SFD Report

Malangwa Municipality
Nepal

Final Report

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

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SFD Report Malangwa Municipality, Nepal, 2023

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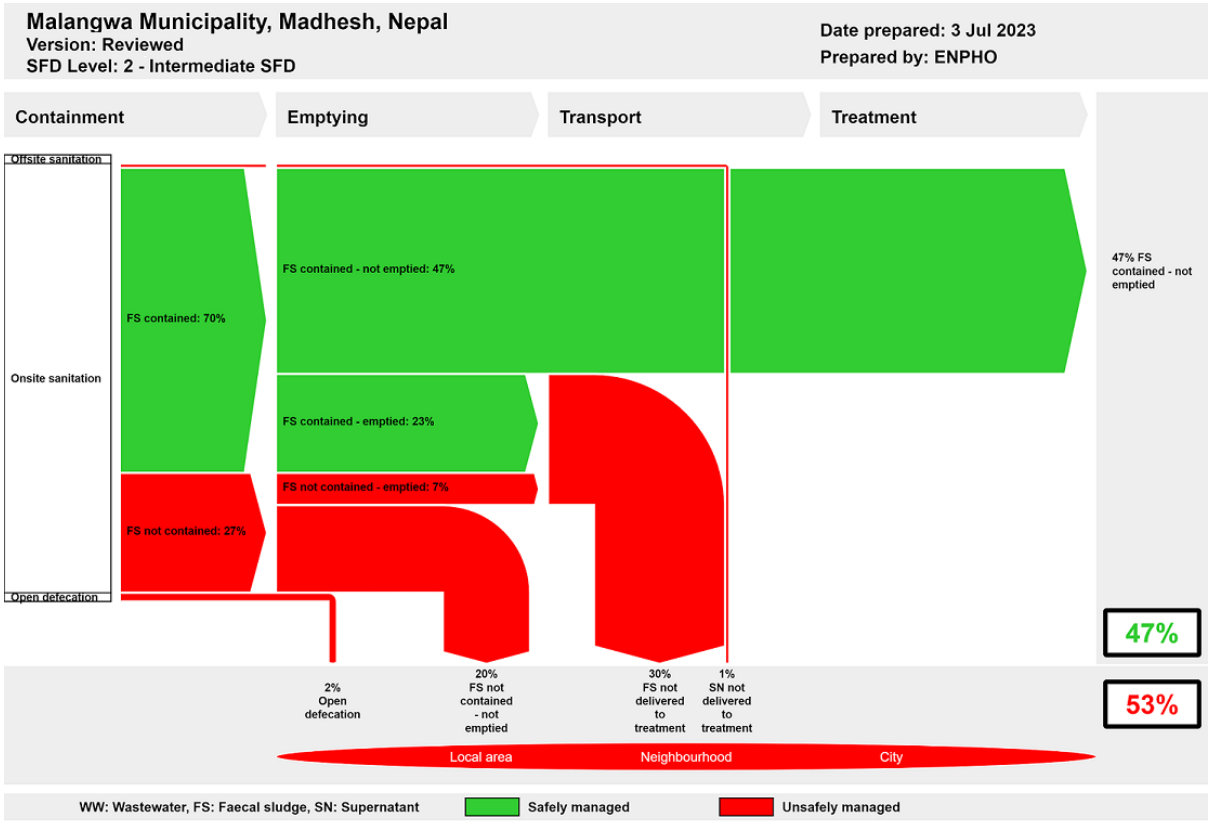
1. The SFD Graphic



The SFD Promotion Initiative recommends preparation of a report on the city context the analysis carried out and data sources used to produce this graphic.
Full details on how to create an SFD Report are available at sfd.susana.org

2. Diagram information

SFD Level:

This SFD is a level 2- Intermediate report

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Collaborating partners:

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

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3. General city information

Malangwa Municipality is in Sarlahi District, Madhesh province of Nepal. It has a total of 12 wards and covers an area of 30.44 square kilometres. The municipality was established in 2 March, 1987. It is bounded by Brahmapuri rural Municipality and Sonbarsa region of India in the east, Chakarghatta, Kaudena and Bishnu rural Municipalities in the west, Kabilasi Municipality in the north and Sitamarhi District of Bihar state, India in the southern part.

According to the national population and housing census 2021, the municipality has a total population of 54,550 with 10,033 households. The population density is 236 people per square kilometre. Ward number 3 has the highest population with 7,736 people and ward number 1 has the least population with 1,669 people (NSO, 2023).

The municipality has hot summers and cool, wet winters. The average annual temperature in Malangawa is 24.5 °C. The annual rainfall is around 1,486 mm per year (Climate Data, 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 (ENPHO, 2023). 98% of the households in the municipality have a toilet. The 2% of the households without toilet defecate in nearby farmlands. The municipality has a public toilet in a bus park area. The public toilet was constructed by the municipality and operated by an individual service provider.

All of the households with access to a toilet rely on onsite sanitation technologies. 41% of the households have installed fully lined tanks and 38% have installed lined pits with semi-permeable walls and open bottom. Similarly, 18% of the households have constructed lined tanks with impermeable walls and open bottom. Only 1% of the households have technically appropriate septic tanks.

According to the assessment of sanitation situation of the municipality by ENPHO in 2023, only 35% of the households have emptied their containments at least once after used. 97% of these containments were emptied mechanically or manually. The private desludging service providers are engaged in emptying and transportation services of faecal sludge.

Nepal Water Supply Corporation (NWSC), Malangwa branch is the major water supply service provider in the municipality. It serves approximately 1,600 households from ward number 2 to 10. The water is chlorinated to provide safe drinking water to its customers. The majority of the households in the municipality depends on groundwater using tube wells and handpump for drinking purposes.

The SFD graphic shows that 47% of the excreta generated are safely managed while 53% are unsafely managed. The safely managed excreta generated by this 47% of the population is temporary. So, once the containments get filled and FS from the containments is emptied, the percentage of unsafely managed excreta would increase.

5. Service delivery context

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

Several policies have been in place to accomplish the sanitation needs of people. Particularly, the National Sanitation and Hygiene Master Plan (NSHMP) 2011 has proved as an important strategic document for all stakeholders to develop uniform programs and implementation mechanism at all levels. It strengthens institutional set up with the formation of water and sanitation coordination committee at every tier of government to actively engage in sanitation campaigns. The document adopted sanitation facilities as improved, basic, and limited in line with WHO/UNICEF guidelines. 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.

The Malangwa Municipality has endorsed the Waste Management Act 2023, which focuses on ensuring the right to a clean environment. The act aims to collaborate with private sector entities, non-government organizations, community-based organizations, and civil society to effectively manage waste and raise public awareness. It emphasizes important elements for safe sanitation management, including enhancing containment through building septic and holding tanks. The act also prohibits connecting toilets to drains and imposes fines for violations. Additionally, it introduces a mandatory annual registration and renewal process for private desludging service providers operating within the municipality.

6. Overview of stakeholders

Based on the regulatory framework for FSM, the major stakeholders for effective and

sustaining service delivery in the municipality are as presented in Table 1.

Table 1: Overview of Stakeholders.

