipality with types of containments in institutions.

c Public Toilets

Based on the Key Informant Interview (KII) with caretaker of public toilet at Daiji, local market at East-West Highway, the public toilet has 3 urinals and 2 pans in male compartment and 2 pans in female compartment. The toilet is connected to twin pits but the pits have not been emptied yet. It has a pour flushing system and requires 250 litres of water per day. The average user of the toilet is 5 people per day. An individual is charged Rs.5 (USD 0.04) for urinal and Rs.10 (USD 0.08) for defecation. The toilet is cleaned daily using toilet cleaning materials. Figure 13 shows the pan and urinals of the public toilet located at Daiji.

Figure 13: Pan and Urinals of Public toilet located at Daiji, Bedkot Municipality.

2.1.2 Emptying

Only 22% of households have emptied the containment at least once since installation, of which 96% were emptied manually, 2.0% were emptied mechanically and 2.0% were emptied using open emptying method. In the municipality, few households practice discharging of FS from containment in drains during rainy seasons, known as open emptying. In addition, remaining 78% reasoned not filling of containment, as for not emptying.

In the municipality, 61% have self-emptied the containment, 30% have contacted traditional labours and only 8.9% contacted private entrepreneur to empty containments.

2.1.3 Transport, Treatment and Disposal/Reuse

The FS emptied mechanically is transported to local farmlands and disposed directly without any treatment in the municipality.

The FS emptied manually is used as composting, dig and dumped in the land, applied to farms directly, disposed of in sewerage, stormwater drainage and water bodies directly. The disposal of FS that is emptied manually is shown in Figure 14.

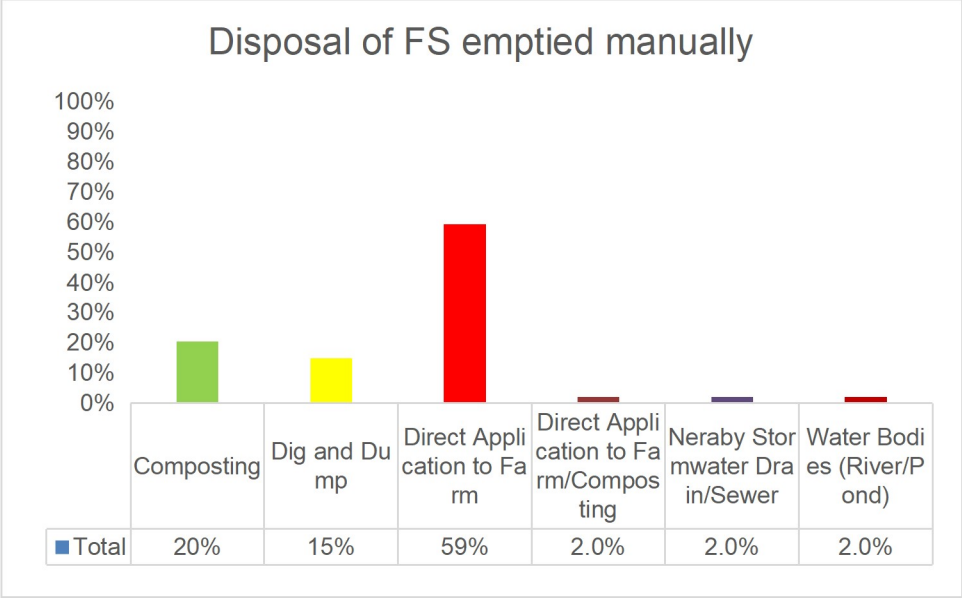


Figure 14: Disposal of manually emptied faecal sludge.

The municipality does not have any kind of treatment plant. Thus, this might be the reason for irrational disposal of emptied FS in the municipality.

Disregard of FS emptying practice, maximum amount of generated FS is disposed directly to open environment and water bodies.

2.1.4 SFD Selection Grid

Figure 15 shows the types of sanitation technologies present in the Bedkot municipality selected in the SFD selection grid. In the municipality, household toilets with no onsite container connected to water body is selected on the grid (T1A1C7) and toilets with no onsite container connected to open ground is selected on the grid (T1A1C8). The septic tanks connected to open drain or storm sewer and open ground are selected on (T1A2C6) and (T1A2C8), respectively. The biogas digesters are taken as fully lined tanks (sealed) with no outlet or overflow (T1A3C10). Similarly, lined tanks with impermeable walls and open bottom connected to open drain or storm sewer, to open ground and with no outlet or overflow are selected on (T1A4C6), (T1A4C8) and (T1A4C10) respectively. Lined tanks with impermeable walls and open bottom with no outlet or overflow with 'significant risk' are selected on (T2A4C10).

Twin pits and single pits are categorized as lined pits with semipermeable walls and open bottom for the SFD graphic. Thus, lined pits with semi-permeable walls and open bottom with no outlet or overflow is selected on (T1A5C10) and lined pits with semi-permeable walls and open bottom with no outlet or overflow with 'significant risk' is selected on grid (T2A5C10).

Furthermore, unlined pits with no outlet or overflow is selected on grid (T1A6C10) and unlined pits with no outlet or overflow with 'significant risk' is selected on grid (T2A6C10). Despite being declared as an ODF city, as the municipality has practice of open defecation at water body and open ground, so this practice is selected on grid (T1B11C7 To C9).

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		T1A1C7	T1A1C8		Not Applicable
Septic tank					Significant risk of GW pollution / Low risk of GW pollution	T1A2C6		T1A2C8		
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	T1A4C6		T1A4C8		T2A4C10 / T1A4C10
Lined pit with semi-permeable walls and open bottom	Not Applicable									T2A5C10 / T1A5C10
Unlined pit										T2A6C10 / T1A6C10
Pit (all types), never emptied but abandoned when full and covered with soil										Significant risk of GW pollution / Low risk of GW pollution
Pit (all types), never emptied, abandoned when full but NOT adequately covered with soil										
Toilet failed, damaged, collapsed or flooded										
Containment (septic tank or tank or pit latrine) failed, damaged, collapsed or flooded										
No toilet. Open defecation	Not Applicable						T1B11 C7 TO C9	T1B11 C7 TO C9		Not Applicable

Figure 15: SFD selection grid for Bedkot Municipality.

2.2 SFD Matrix

SFD matrix is the second step to generate the SFD graphic. SFD matrix calculates the proportion of people using each type of system and the proportion of each system from which FS and supernatant is emptied, transported and treated. A detailed instruction on how to calculate SFD proportion in SFD PI was used as guide to calculate SFD proportion. As stated on SFD PI, the default "100%" value is used for onsite containers which are connected to soak pits, water bodies or to open ground. This will model the contents as 100% faecal sludge and a proportion of this may be emptied periodically. The remaining not emptied fraction is made up of one or more of the following: faecal sludge which remains in the container, supernatant (when discharging to water bodies or to open ground), and infiltrate. The value for onsite containers that are connected to a sewer network or to open drains is used as "50%" which means half of the contents are modelled FS and a proportion of this may be emptied periodically. The remaining not emptied fraction will comprise faecal sludge which remains in the container and, in the case of open-bottomed tanks, infiltrate. The other half of the contents is modelled as supernatant discharging into the sewer network or to open drains. The formula obtained from SFD PI used for FS proportion calculation is shown below:

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

For septic tanks, the FS proportion calculation is obtained from the formula below:

$$\frac{[1\%\ (T1A2C8) * 100 + 1\%\ (T1A2C6) * 50]}{2\%}$$

Here, under fully lined tanks (T1A3C10), 69% of population using biogas digester and 9% of population practising composting and treated, and 3% of population practising dig and dump after emptying is considered as delivered to treatment plant. Thus, showing 81% of total from (T1A3C10) as delivered to treatment plant and 96% of 81% is taken as treated. Similarly, under (T1A2C8), (T1A4C10), (T1A5C10), (T2A4C10), (T2A5C10) and (T2A6C10), F4 variable is the percent of population practising composting and dig and dump and F5 variable is the percent of population practising composting whereby, the percent is obtained as grand total from F4 variable. The data for each system is entered on the SFD matrix. Figure 16 shows the SFD matrix of Bedkot municipality.

Bedkot Municipality, Sudurpaschim, Nepal, 28 Apr 2022. SFD Level: 2 - Intermediate SFD
Population: 49479
Proportion of tanks: septic tanks: 75%, fully lined tanks: 100%, lined, open bottom tanks: 99%

Containment						
System type	Population	FS emptying	FS transport	FS treatment	SN transport	SN treatment
	Pop	F3	F4	F5	S4e	S5e
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	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
T1A1C7 Toilet discharges directly to water body	1.0					
T1A1C8 Toilet discharges directly to open ground	1.0					
T1A2C6 Septic tank connected to open drain or storm sewer	1.0	0.0	0.0	0.0	0.0	0.0
T1A2C8 Septic tank connected to open ground	1.0	75.0	67.0	50.0		
T1A3C10 Fully lined tank (sealed), no outlet or overflow	27.0	32.0	81.0	96.0		
T1A4C10 Lined tank with impermeable walls and open bottom, no outlet or overflow	16.0	5.0	25.0	0.0		
T1A4C6 Lined tank with impermeable walls and open bottom, connected to an open drain or storm sewer	1.0	0.0	0.0	0.0	0.0	0.0
T1A4C8 Lined tank with impermeable walls and open bottom, connected to open ground	1.0	0.0	0.0	0.0		
T1A5C10 Lined pit with semi-permeable walls and open bottom, no outlet or overflow	3.0	46.0	50.0	67.0		
T1A6C10 Unlined pit, no outlet or overflow	1.0	75.0	0.0	0.0		
T1B11 C7 TO C9 Open defecation	4.0					
T2A4C10 Lined tank with impermeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	32.0	7.0	33.0	33.0		
T2A5C10 Lined pit with semi-permeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	9.0	41.0	38.0	80.0		
T2A6C10 Unlined pit, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	2.0	30.0	33.0	100.0		

Figure 16: SFD Matrix of Bedkot Municipality.

2.2.1 SFD Matrix Explanation

The sanitation technologies and the corresponding percentage of the population using such technologies are shown in Table 3.

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

S.N.	Sanitation Technologies	SFD Reference Variable	Percentage of Population
1	Toilet discharges directly to water body	T1A1C7	1%
2	Toilet discharges directly to open ground	T1A1C8	1%
3	Septic tank connected to open drain or storm sewer	T1A2C6	1%
4	Septic tank connected to open ground	T1A2C8	1%
5	Fully lined tank (sealed), no outlet or overflow	T1A3C10	27%
6	Lined tank with impermeable walls and open bottom, connected to an open drain or storm sewer	T1A4C6	1%
7	Lined tank with impermeable walls and open bottom, connected to open ground	T1A4C8	1%
8	Lined tank with impermeable walls and open bottom, no outlet or overflow	T1A4C10	16%
9	Lined pit with semi-permeable walls and open bottom, no outlet or overflow	T1A5C10	3%
10	Unlined pit, no outlet or overflow	T1A6C10	1%
11	Open defecation	T1B11 C7 TO C9	4%
12	Lined tank with impermeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	T2A4C10	32%
13	Lined pit with semi-permeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	T2A5C10	9%
14	Unlined pit, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	T2A6C10	2%

2.2.2 Risk of Groundwater Pollution

a. Sources of Drinking Water and Water Production

Based on the household survey data and KII with focal person of Sula Water Supply and Sanitation Project (SWSSP), the major source of drinking water source of Bedkot Municipality is groundwater and spring source. The household survey data shows that 21% have accessibility of drinking water through private tap at household and 2% have accessibility of drinking water through public tap. As per the KII, SWSSP is providing drinking water supply service to 2,000 households of Bedkot Municipality. SWSSP extract groundwater from depth of 475 ft (145 m). The extracted water is treated with chlorine dosing prior to supply to users.

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

The municipality lies on Northern Terai and Siwalik range with geological structure consisting of boulders, pebbles, cobbles and coarse in Northern Terai and the type of geological structure is considered sandy loam (Dahal, 2006) (FAO, 2006). Similarly, Siwalik range of the region consists of fluvial sedimentary rocks known as sandstone, siltstone, mudstone and conglomerate which are characterized as soft, loose and easily erodible (Dhakal, 2014) . Most residents however are in the Northern Terai region. The sandy loam structure has higher permeability and results in high risk of shallow groundwater contamination (FAO, 2006) (INREM, 2011) . Based on the depth of hand pumps installed at households and groundwater contamination risk, lined tanks with impermeable walls and open bottom and lined pits with semi-permeable walls, open bottom and unlined pits were assessed.

A total of 76% of HHs uses groundwater source for drinking. Among 49% of HHs with lined tanks with impermeable walls and open bottom, 6% extract water from depth of 20 feet (6 m), 75% extract water from 40 feet (12 m) and 3% extract water from 60 feet (18 m). Similarly, of 16% HHs with lined pits with semi-permeable walls and open bottom, 2%, 70% and 12% extract groundwater from 20 feet (6 m), 40 feet (12m) and 60 feet (18 m), respectively. And, of 4% HHs with unlined pits, 25% and 58% extract groundwater from 20 feet (6 m) and 40 feet (12 m), respectively. Figure 17, 18 and 19 shows the depth of hand pumps and lateral spacing of it with containment types such as lined pits with semipermeable walls and open bottom, lined tanks with impermeable walls and open bottom and unlined pits, respectively.

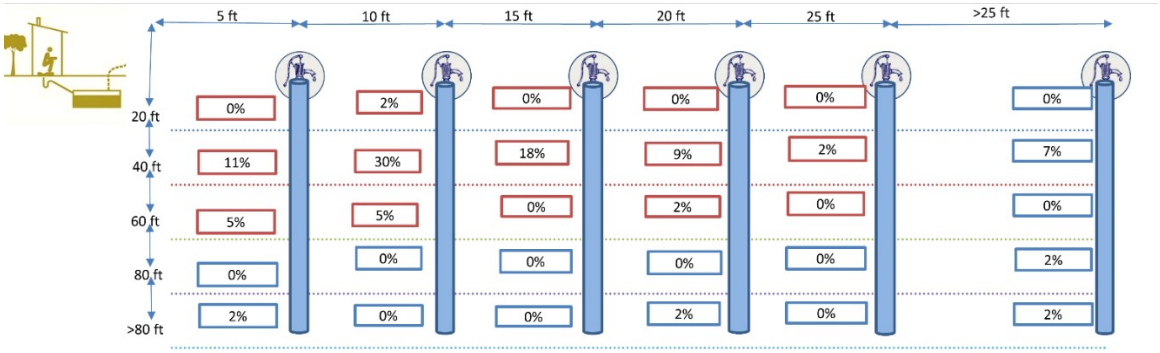


Figure 17: Depth of hand pumps and lateral spacing of it with containment type lined pit with semipermeable walls and open bottom.