Key Stakeholders	Institutions / Organizations
Public Institutions at Federal Government	Ministry of Water Supply Department of Water Supply and Sewerage Management (DWSSM)
Public Institutions at Provincial Government	Ministry of Physical Infrastructure Development Water Supply and Sanitation Division Office (WSSDO)
Public Institutions at Local Government	Malangwa Municipality Office Nepal Water Supply Corporation, Malangwa Branch
Non-governmental Organizations	Environment and Public Health Organization (ENPHO)
Private Sector	Public toilet operators, Desludging service providers
Development Partners, Donors	MuAN, BMGF, UCLG ASPAC

7. Credibility of data

The major data were collected from random household sampling. Altogether, 375 households and 35 institutions were surveyed from 12 wards of the municipality on 27-28 February 2023 (ENPHO, 2023). Primary data on current sanitation practices in the municipality were triangulated from Key Informant Interviews (KIIs) with municipal officials, public toilet operators, desludging service providers and water supply committee. The overall data and findings were shared with the stakeholders of the municipality and validated through a sharing program on 2 June 2023.

8. Process of SFD development

Data on sanitation situation were collected through household and institutional survey. The local enumerators from each ward of the municipality were trained on all aspects of sanitation service chain starting from user interface, containment, emptying, transport, treatment, end use or safe disposal of excreta and the use of mobile application; *KoboCollect* was used for collection of data from households and institutions. Moreover, KIIs were conducted with officers and the engineer of the municipality, public toilet operators, desludging service providers and water supply service provider 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. List of data sources

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

- Climate Data. (n.d.). Climate data. Retrieved from https://en.climate-data.org/asia/nepal-26/
- ENPHO. (2023). Assessment of Sanitation status of Malangwa Municipality.
- Malangwa Municipality. (2023). Waste Management Act, 2023 Malangwa Municipality, Sarlahi, Goverment of Nepal. https://malangwamun.gov.np/en.
- MoWS. (2017a). Institutional and Regulatory Framework for Faecal Sludge Management in Urban Areas of Nepal. Kathmandu,Nepal: Ministry of Water Supply.
- MoWS. (2022a). Water Supply and Sanitation Act. Ministry of Water Supply; Government of Nepal.
- NSO. (2023). National Population and Housing Census 2021. National Statistics Office.

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Abbreviations

ADB	Asian Development Bank
AEPC	Alternative Energy Promotion Centre
CFU	Colony Forming Unit
DUDBC	Department of Urban Development and Building Construction
DWSSM	Department of Water Supply and Sewerage Management
ENPHO	Environment and Public Health Organization
FS	Faecal Sludge
FSM	Faecal Sludge Management
FSTP	Faecal Sludge Treatment Plant
FWSSMP	Federal Water Supply and Sewerage Management Project
GIS	Geographical Information System
GPS	Global Positioning System
HH	Household
IRF	Institutional and Regulatory Framework
KII	Key Informant Interview
KM	Kilometre
MoUD	Ministry of Urban Development
MoWS	Ministry of Water Supply
MuAN	Municipal Association of Nepal
NGO	Non-Governmental Organization
NPC	National Planning Commission
NUWSSSP	National Urban Water Supply and Sanitation Sector Policy
NWSC	Nepal Water Supply Cooperation
NWSSP	National Water Supply and Sanitation Policy
ODF	Open Defecation Free
RVT	Reservoir Tank
RWSSNP	Rural Water Supply and Sanitation National Policy
SDG	Sustainable Development Goal
SDP	Sector Development Plan
SFD PI	Shit Flow Diagram Promotion Initiative
SFD	Shit Flow Diagram
SN	Supernatant
UCLG ASPAC	United Cities and Local Governments Asia Pacific
UNICEF	United Nations Children's Education Fund
WASH	Water, Sanitation and Hygiene
WSSDO	Water Supply and Sanitation Divisional Office

1 City context

Malangwa Municipality is in Sarlahi District, Madhesh province of Nepal (Figure 1). It has a total of 12 wards and covers an area of 30.44 square kilometres. The municipality was established in 2 March, 1987. It is bounded by Brahmapuri Rural Municipality and Sonbarsa region of India in the east, Chakarghatta, Kaudena and Bishnu Rural Municipalities in the west, Kabilasi Municipality in the north and Sitamarhi District of Bihar state, India in the southern part. The main commercial gateway to Sonbarsa and Bhediyahi is located in this municipality with its connection to India.

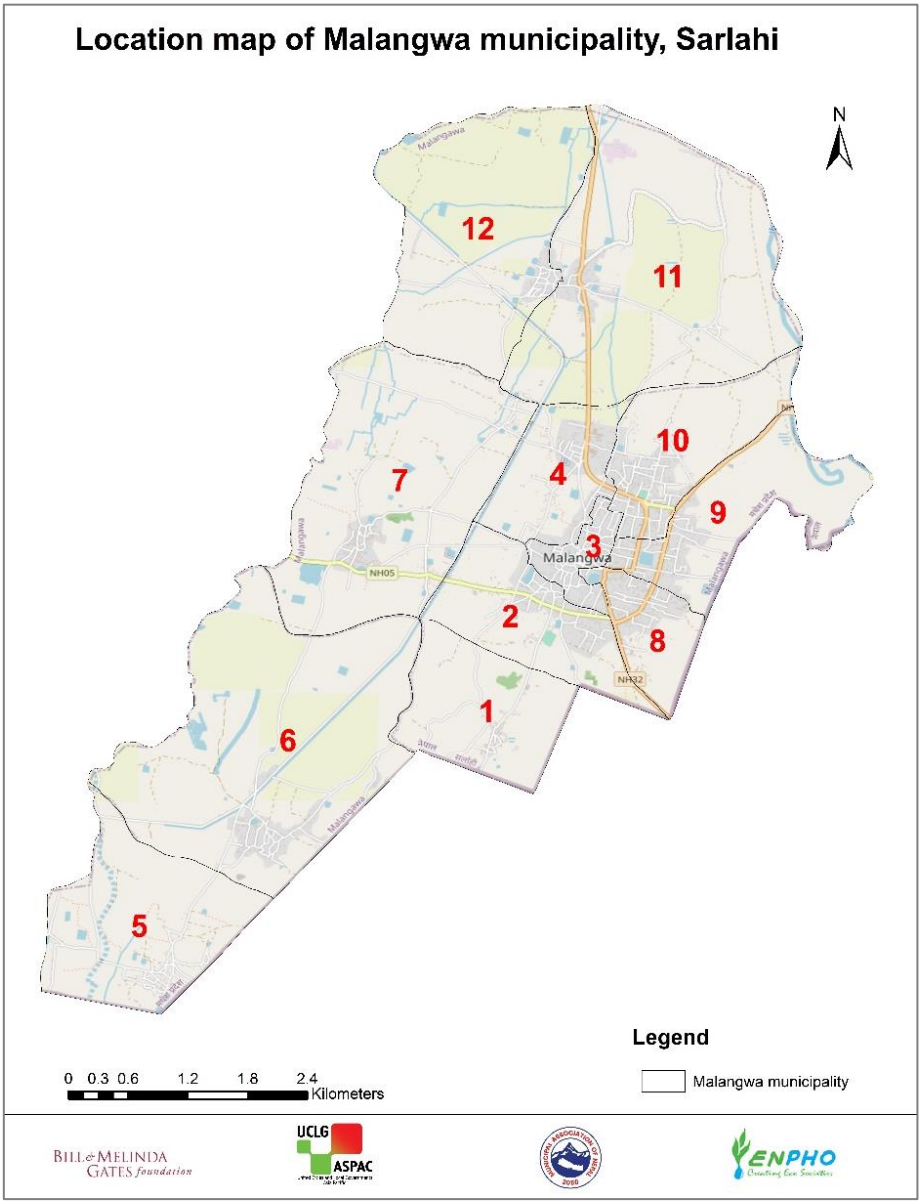

Figure 1: Map of Malangwa Municipality with ward boundaries.