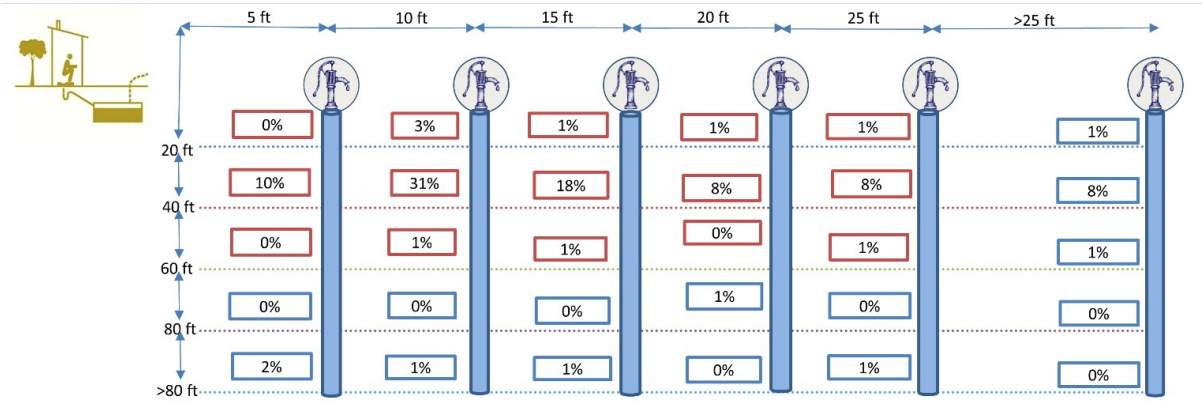


Figure 18: Depth of hand pumps and lateral spacing of it with containment type lined tank with impermeable walls and open bottom.

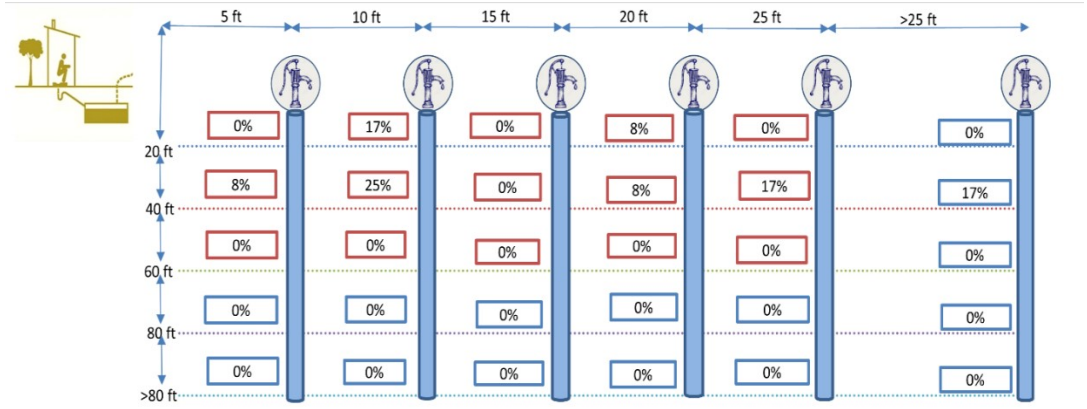


Figure 19: Depth of hand pumps and lateral spacing of it with containment type unlined pit.

2.3 Summary of assumptions

Offsite sanitation systems:

- ✓ 1% of the toilets discharge directly to a water body (T1A1C6) and another 1% discharge to open ground (T1A1C8). Since there is no WWTP, all wastewater is disposed of untreated into the environment.

Onsite sanitation systems:

- ✓ The proportion of FS in septic tanks were set to 75%, 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 99% according to the relative proportions of the systems in the municipality, as per the guidance given in the Frequently Asked Questions (FAQs) in the Sustainable Sanitation Alliance (SuSanA) website.
- ✓ Variables F3, F4 and F5 for all onsite sanitation systems were derived from the HH survey and cross-checked with the KIIs and FGDs conducted. For F4 variable, composting, dig and dump and biogas digester is taken as FS delivered to treatment plant as for composting and dig and dump are practised for manual emptying thus are done in a nearby spot. Biogas digester are directly connected to toilet. For F5 variables,

biogas digester and composting are taken as FS treated. Biogas digester is a waste-to-energy conversion technology designed to treat household organic waste and Faecal Sludge (FS) to generate biogas. The composting is basic approach for organic waste management and final products are considered safe (Mengistu, et al., 2018).

2.4 SFD Graphic

Figure 20 shows the SFD graphic for Bedkot Municipality. In the graphic, FS from 44% of population using onsite sanitation is shown as safely managed. The percent is obtained as 35% of population using containments namely fully lined tanks with impermeable walls and open bottom without outlet or overflow (T1A4C10), lined pits with semi-permeable walls and open bottom without outlet or overflow (T1A5C10) and unlined pits (T1A6C10) without significant risk to groundwater is contained and have not been emptied. The treated FS from remaining 9% of population is obtained as the user anaerobic biogas digester (T1A3C10).

FS, wastewater (WW) and Supernatant (SN) from 56% of population using onsite, offsite and open defecation is shown as unsafely managed. The description of SFD graphic is presented on Table 2.

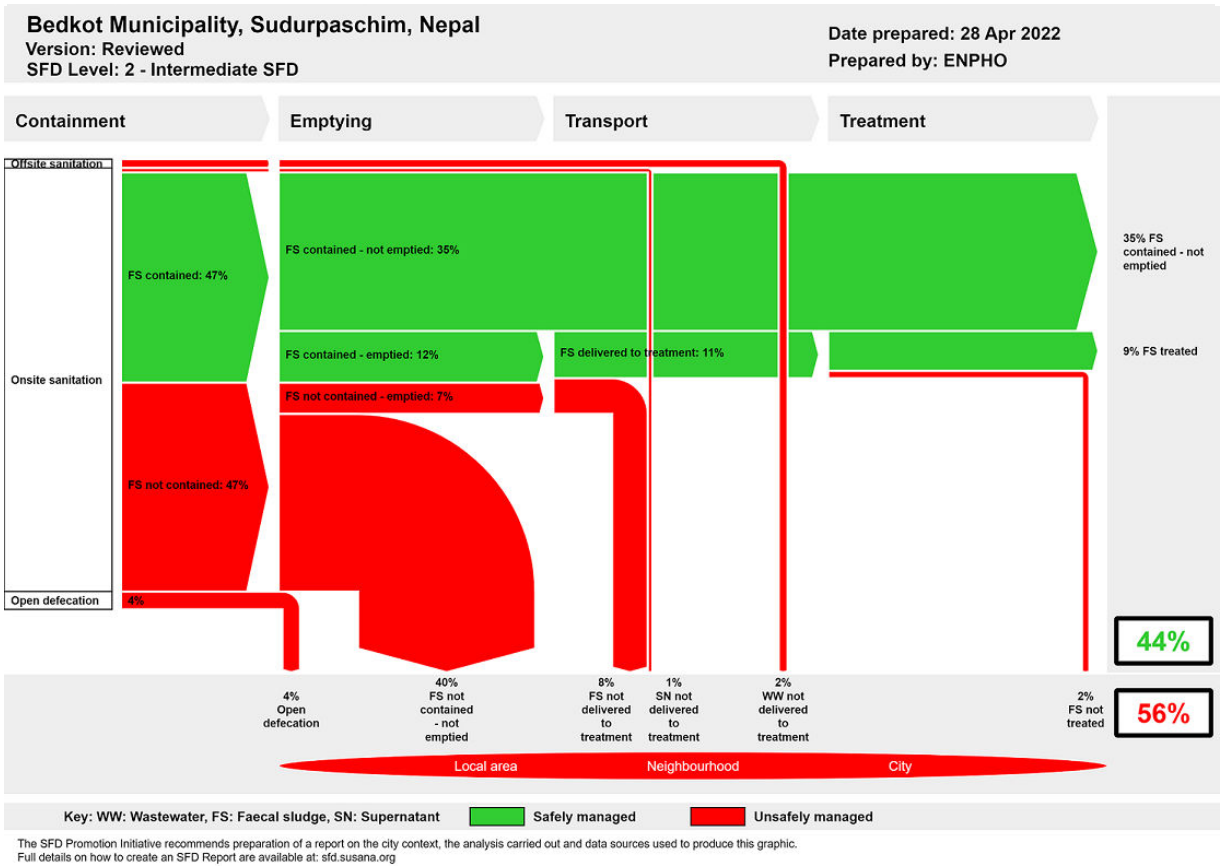


Figure 20: SFD Graphic of Bedkot Municipality.

Table 2: Description of the percentage of the SFD graphic.

Variables	Description	Percent
FS contained	Faecal sludge that is contained within an onsite sanitation technology which is technically effective. These containments are fully lined tanks (T1A3C10), lined tanks with impermeable walls and open bottom without outlet or overflow (T1A4C10), lined pits with semi-permeable walls and open bottom without outlet or overflow (T1A5C10) and unlined pits without outlet or overflow (T1A6C10) without significant risk to groundwater.	47%
FS not contained	Faecal sludge that is stored in an unsafe onsite sanitation technology.	47%
FS contained not emptied	FS that is contained within an onsite sanitation technology and not removed where there is no significant risk to groundwater pollution. These containments are fully lined tanks (T1A3C10), lined tanks with impermeable walls and open bottom without outlet or overflow (T1A4C10), lined pits with semi-permeable walls and open bottom without outlet or overflow (T1A5C10) and unlined pits (T1A6C10) without significant risk to groundwater.	35%
FS contained – emptied	FS that is contained in onsite sanitation technology and emptied either mechanically or manually.	12%
FS not contained emptied	FS that is removed from an onsite sanitation technology where FS is not contained which is emptied using wither motorized or manual emptying equipment.	7%
FS not contained – not emptied	FS that is not contained within an onsite sanitation technology and not removed which may either remain in the containment or infiltrate to ground polluting groundwater.	44%
FS - treated	FS treated in a well functioned anaerobic biogas digester and composting.	9%
FS not delivered to treatment	FS emptied from an onsite sanitation system is either FS contained or not but is not delivered to the treatment plant.	8%
SN not delivered to treatment	SN not contained from septic tanks connected to open drain or storm sewer.	1%
WW not delivered to treatment	All wastewater from toilets discharges going directly to open drain or water bodies.	2%
FS not treated	FS emptied from an onsite sanitation system but is not delivered to the treatment plant.	2%

3 Service delivery context

3.1 Policy, legislation and regulation

3.1.1 Policy

The Constitution of Nepal 2015 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, promote and fulfil the provisions related to right on water and sanitation, Government of Nepal has billed Drinking Water and Sanitation Act, 2019 through Ministry of Water Supply. The act elaborates right to clean water as to receive affordable, sufficient, and quality drinking water regularly, Also, access to sanitation as affordable access to quality sanitation services (MoWS, 2019).

Historically, 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 in 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, 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. Cost recovery principles, public private partnership, and sector effectiveness for improved service delivery are key principles of the policy (DWSSM, 2009). Both these policies were limited to address emerging issues and challenges in the rural and urban areas. Thus, National Water Supply and Sanitation Policy (NWSSP) was formulated in 2014 by the Government of Nepal (GON) to address the emerging challenges and issues with the adoption of new approaches and resolve the inconsistency in RWSSNP and NUWSSSP. The goal of the NWSSP was to reduce urban and rural poverty by ensuring equitable socio-economic development, improving health and the quality of life of the people and protection of environment through the provision of sustainable water supply and sanitation services. It adopted innovative technologies and knowledge emerged in the sector. Remarkably, it was the first official document that recognized discharge of untreated wastewater and dumping of septic sludge heavily polluted the surface water sources in urban areas.

Recently, National Water, Sanitation and Hygiene Policy, 2022 has been drafted and undergone the process for endorsement. The draft policy is updated policy till date which has included the wide range of the sanitation services including treatment, reuse/ safe disposal of faecal sludge / wastewater. It emphasizes on the preparation of the municipal level WASH plan with the local leadership to ensure the WASH services for all (MoWS, 2022).

Nepal is a signatory of the historical resolution of 2010 United Nations General Assembly on the Human Right to Water and Sanitation (UNGA, 2010). 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 (NSHMP), 2011 was developed for coordinated planning and implementation of National Sanitation Campaign. The campaign strengthened institutional setup tier of government in a participatory approach. In an alignment total sanitation campaign was initiated formally to sustain ODF. The guideline set various indicators to assess the sustainability of sanitation services. Remarkably, it extended sanitation definition as management of services and facilities to safely dispose of/reuse faecal sludge, collection and treatment of solid waste and wastewater to establish the hygienic environment and promote public health (NPC, 2017).

Similarly, Nepal Water Supply, Sanitation and Hygiene Sector Development Plan (SDP 2016-2030) was formulated in 2016 for sector convergence, institutional and legal reforms, capacity development and establishing coordination and harmonization in the sector. The SDP classified service system and delineated roles and responsibilities for effective and sustainable service delivery. The SDP highlighted that majority of households rely on onsite sanitation system (70%) that requires effective treatment of faecal sludge. However, there is lack of concrete policies, guidelines, and indicators on Faecal Sludge Management in the sector for effective planning, implementation and service delivery. In alignment, 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 Faecal Sludge Management (FSM). It is framed upon existing laws such as Environmental Protection Act (2019) and Environmental Protection Rules (2020), 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.

The constitution of Nepal has provided the right for local government to form acts, rules and regulation based on the national policies and laws. Local Governance Operation Act 2017 has been formed to implement the right of local government and promote co-operation, co-existence, and co-ordination among federal, provincial, and local government. The act has mentioned the right, roles and responsibility of municipalities along with provision and procedure for approving laws and regulations at local level.

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 Level

National Planning Commission: At the federal government, the National Planning Commission is the specialized and apex advisory body for formulating a national vision, develop policy, periodic plans, and sectoral policies. The NPC assesses resource needs, identifies sources of funding, and allocates budget. It serves as a central agency for monitoring and evaluating development policy, plans and programs. It supports, facilitates and coordinates with federal, provincial, and local government for developing policy plan 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 21.