1.1. Population

According to national population and housing census 2021, the municipality has a total population of 54,550 with 10,033 households. The total male and female populations are 27,849 and 26,701 respectively. The population density is 236 people per square kilometre. Ward number 3 has the highest population with 7,736 (3,882 male and 3,854 female) and ward number 1 has the least population with 1,669 (861 male and 808 female). Similarly, ward 3 has the highest number of households (1,280) while ward 1 has the least number of households (272) (NSO, 2023).

1.2. Climate

The municipality has hot, dry summers and cool, wet winters. Under the Köppen–Geiger climate classification Malangwa features monsoon-influenced humid subtropical climate (Cwa). The average annual temperature in Malangawa is 24.5 °C. The rainfall here is around 1,486 mm per year. The month with the highest relative humidity is August (84.08%). The month with the lowest relative humidity is April (39.23%) (Climate Data, n.d.).

1.3. Topography

Malangwa Municipality is located at 26.8627-degree north latitude and 85.5561 east longitude. The elevation is approximately 79 metres above mean sea level. In 2017, a comprehensive investigation of the soil fertility in the Sarlahi District, including Malangwa, was carried out using the Global Positioning System (GPS) and Geographical Information System (GIS). Soil samples were collected from a depth of 0-20 cm and subjected to analysis. The findings of the study indicated that the study area contains four distinct soil textural classes. The sandy loam soils accounted for the largest proportion (75%), followed by loamy sand (12%) and sandy clay loam (11%) (Malla R. et al., 2020).

2 Service Outcomes

2.1. Overview

Data on sanitation situation were collected through household and institutional surveys (ENPHO, 2023). A total of 370 households were sampled from 10,033 households distributed in 14 wards (further details are presented in section 4). The results obtained after the triangulation and validation of the data with all the data sources including literature reviews, Key Informant Interviews (KIIs) and a validation workshop is presented in this section.

Particularly over the past 20 years, sanitation has been promoted in Nepal, which led to the nation as Open Defecation Free (ODF) nation on September 30, 2019, with the combine effort of the 3 tiers of the government (MoWS, 2020). The municipality was declared as an open defecation free municipality in 28 January, 2019 (KII_1, 2023). However, the household survey reveals that 2% of the households in the municipality do not have access to a toilet and defecate in open spaces such as farmlands.

2.1.1 Sanitation System in Households Building

The onsite sanitation refers to a sanitation technology or sanitation system in which excreta is collected and stored and emptied from or treated on the plot where they are generated (SuSanA, 2018). All the households with access to toilet in the municipality rely on onsite sanitation systems. Table 1 shows the percentage of households with different types of containment in the municipality

Table 1: Types of containment in households building in Malangwa Municipality (ENPHO, 2023).

Containment	Wall construction Materials	Bottom of containment	Chamber	Number	Connected to	%	Recategorized as SFD	%
Septic tank	Cemented walls or cemented brick/ stone wall	PCC or plastered	Two or more than Two	NA	Open drain	1%	Septic tank	1%
Fully lined tank	Cemented walls or cemented brick/ stone wall	PCC or plastered	One	NA	No outlet/ overflow or open drain	41 %	Fully lined tank	41%
			Two		No outlet/ overflow			
Lined tank with impermeable walls and open bottom	Cemented walls or cemented brick/ stone wall	Soiling/ nothing	One/ Two/ More than Two	NA	Open ground or No outlet/ overflow	18 %	Lined tank with impermeable wall and open bottom	18%
Single pit	Concrete rings piled one	Soiling/ nothing	NA	One	NA	34 %	Lined pit with semi-permeable wall and open bottom	38%
Twin pit	Concrete rings piled one	Soiling/ nothing	NA	Two	NA	4%		
Open Defecation	NA	NA	NA	NA	NA	2%	Open Defecation	2%

A well-designed septic tank is installed in 1% of households. The septic tank is a properly designed technology with sealed walls and bottom having at least two chambers and the effluent discharged into a soak pit or sewer network.

Fully lined tanks are the most popular containment type in the municipality and constructed by 41% of the households while lined tanks with impermeable walls and open bottom are constructed by 18% of the households.

34% of the households have single pits. The single pits are onsite technologies made from pre-cast concrete rings. There is no lining between rings and allows infiltration from both walls and bottom. These pits are categorized as lined pits with semi-permeable walls and open bottom for the preparation of the SFD graphic.

Twin-pits are an upgraded version of pit latrines that allow for the safe treatment and conversion of fecal sludge into a beneficial soil amendment. They basically consist of two pits which are linked, using a Y-junction at a minimum horizontal distance of 1.2m. Only one pit is used at a time, with the other resting while the first is in use. During storage, excreta undergo decomposition through a combination of anaerobic digestion and composting processes. The end product is sanitized and can be utilized as compost to enhance soil quality, water retention capacity, and fertility. This process usually takes around two years (Elizabeth Tilley, 2014).

4% of the households have constructed twin pits. However, most twin pits installed by the households are not as per the design. The minimum distance between two sets of pits is not maintained. Also, the connection pipes to the pits are in series. Thus, these pits function only as lined tanks with semi-permeable walls and open bottom. Figure 2 shows the design of twin pits and pits installed at household level. In areas where the groundwater table is high or there is a risk of frequent flooding, the twin pit system may not be appropriate since the leachate may hinder the dewatering process, particularly in the resting pit. Therefore, it is recommended to use this system only in areas with a low groundwater table (Elizabeth Tilley, 2014).

Figure 2: Inappropriate design of the twin pits.

Figure 3 shows a map of the households with the types of containment observed in the survey. It is observed that fully lined tanks were mostly installed in the urban cluster of the municipality while lined pits with semi-permeable walls were installed in households in the rural areas in wards number 11, 12, 4, 5 and 6.