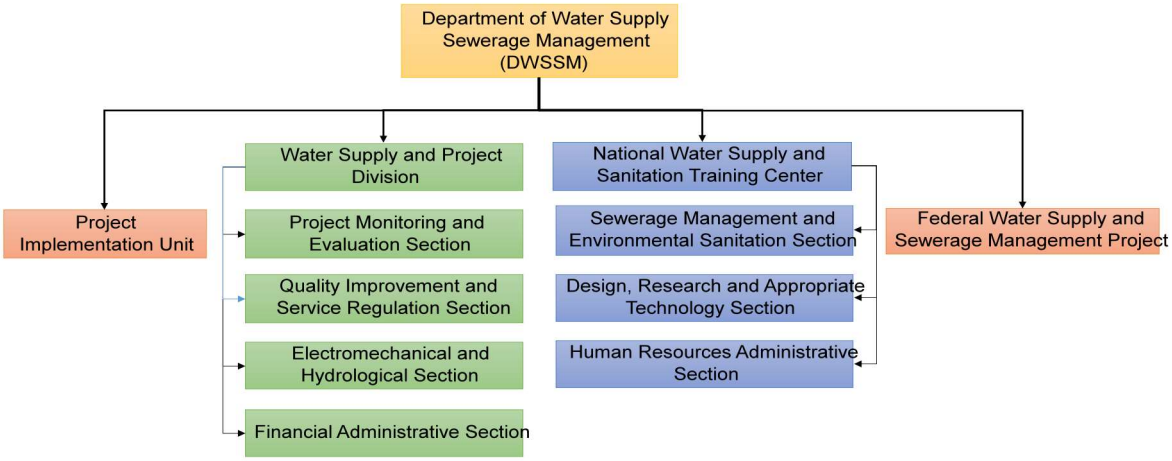


Figure 21: Organizational Structure Department of Water Supply and Sewerage Management (DWSSM).

Ministry of Urban Development: The Ministry of Urban Development (MoUD) works on integrated urban planning and development in municipalities, including faecal sludge management. Department of Urban Development and Building Construction (DUDBC) under MoUD is implementing body and also sets the standards for safe, affordable building construction and implementation for managed residential environment.

At Provincial Level

Ministry of Physical Infrastructure: Ministry of physical infrastructure of provincial government in Sudurpaschim is major executing body in the province. Planning and implementation of water supply and sanitation infrastructure is 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 5,00 to 1,000 in Himalayan region.

At Local Government:

Municipal council: The activities related to sanitation, environment and social work is managed under administrative section in the municipality. There is no specific section for sanitation and environment in the municipality.

3.1.3 Service provision

Urban Water Supply and Sanitation Policy 2009 has emphasized the Public-Private Partnership (PPP) in water supply and sanitation to improve service delivery (MoPIT, 2009). Also, 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).

Sula Town Water Supply and Sanitation Project is supplying drinking water since 2019 in ward 6, 7 and 8 of Bedkot municipality. The source of water is groundwater. It is distributed after water treatment using chlorine dosing (KII-4, 2022).

The municipality does not have sewer network. Toilet system is either directly connected to river or the toilets connected to containments are emptied by mechanical desludger or manually by traditional desludgers (KII-1, 2022).

3.1.4 Service standards

The sanitation service standards have been 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 3. However, FSM specific standards have yet to be developed and implemented.

Table 3: 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	✓	✓	✓

3.2 Equity

3.2.1 Current choice of urban poor

The government has developed a Multiple Indicator Cluster Survey (MICS) for periodic monitoring of different sectors of SDG including water and sanitation service delivery (CBS, 2022) . The program is supported by the Joint Monitoring programme (JMP) from the WHO/UNICEF.

3.2.2 Stimulating demand for services

The mandatory provision of septic tanks during construction of building as per the National Building Code and promotion of biogas digester at household level through the Alternative Energy Promotion Centre with subsidies are major legal and initiatives for stimulating sanitation service demand in the city. Besides, the sub-metropolitan city must conduct awareness programs on sanitation at the community level for increasing the demand.

3.2.3 Strengthening service provider roles

Local government operation act 2017 and bill on drinking water and sanitation 2019 has entitled local government with authority for planning, implementation, monitoring and supervision of water and sanitation programs and services in the city. Similarly, institutional and regulatory framework on FSM has designated the local government with authority for planning, implementation, monitoring and supervision of sanitation programs (MoWS, 2017).

4 Stakeholder Engagement

4.1 Key Informant Interview

The Key Informant interviews (KIIs) and objective sharing of the study were conducted with major stakeholders of the sanitation sector in the municipality. Administrative officer of the municipality and IT officer were interviewed on current sanitation services with respect to technical, institutional, and financial aspects. Also, the interview with the caretaker of public toilet was conducted to understand faecal sludge generation from the public toilets of the municipality as well as to understand public toilet management practice.

Table 4: List of Key Informant Interviewed personnel.

S.N.	Name	Designation	Organization/Company	Purpose of KII	Date
1.	Padam Bahadur Thakurathi (KII-1)	Administrative Officer	Bedkot Municipality	Sanitation status, municipality representatives	2 April, 2022
2.	Sunil Chand (KII-2)	IT Officer	Bedkot Municipality	Sanitation status, municipality representatives	2 April, 2022
3.	(KII-3)	Public Toilet caretaker	Daiji, Bedkot Municipality	Quantitative and management data on public toilet and public toilet operation	3 April, 2022
4.	Yogesh Joshi (KII-4)	Meter Reader	Sula Town Water Supply and Sanitation Project	Supply and demand of water, water sources, groundwater contamination risk, availability of water	3 April, 2022

4.2 Household Survey

A random household survey was conducted in all wards of the municipality. The municipality selected local enumerators who were oriented prior to the survey and were mobilized for data collection. A mobile application “KOBOCOLLECT” was used for the household survey. In the orientation, enumerators were clarified on survey objectives, technical terms concerning sanitation, use of the mobile application and procedure of random sampling survey based on the provided map.

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^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 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 373 households were sampled from 12,574 households distributed in 10 wards with proportionate stratification random sampling. The total number of households here was calculated by dividing population acquired from municipality website by household size acquired from census 2021 (Figure 22).