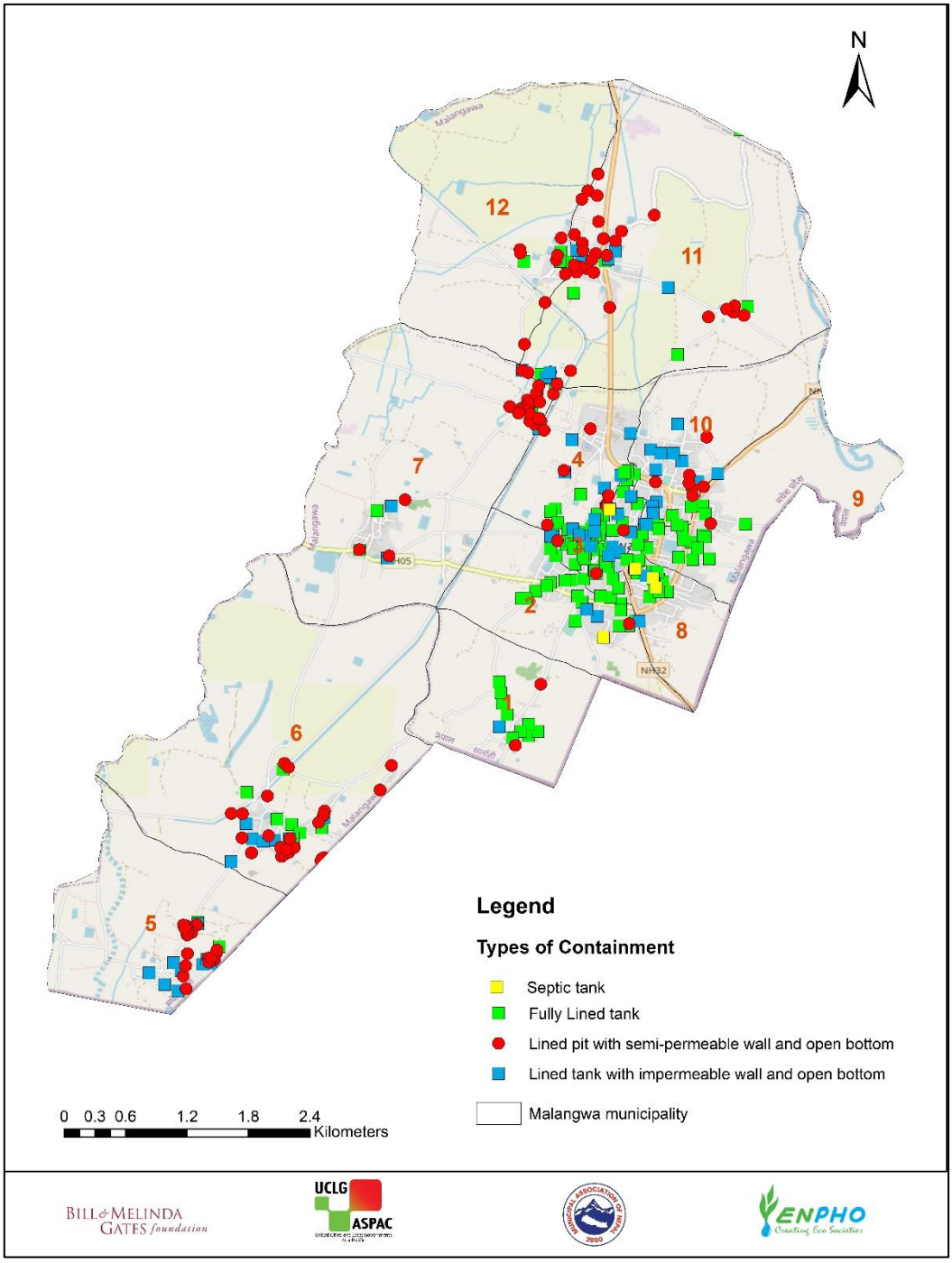

Figure 3: Map showing the households with the types of containments in Malangwa Municipality.

2.1.2. Sanitation System in Institutional building

All institutional buildings (35 institutions) surveyed have connected waste from toilets into onsite sanitation technologies. 60% of the institutions have constructed a fully lined tank in their building. Only 6% of the institutional buildings have constructed technically appropriate septic tanks. Figure 4 shows the different sanitation technologies available in the institutions of Malangwa Municipality.

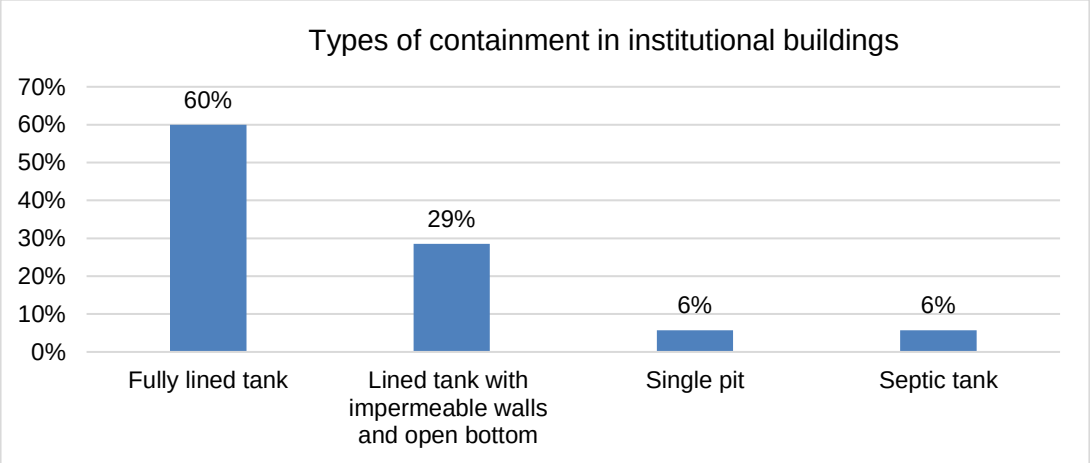

Figure 4: Types of containment in the institutional building of Malangwa Municipality.

Figure 5 shows a map locating surveyed institutional buildings and types of sanitation technologies.

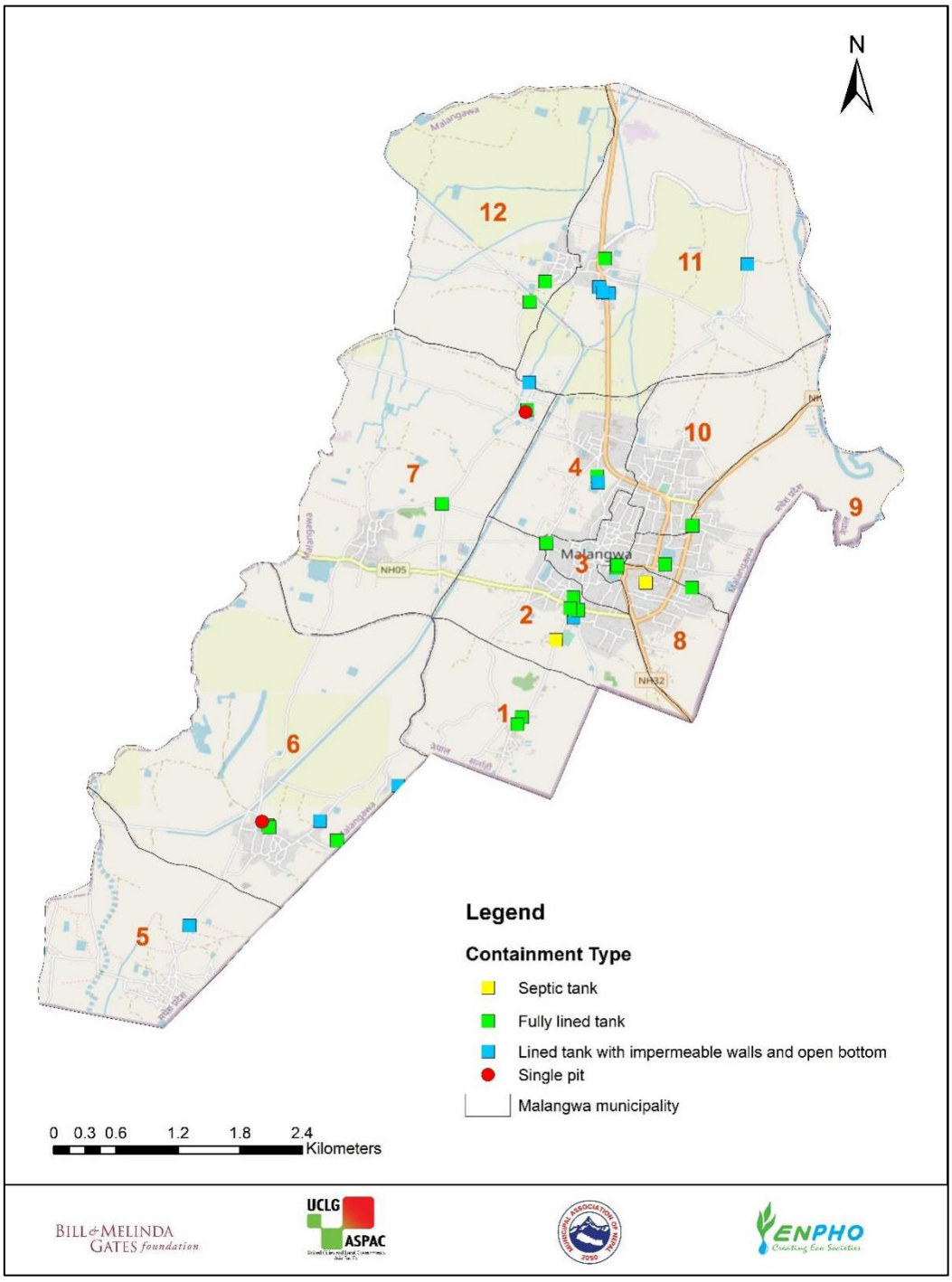

Figure 5: Map locating institutional building with types of sanitation technologies.

2.1.3. Public Toilets

A public toilet is constructed and operated in the old bus park of the municipality (Figure 6). It was constructed by the municipality in 2009. The operation and maintenance of the toilet has been done by the private sector. There are three pans and three urinals at female compartment and three pans and three urinals at male compartment. Approximately, 100-200 users visit the public toilet per day. The toilet is connected to a fully lined tank. It is emptied every year. The water required for cleaning the toilet is fulfilled from groundwater using a tube well (KII_2, 2023).

Figure 6: The componentes of public toilet at bus park of Malangwa Municipality.

2.1.4. Emptying and Transport

Emptying and transporting faecal sludge is an essential service for proper functioning of onsite sanitation technologies (Linda Strande, 2014). Only 35 % of the households have emptied their containments at least once since it was used. Among these households, 97% have emptied them mechanically while the rest rely on traditional sanitation workers.

Poor emptying practices can lead to direct exposure of person involved in emptying activities to pathogens (WHO, 2018). Private desludging service providers and traditional labour are engaged in desludging. Three private desludging service providers (Kismat desludging service

provider, New Malangwa desludging service provider and Malangwa desludging service provider) have their main service area in the municipality (KII_1, 2023) (KII_3, 2023). The service providers are informal as these services have not been registered in any government agencies.

The desludging vehicle of Kismat desludging service provider has a capacity of 7,500 litres and approximately carries out 60 trips per month (Figure 7). Users submit an application to the municipality office to get this service. It charges on average NPR 2,500 (USD 18) per trip for rectangular tank and NPR 250 (USD 2) per ring for circular pits. Usually, 2 staff members are involved for the desludging service (KII_3, 2023).

Figure 7: Faecal sludge desludging service providers.

2.1.5. Treatment and Disposal

The municipality does not have a faecal sludge treatment plant. The mechanically emptied faecal sludge is disposed of into farmlands and the irrigation canal (KII_3, 2023). Manually emptied faecal sludge is either mixed with organic solid waste at household level without following any procedure to produce compost manure or directly applied into farmlands. The direct use of faecal sludge has the highest level of risk for human health, therefore not recommended to practice it (Strande et. al., 2014). Thus, both the handling of the mechanically or manually emptied faecal sludge in the municipality is unhygienic and possess risk to human health.

2.1.6. Risk Assessment of Groundwater Pollution

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

a. Sources of drinking water

The household survey conducted by ENPHO shows that 85% of households in the municipality rely on hand pumps and tubewells while 15% of households have been connected to a piped water supply (ENPHO, 2023).

Nepal Water Supply Corporation (NWSC), Malangwa branch is the major water supply service provider in the municipality. It is a public utility under the Ministry of Water Supply (MoWS). It has provided services to 1,600 households in ward 2 to 10. There is an overhead Reservoir Tank (RVT) in Malangwa office premises with a capacity of 450 m^3 and with 4 deep boring under NWSC. The water is chlorinated prior to distribution (KII_4, 2023). The construction of RVT in Gamhariya with 2 deep boring has been completed and will be operated in near future (KII_5, 2023). Figure 8 shows the RVT operated by NWSC, Malangwa branch.

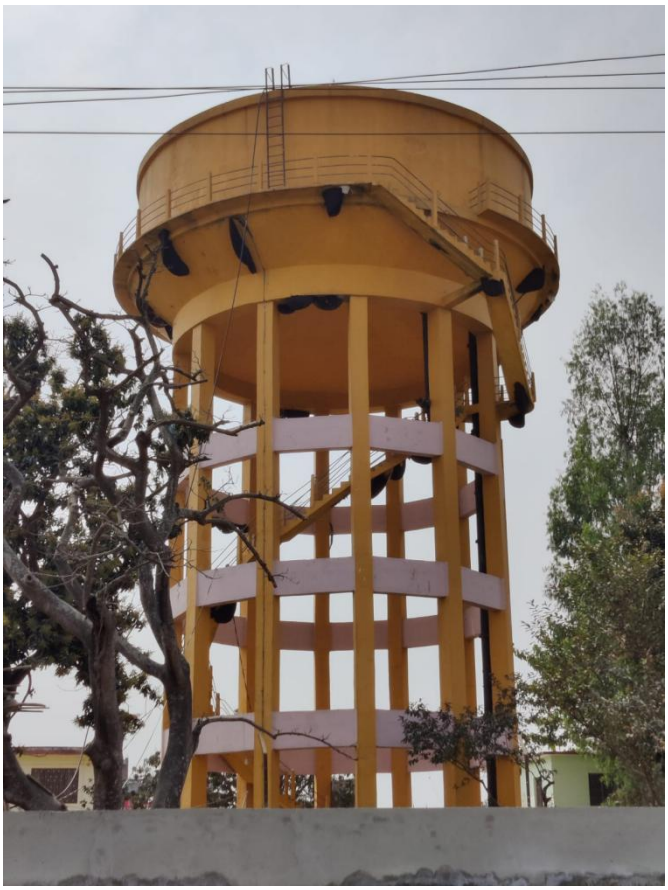

Figure 8: RVT operated by NWSC, Malangwa branch.

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

The term aquifer pollution vulnerability is intended to represent the varying level of natural protection afforded by the contaminant attenuation capacity of the unsaturated zone or semi-confining beds above an aquifer, because of physicochemical processes (filtration, biodegradation, hydrolysis, adsorption, neutralization, volatilization, and dispersion) all of which vary with their texture, structure, clay content, organic matter, pH, redox and carbonate equilibria. Groundwater vulnerability is specific to containment type and pollution scenarios (Andreao, 2013). Here, among the various types of onsite sanitation technologies, lined tanks with impermeable walls and open bottom and lined pits are more prone to aquifer pollution as the nature of such containments impose more containment load from the land surface to groundwater.