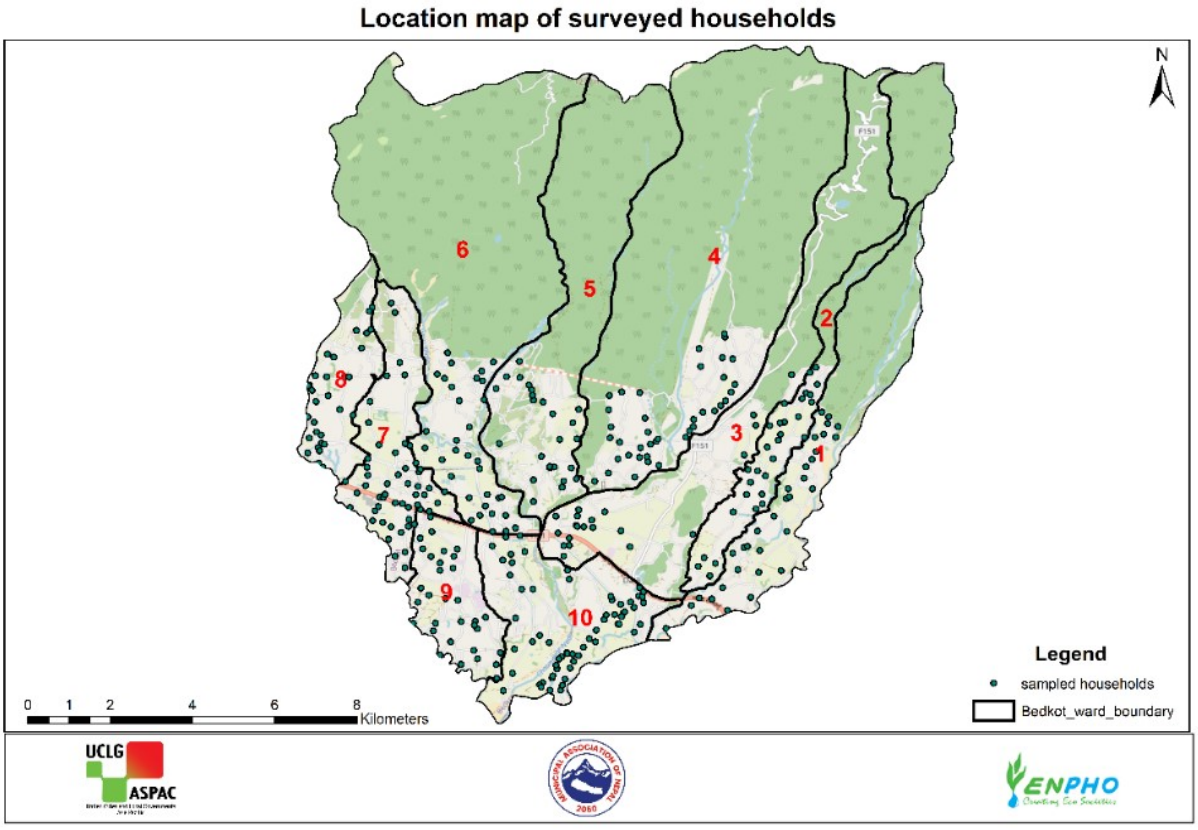


Figure 22: Location map of sample households.

4.2.2 Direct Observation

Various sanitation technologies and drinking water sources in the households were observed and visual references were kept. Also, status of public toilets were observed (Figures 23, 24 and 25).

Figure 23: Toilet at household and Public toilet in Bedkot Municipality.

Figure 24: Handpump at surveyed household used for drinking water.

Figure 25: Survey monitoring at household and observation at drinking water service provider.

4.2.3 Sharing and Validation of Data

The sharing and validation of findings on sanitation status were conducted in the municipality hall in participation of the mayor, ward chairpersons, general members of municipal council and other relevant stakeholders shown in Figure 27. The participants agreed upon the findings of this study that showed current sanitation status of the municipality. The mayor focused on the need to improve knowledge on faecal sludge of general members of municipal council, key stakeholders and general public as well. As the municipality is shifting towards urbanization, the mayor also mentioned the necessities of proper sanitation system for safe and beautiful city and added that findings of this study support in further planning of sanitation in the municipality.

Figure 26: Sharing and validation workshop of SFD at Bedkot municipality.

5 Acknowledgements

We would like to acknowledge the executing agency, United Cities Local Government – Asia Pacific (UCLG ASPAC) and implementing agency Municipal Association of Nepal (MuAN) of the Municipalities Advocacy on Sanitation in South Asia – II (MuNASS-II) for coordination with the sub-metropolitan city.

We offer sincere acknowledgement to Mr. Bhoj Raj Bohara, Mayor of the municipality and Mr. Padam Bahadur Thakurathi, Administrative Officer for providing valuable time and information during study. Similarly, we would like to thank all the respective staffs of the municipality, key stakeholders and enumerators involved during the study, without whose help this study would not have been completed. We appreciate former Mayor Ashok Kumar Chand for his support and guidance during the study.

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

We are very much grateful to Ms. Bhawana Sharma, Executive Director and Mr. Rajendra Shrestha, Program Director of Environment and Public Health Organization (ENPHO) for tremendous support and guidance during the whole process of the study. Together, we would like to thank entire team of ENPHO for their gracious support and MuNASS-II team without whom the study would not have been possible.

We are grateful towards the enumerators, Mr. Akash Puri, Mr. Chet Raj Badu, Mr. Shusil Aauji, Mr. Dhirendra Singh Dhami, Ms. Basanti Kumari Badu, Ms. Kabita Pant, Ms. Sangita Chaudhary, Ms. Manju Bhandari, Ms. Maya Bhatt, Mr. Deepak Raj Joshi for their support during the survey.

6 References

AEPC, 2018. *Biogas technology.* [Online]
Available at: https://www.aepc.gov.np/biogas-technology

Affam, A. C. & Ezechi, H. E., 2021. Sanitation Systems and Technology Options. In: *Clean Water and Sanitation.* Cham: Springer, pp. 1-16.

Bedkot Municipality, 2022. *Bedkot Municipality.* [Online]
Available at: https://bedkotmun.gov.np/ne/node/3

Carr, R., 2001. Excreta-related infections and the role of sanitation in the control of transmission. In: J. B. Lorna Fewtrell, ed. *Water Quality: Guidelines, Standards & Health.* London: IWA, pp. 89-106.

CBS, 2022. *Multiple Indicator Cluster Survey 2019,* s.l.: Central Bureau of Statistics and United Nations Children's Fund.

Dahal, K. R., 2006. *Geology of Nepal.* [Online]
Available at: http://www.ranjan.net.np/index.php/resources/geology-of-nepal

Dahal, K. & Timalsina, K. P., 2020. Dimensions of land use change and implications in spatial planning of emerging town Bedkot municipality, Kanchanpur district, Nepal. *The Geographical Journal of Nepal,* March, Volume 13, pp. 185-200.

Dhakal, S., 2014. Geological Divisions and Associated Hazards in Nepal. *Contemporary Environmental Issues and Methods in Nepal,* pp. 100-109.

Dhangadhi Sub-metropolitan, 2022. *Dhangadhi Sub-Metropolitan City.* [Online]
Available at: https://dhangadhimun.gov.np/en

DWSSM, 2004. *National Rural Water Supply and Sanitation Sector Policy. Kathamndu, Nepal.* s.l.:Department of Water Supply and Sewarage Management, Ministry of Water Supply, Goverment of Nepal.

DWSSM, 2009. *National Urban Water Supply and Sanitation Sector Policy.* Kathmandu, Nepal: Department of Water Supply and Sewerage Management, Ministry of Water Supply, Government of Nepal.

DWSSM, 2020. *Open Defecation Free Nepal:Narration of the Journey,* Kathmandu: Secretariat of National Sanitation and Hygiene Coordination Committee, Nepal.

FAO, 2006. *Guidelines for Soil Description.* [Online]
Available at:
https://www.fao.org/fishery/docs/CDrom/FAO_Training/FAO_Training/General/x6706e/x6706e09.htm#104a

GoN, 2015. *Constitution of Nepal: Goverment of Nepal.* [Online]
Available at: https://lawcommission.gov.np/en/wp-content/uploads/2021/01/Constitution-of-Nepal.pdf

INREM, 2011. *On-Site Sanitation and Groundwater Contamination: A Policy and Technical Review,* Anand, India: INREM Foundation.

Jayathilake, N. et al., 2019. *Guidelines and Regulations for Fecal Sludge Management from On-Site Sanitation Facilities.* Colombo: International Water Management Institute.

Kansakar, D. R., 1980. *Understanding Groundwater for Proper Utilization and Management in Nepal,* s.l.: IWMI.

Karki, R., Talchabhadel, R. & Aalto, J., 2015. New climatic classification of Nepal. *Theoretical and Applied Climatology,* pp. 799-808.

KII_11, 2022. *Status of water supply in Dhangadhi sub-metropolitan city* [Interview] 2022.

KII-1, 2022. *Sanitation Status of Bedkot Municipality.* Bedkot: s.n.

KII-4, 2022. *Status of Water Quality and Quantity in Bedkot Municipality.* Bedkot: s.n.

Mengistu, T. et al., 2018. Comparative effectiveness of different composting methods on the stabilization, maturation and sanitization of municipal organic solid wastes and dried faecal sludge mixtures. *Environmental Systems Research ,* 6(5).

MoF, 2015. Public-Private Partnership Policy. In: Kathmandu, Nepal: Goverment of Nepal.

MoFAGA, 2017. *Ministry of Federal Affairs & General Administration.* [Online]
Available at: https://www.sthaniya.gov.np/gis/

MoPIT, 2009. National Urban Water Supply and Sanitation Sector Policy. In: s.l.:Ministry of Physical Infrastructure and Transport.

MoWS, 2017. *Institutional and Regulatory Framework for Faecal Sludge Management in Urban Areas of Nepal.* Kathmandu,Nepal: Ministry of Water Supply..

MoWS, 2017. *Institutional and Regulatory Framework for Faecal Sludge Management in Urban Areas of Nepal,* Kathmandu, Nepal: Ministry of Water Supply.

MoWS, 2019. *Bill on Drinking Water and Sanitation.* s.l.:Ministry of Water Supply; Goverment of Nrpal.

MoWS, 2022. *Draft National Water, Sanitation and Hygiene Policy ,* s.l.: Ministry of Water Supply.

National Census , 2021. *National Census 2021.* [Online]
Available at: https://censusnepal.cbs.gov.np/Home/Details?tpid=5&dcid=3479c092-7749-4ba6-9369-45486cd67f30&tfsid=17

NPC, 2017. *Nepal Sustainable Development Goals, Status and Roadmap: 2016-2030.* s.l.:National Planning Commission.

Peal, A. et al., 2020. Estimating Safely Managed Sanitation in Urban Areas; Lessons Learned From a Global Implementation of Excreta-Flow Diagrams. *Frontiers in Environmental Science,* Volume 8, pp. 1-13.

Saxena, S. & Den, W., 2022. In situ treatment technologies for pit latrines to mitigate groundwater contamination by fecal pathogens: a review of recent technical advances. *Journal of Water, Sanitation and Hygiene for Development,* 12(1), pp. 102-115.

Strande, L., Ronteltap, M. & Brdjanovic, D., 2014. *Faecal Sludge Management Systems Approach for Implementation and Operation.* London: IWA Publishing.

UNGA, 2010. *Human Right to Water and Sanitation.* [Online].

WIKIMEDIA, 2022. *WKIMEDIA CLOUD SERVICES.* [Online]
Available at:
https://geohack.toolforge.org/geohack.php?pagename=Bedkot&params=28.95_N_80.23_E_type:adm2nd_region:NP_source:unmaps-enwiki

7 Appendix Annexes

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

Table 5: Roles and responsibilities of various tiers of government delineated in drafted SDP 2016-2030.

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

7.2 Appendix 2: Number of Institutions in the Survey

Table 6: Number of the surveyed institution.

Ward	Educational	Government /Non government Office	Health care centre	Total
1	1	1	1	3
2	1	1	1	3
3	1	1	1	3
4	1	2		3
5	2	1	1	4
6	2	1		3
7	6	5	1	12
8	1	1	1	3
9	1	1		2
10	2	1	1	4
Total	**18**	**15**	**7**	**40**

7.3 Appendix 3: Description of Public Toilet at Daiji

Table 7: Description of Public Toilet at Daiji.

Public Toilet	No. of Urinals	No. of a toilet seat		The average number of users per day
		Male	Female	
Public Toilet located at Daiji local market	3	2	2	5

7.4 Appendix 5: Number of household in each ward and sampled number of household

Table 8: Number of total household in each ward and sampled households.

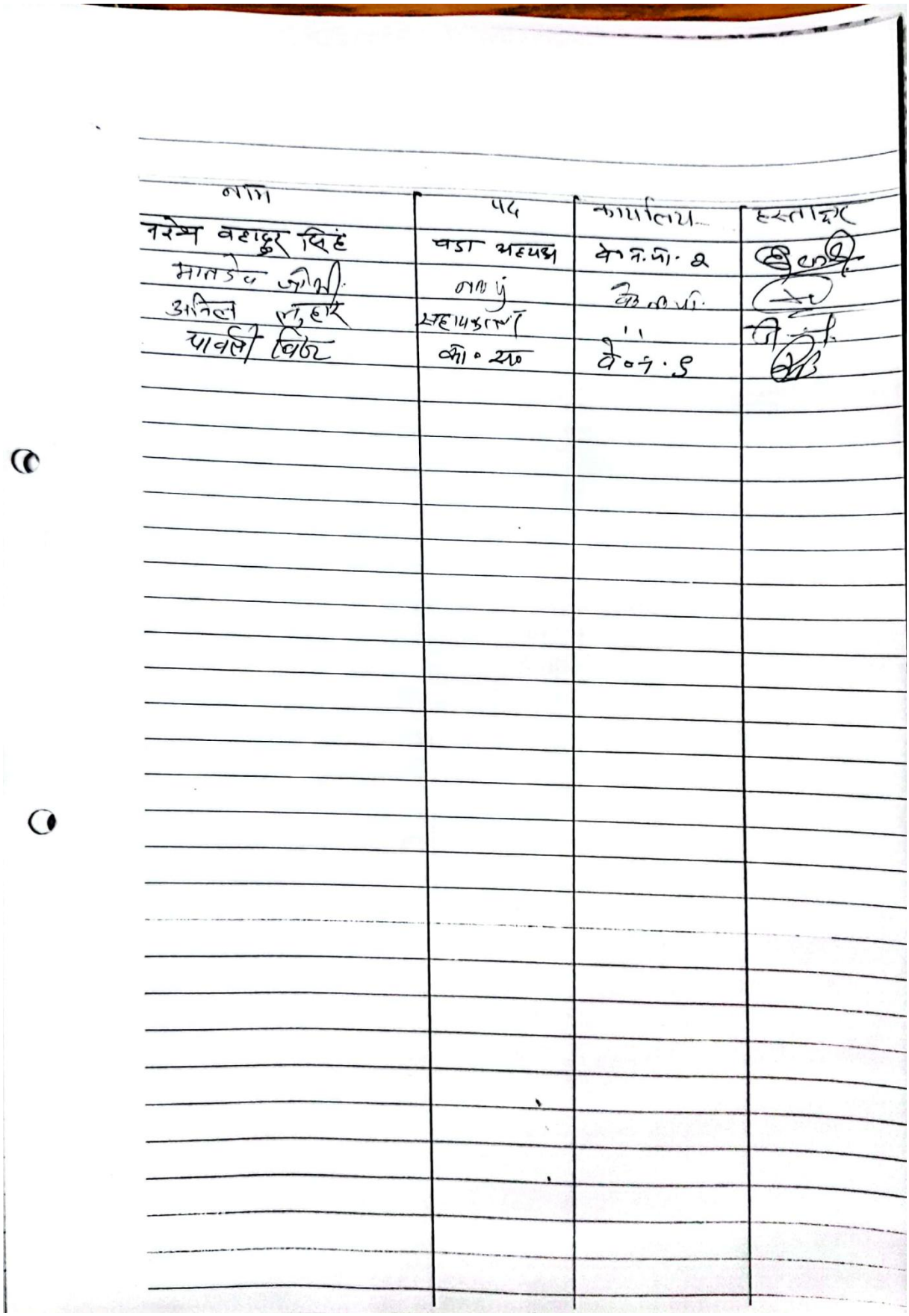
Ward	Households	Sample
1	1,037	31
2	1,112	33
3	700	21
4	1,323	39
5	1,267	38
6	1,059	31
7	1,834	54
8	1,100	33
9	1,157	34
10	1,986	59
Total		**373**