Key determinants of risk variation of the groundwater are the soil and geological setting. The size of pores in the soil determines the infiltration rate. According to the soil analysis of Sarlahi District, sandy loam soils accounted for the largest proportion (75%) in Malangwa (Malla R. et al., 2020). In the sandy loam soil, the permeability is approximately 2.5 cm per hour (FAO, n.d.). Thus, between 25 and 50 days the pollutant could travel to the depth of approximately 30 metres (98.67 feet) in sandy loam soil.

The Federal Water Supply and Sewerage Management Project (FWSSMP) has tested Water Quality of groundwater from 39 locations in Malangwa Municipality on 7 June, 2023. The results obtained from the report have been tabulated in Appendix 2. The results revealed that the groundwater from tube wells with more than 100 feet (30.4 m) depth was contaminated with faecal coliforms as shown in Figure 9. Thus, the people using open bottom tanks and consuming water from the hand pumps and tube wells with the depth up to 120 feet (36.6 m) and horizontal distance of the pump within 25 feet (7.62 m) from the source of pollutants are assumed at significant risk to groundwater pollution.

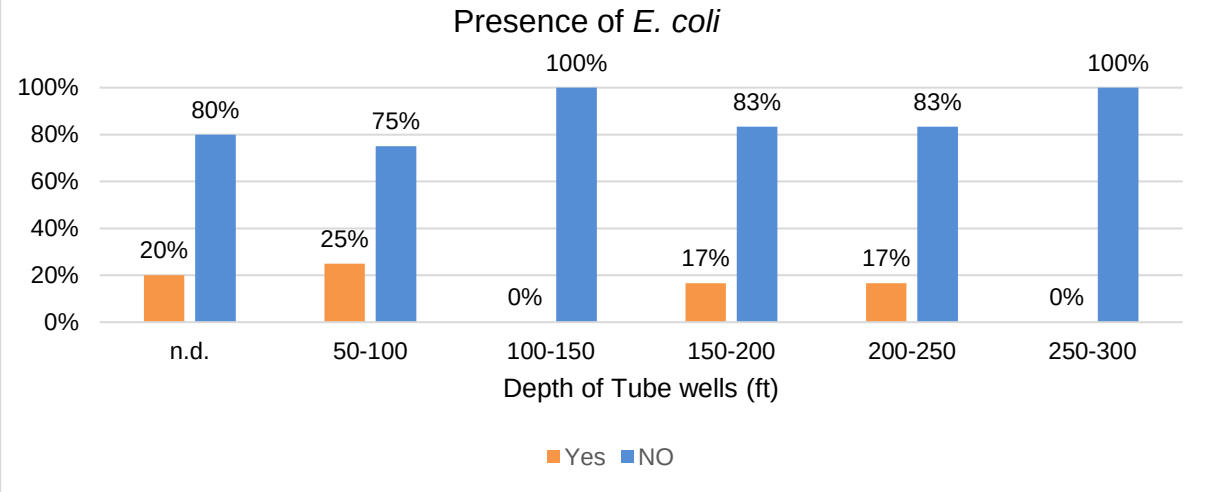

Figure 9: Summary of presence of *E.coli* along with the depth of tube wells in Malangwa Municipality (FWSSMP, 2023).

Figure 10 demonstrates the depth of hand pumps and tube wells and horizontal distance of it with the containment type lined tank with impermeable walls and open bottom. Altogether 18% of the households have installed lined tanks with impermeable walls and open bottom. Among them, 77.8% of the households rely on groundwater for drinking water. Upon assessing the depth of groundwater and horizontal distance of the handpumps/tube wells from the source of pollution, it was found that 38% of these households are at higher risk to consumption of contaminated water. Thus, the population with lined tanks with impermeable walls and open bottom without outlet or overflow with significant risk to groundwater pollution (T2A4C10) is 5% (18% x 77.8% x 38% = 5%).

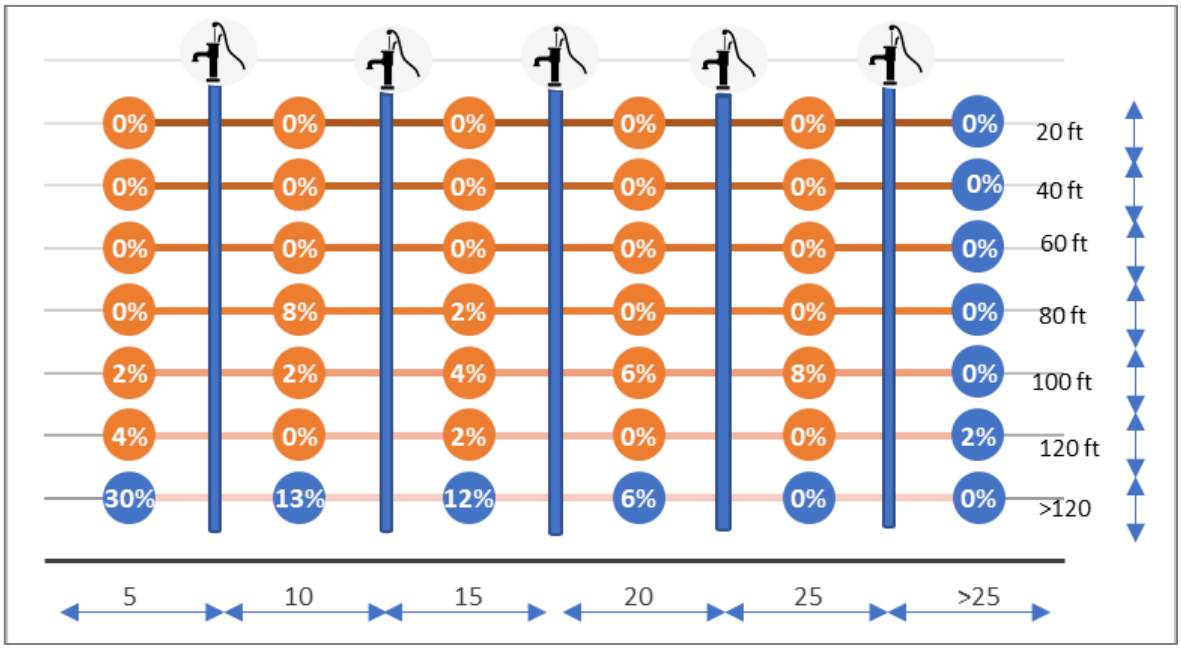

Figure 10: Depth of hand pumps and tubewells and lateral spacing of it with containment lined tank with impermeable walls and open bottom.

Figure 11 demonstrates the depth of hand pumps and tubewells and horizontal distance of it with the containment type lined pit with semi-permeable walls and open bottom. Altogether 38% of the households used lined pits with semi-permeable walls and open bottom. Among these, 97.5% of them use groundwater for drinking water. Upon assessing the depth and horizontal distance between source of water and location of containment, it was observed that 54% of these have higher potential on consuming contaminated groundwater. Thus, the population with lined pits with semipermeable wall and open bottom with significant risk to groundwater pollution (T2A5C10) is calculated as: 38% x 97.5% x 54% = 20%.

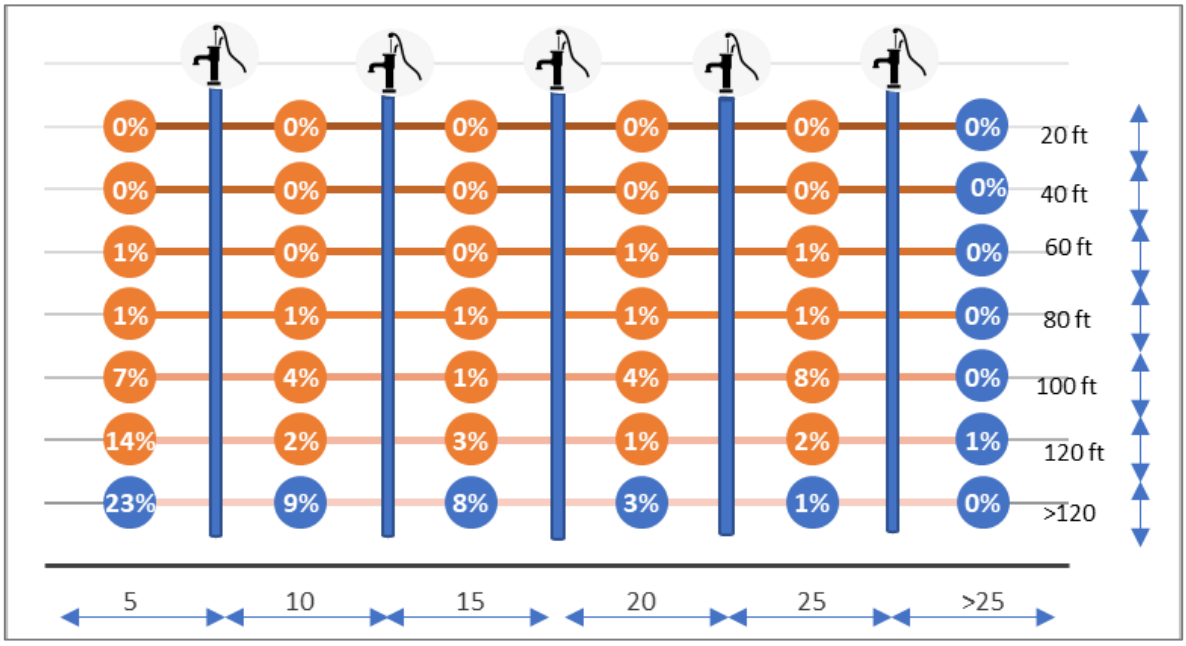

Figure 11: Depth of hand pumps and tubewells wells and lateral spacing of it with containment types lined pit with semi-permeable walls and open bottom.

2.2. SFD Matrix

2.2.1. SFD Selection Grid

The SFD selection grid consists of the types of containment technologies in vertical column in List A, while top horizontal row (List B) consists of a list where each of containment technologies are connected to. The existing containment technology was classified to fit in the SFD grid.

Prior to selection of containment technologies, single pits constructed by assembling pre-cast concrete rings one above another is categorized as lined pits with semi-permeable walls and open bottom.

The various types of sanitation technologies selected for the SFD graphic generator are shown in the SFD selection grid, as shown in Figure 12 and explained in Table 2.

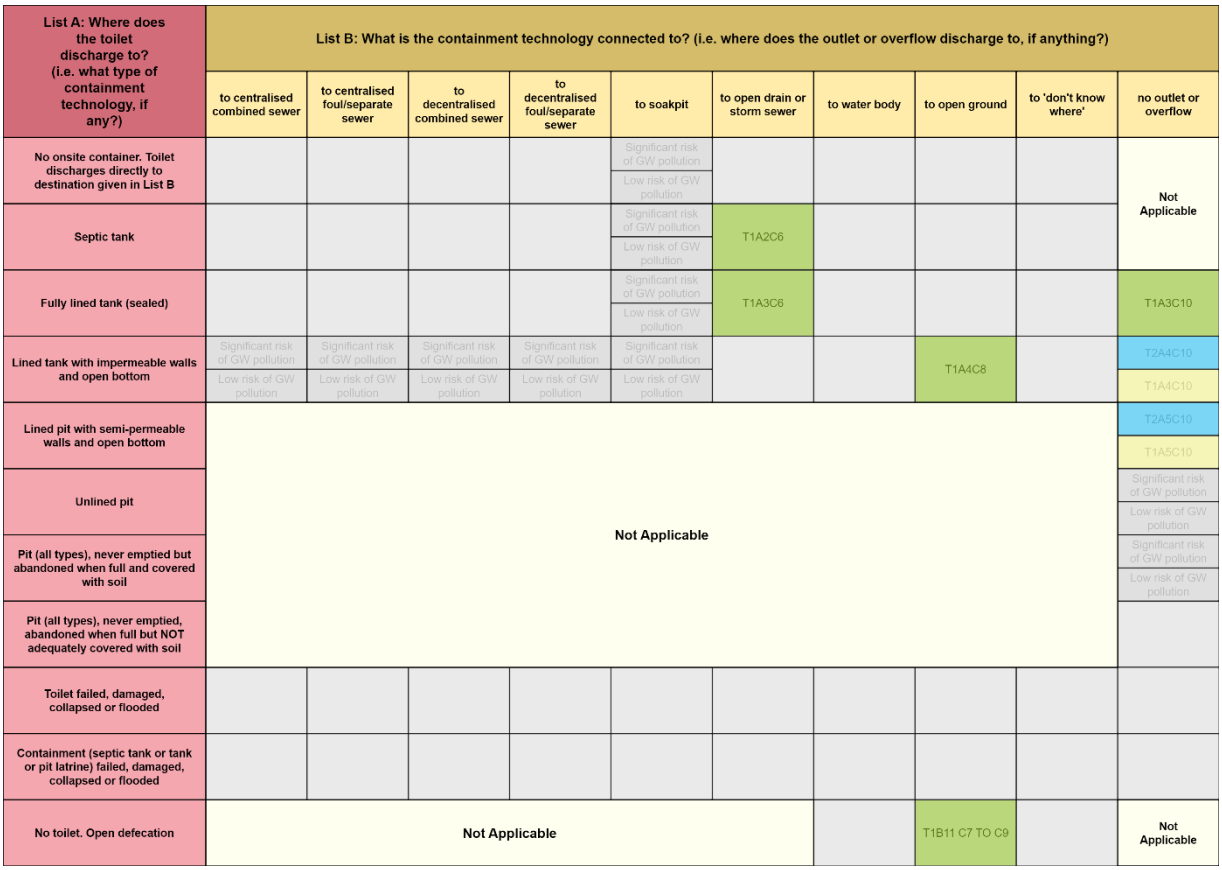

Figure 12: SFD selection grid of Malangwa Municipality.

Table 2: Explanation of different variables and containment technologies selected in SFD selection grid (SuSanA, 2018).

SN	Variables	Explanation
1	T1A2C6	This is a correctly designed, properly constructed, fully functioning septic tank with an outlet connected to an open drain or storm sewer. The supernatant/effluent flowing from the tank is only partially treated and is still hazardous, therefore all the excreta in this system is considered not contained.
2	T1A3C6	A correctly designed, properly constructed, and well maintained fully lined tank with impermeable walls and open bottom. Since the tank is fitted with a supernatant/effluent overflow connected to an open drain or storm sewer the excreta in this system are considered not contained.
3	T1A3C10	A correctly designed, properly constructed and well maintained fully lined tank with impermeable walls and base. Since the tank is not fitted with a supernatant/effluent overflow this system is considered contained.
4	T1A4C8	A correctly designed, properly constructed and well-maintained lined tank with sealed, impermeable walls and an open, permeable base, through which infiltration can occur. Since the tank is fitted with a supernatant/effluent overflow connected to open ground, the excreta in this system is considered not contained.