7.5 Appendix 6: List of Participants in Sharing and Validation of Findings

आज मिति २०७९ जेष्ठ २३ गतेका दिन नेपाल नगरपालिका संघको आयोजनामा र वातावरण तथा जनस्वास्थ्य संस्था, इन्फोको प्राविधिक सहयोगमा MuNASS-II कार्यक्रम अन्तर्गत बेदकोट नगरपालिकामा संचालित समावेशी सरसफाइ र Shit Flow Diagram सम्बन्धी अभिमुखीकरण तथा अन्तरक्रिया कार्यक्रममा निम्न अनुसार जनप्रतिनिधिहरू, विषयगत कर्मचारी लगायतका अन्य सरोकारवालाहरूको उपस्थिति रहेको छ।

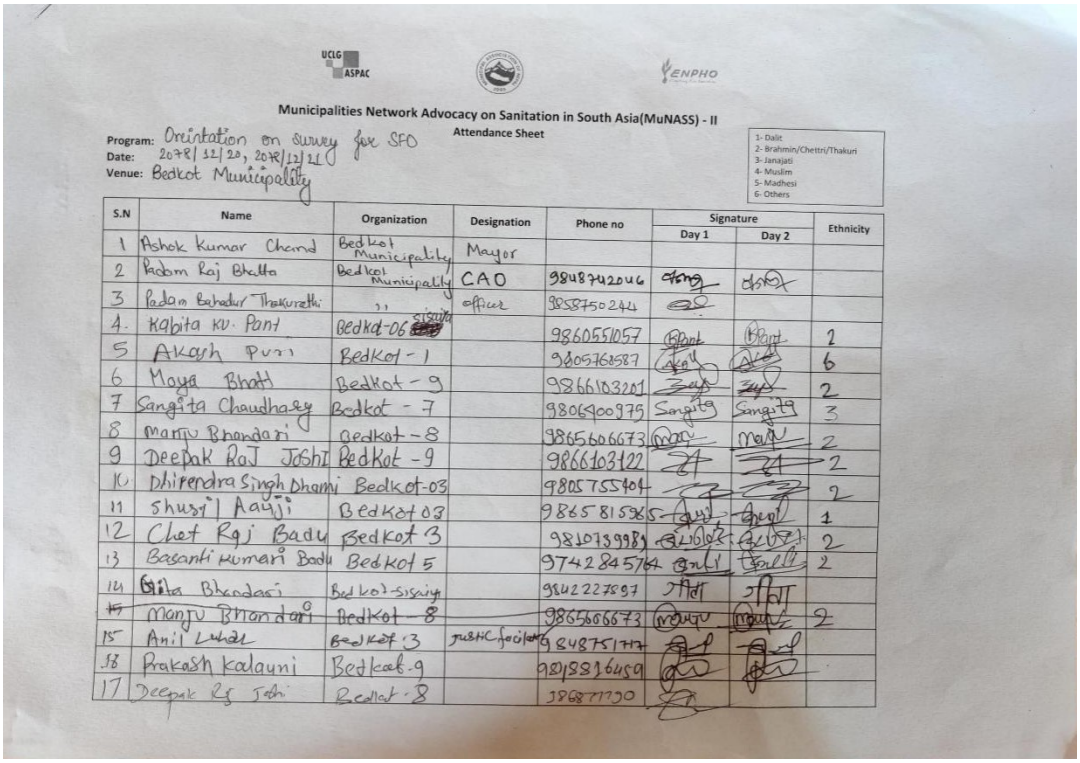
उपस्थिति :

नाम	पद	कार्यालय	हस्ताक्षर
मोज राज बोहरा	नगर प्रमुख	बेदकोट नगरपालिका	[illegible]
तुलसी जोशी	उप प्रमुख	"	[illegible]
पदम राज भट्ट	प्र.प्र.अ.	"	[illegible]
पदम ब. ठकुराठी	अधिकृत	"	[illegible]
भोज राज अवस्थी	रोजगार संयोजक	"	[illegible]
सुनिल चन्द	सू.प्र.अ.	"	[illegible]
नर बहादुर कार्की	[illegible]	"	[illegible]
सुनिता भट्ट	स. पाँचौं	"	[illegible]
राधिका पन्त	अधिकृत छैठौं	"	[illegible]
टेक बहादुर चंद	स. पाँचौं	"	[illegible]
हिरा देवी [illegible]	[illegible]	" ४	[illegible]
भरत ब. बिष्ट	वडा अध्यक्ष	"	[illegible]
रमेश सिंह भण्डारी	वडा १ अध्यक्ष	"	[illegible]
धनेश्वर प्रसाद भट्ट	वडा अध्यक्ष	बे. न. पा. ७	[illegible]
रतन सिंह बिष्ट	वडा अध्यक्ष	बे. न. पा. १०	[illegible]
कुलदीप राज [illegible]	वडा अध्यक्ष	बे.न.पा. ६	[illegible]
रमेश प्रसाद भट्ट	[illegible]	बे.न.पा. ३	[illegible]
रामराते राना	का.पा. [illegible]	" ६	रामजति



नाम	पद	कार्यालय	हस्ताक्षर
नरेश बहादुर सिंह	वडा अध्यक्ष	के.न.पा. २	
मातवेन जोशी	वडा	के.न.पा.	
अनिल [illegible]	सहायकस्तर	"	
पार्वती विष्ट	को० स्त०	के०न०पा०	

7.6 Appendix 7: Attendance sheet of SFD orientation program in Bedkot Municipality



UCLG ASPAC | ENPHO

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

Attendance Sheet

Program: Orientation on survey for SFD
Date: 2078/12/20, 2078/12/21
Venue: Bedkot Municipality

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

S.N	Name	Organization	Designation	Phone no	Signature		Ethnicity
					Day 1	Day 2	
1	Ashok Kumar Chand	Bedkot Municipality	Mayor				
2	Padam Raj Bhatta	Bedkot Municipality	CAO	9848742046			
3	Padam Bahadur Thakurathi	,,	officer	9858750241			
4	Kabita KU. Pant	Bedkot-06 Sisuwa		9860551057			1
5	Akash Puri	Bedkot - 1		9805761587			6
6	Maya Bhatt	Bedkot - 9		9866103201			2
7	Sangita Chaudhary	Bedkot - 7		9805400979			3
8	Manju Bhandari	Bedkot - 8		9865606673			2
9	Deepak Raj Joshi	Bedkot - 9		9866103122			2
10	Dhirendra Singh Dhami	Bedkot-03		9805755404			2
11	Shusil Aayji	Bedkot 03		9865815385			1
12	Chet Raj Badu	Bedkot 3		9810739989			2
13	Basanti Kumari Badu	Bedkot 5		9742845764			2
14	Gita Bhandari	Bedkot-Sisuwa		9842227597			
15	Manju Bhandari	Bedkot - 8		9865606673			2
15	Anil Luhar	Bedkot 3	Public facilitator	9848751777			
16	Prakash Kalauni	Bedkot-9		9818816459			
17	Deepak Raj Joshi	Bedkot-8		9868771730			

SFD Bedkot Municipality, Nepal, 2022

Produced by:

Anita Bhuju, ENPHO

Buddha Bajracharya, ENPHO

Co-authors:

Jagam Shrestha, ENPHO
Sabuna Gamal, ENPHO
Rupak Shrestha, ENPHO
Shreeya Khanal, ENPHO

This Executive Summary and the SFD Report are available from:

www.sfd.susana.org

SFD Promotion Initiative