5	T1A4C10	This is a correctly designed, properly constructed and well maintained lined tank with sealed, impermeable walls and an open, through which infiltration can occur. Since there is not a 'significant risk' of groundwater pollution, the excreta of this system are considered contained.
6	T1A5C10	This is a correctly designed, properly constructed and well maintained pit with semi-permeable, honeycombed lined walls and an open, permeable base, through which infiltration can occur. The tank is not fitted with a supernatant/effluent overflow so this system is considered contained.
7	T1B11 C7 TO C9	With no toilet, users defecate in water bodies, on open ground and to don't know where; consequently, the excreta is not contained.
8	T2A4C10	A correctly designed, properly constructed and well-maintained lined tank with sealed, impermeable walls and an open, permeable base, through which infiltration can occur - the excreta is therefore likely to be partially treated. The tank is not fitted with a supernatant/effluent overflow but since there is a 'significant risk' of groundwater pollution this system is considered not contained.
9	T2A5C10	A correctly designed, properly constructed and well-maintained pit with semi-permeable, honeycombed lined walls and an open, permeable base, through which infiltration can occur. The tank is not fitted with a supernatant/effluent overflow but since there is a 'significant risk' of groundwater pollution this system is considered not contained.

2.2.2. Proportion of the FS contents of each type of onsite container which is faecal sludge

A detailed instruction from the SFD PI was used as guide to calculate the proportion of the contents of each type of onsite container which is faecal sludge. It stated that the default "100%" value should be used where onsite containers are connected to soak pits, to 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. Where onsite containers are connected to a sewer network or to open drains, a value of "50%" is used which means that half the contents are modelled as faecal sludge; 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 used for faecal sludge proportion calculation is shown below:

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

The proportion of Faecal Sludge (FS) in septic tanks was set to 50% as they are connected to open drains. The proportion of FS in fully lined tanks was set to 99% and the proportion of FS in lined tanks with impermeable walls and open bottom and all types of pits was set to 100% according to the relative proportions of the systems in the municipality, as per the guidance provided by SuSanA.

2.2.2. SFD matrix

SFD matrix is a table which contains the means to calculate the variables for each of the sanitation systems chosen in the SFD selection grid. It comprises of list of possible containment technologies in the first column and list of all possible places to which the containment technology could be connected in the top rows.

The sanitation technologies and the corresponding percentage of the population using such technologies are shown in Figure 13. These values are derived from the HH survey (ENPHO, 2023) and KIIs with desludging service providers (KII_3, 2023).

Malangwa Municipality, Madhesh, Nepal, 3 Jul 2023. SFD Level: 2 - Intermediate SFD Population: 54550 Proportion of tanks: septic tanks: 50%, fully lined tanks: 99%, lined, open bottom tanks: 100%						
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
T1A2C6 Septic tank connected to open drain or storm sewer	1.0	0.0	0.0	0.0	0.0	0.0
T1A3C10 Fully lined tank (sealed), no outlet or overflow	40.0	40.0	0.0	0.0		
T1A3C6 Fully lined tank (sealed) connected to an open drain or storm sewer	1.0	30.0	0.0	0.0	0.0	0.0
T1A4C10 Lined tank with impermeable walls and open bottom, no outlet or overflow	12.0	20.0	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	18.0	24.0	0.0	0.0		
T1B11 C7 TO C9 Open defecation	2.0					
T2A4C10 Lined tank with impermeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	5.0	26.0	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	20.0	29.0	0.0	0.0		

Figure 13: SFD matrix of Malangwa Municipality.

2.2.4. Calculation of proportion of FS emptied from containment (Variable F3)

The proportion of faecal sludge emptied (F3) is calculated based on percentage containment emptied (ENPHO, 2023) and amount of FS emptied during the process (KII_3, 2023). In average, 90% of total faecal sludge from the containment is emptied during emptying mechanism as per household survey conducted. Thus, actual emptied proportion of faecal

sludge was taken as 90% of the emptied containment. Hence, the proportion of FS emptied from the sanitation technology is calculated as 90 % on the sanitation technology emptied.

Table 3: Actual emptying proportion for existing containment technologies (ENPHO, 2023[(1)]; KII_3 and KII_4, 2023[(2)]).

SN	Reference Variables	Containment technologies	Percentage of emptied containment (1)	Emptied proportion of FS (2)	Actual proportion of emptied FS (F3) (%)
1	T1A2C6	Septic tank connected to open drain or storm sewer	0.0%	90%	0%
2	T1A3C6	Fully lined tank (sealed) connected to an open drain or storm sewer	33.3%	90%	30%
3	T1A3C10	Fully lined tank (sealed), no outlet or overflow	44.7%	90%	40%
4	T1A4C8	Lined tank with impermeable walls and open bottom, connected to open ground	0.0%	90%	0%
5	T1A4C10	Lined tank with impermeable walls and open bottom, no outlet or overflow	22.7%	90%	20%
6	T1A5C10	Lined pit with semi-permeable walls and open bottom, no outlet or overflow	26.2%	90%	24%
7	T1B11 C7 TO C9	Open defecation	0.0%	90%	0%
8	T2A4C10	Lined tank with impermeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	29.0%	90%	26%
9	T2A5C10	Lined pit with semi-permeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	31.6%	90%	29%

2.2.5. Calculation of FS emptied delivered to treatment plant and treated (Variables F4 and F5)

FS is emptied both manually and mechanically. Since there is no Faecal Sludge Treatment Plant (FSTP) within the municipality for FS treatment (KII_1, 2023) the emptied FS is directly disposed of in farmlands with no treatment. Thus, all percentages of FS transported to treatment plant (F4) and FS treated (F5) have been set to 0% for all sanitation systems.

2.3. Summary of Assumptions

Onsite Sanitation Systems

- ✓ The proportion of FS in septic tanks was set to 50%, the proportion of FS in fully lined tanks was set to 99% and the proportion of FS in lined tanks with impermeable walls and open bottom and all types of pits was set to 100% according to the relative proportions of the systems in the municipality, as per the guidance given in the Frequently Asked Question (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 KIIs conducted.
- ✓ The municipality does not have any form of treatment plant to treat faecal sludge. The FS emptied from the containments is dumped openly in farmlands. Thus, variables F4 and F5 for all sanitation systems are set to 0%. Values for supernatant (S4e and S5e) are also set to 0% in septic tanks and lined tanks connected to drains (T1A2C6 and T1A3C6).

2.4. SFD Graphic

Figure 14 represents the fate and flow of faecal sludge and supernatant through each sanitation service chain. It shows that FS generated from 47% of the population is safely managed represented by “Green” colour arrowhead. However, this 47% resembles the FS stored in the containments without significant risk to groundwater pollution. Thus, the safely managed percentage of FS generated by this 47% of the population is temporary until the FS from the containment is emptied. Therefore, these systems will require emptying services in the short and medium term as they fill up.

The FS and supernatant from 53% of the population is unsafely managed, represented by “Red” arrow heads. The percentage of unsafely managed FS is generated from FS emptied but not delivered to treatment plant (30%), FS from containments where FS is not contained - not emptied (20%), people practising open defecation (2%) and supernatant not delivered to treatment (1%).

All of the population with access to toilets relies on onsite sanitation systems. As shown on the SFD graphic (Figure 14), it is estimated that 70% of the population uses systems where the FS is considered contained, while 27% of the population uses systems where the FS is considered not contained.

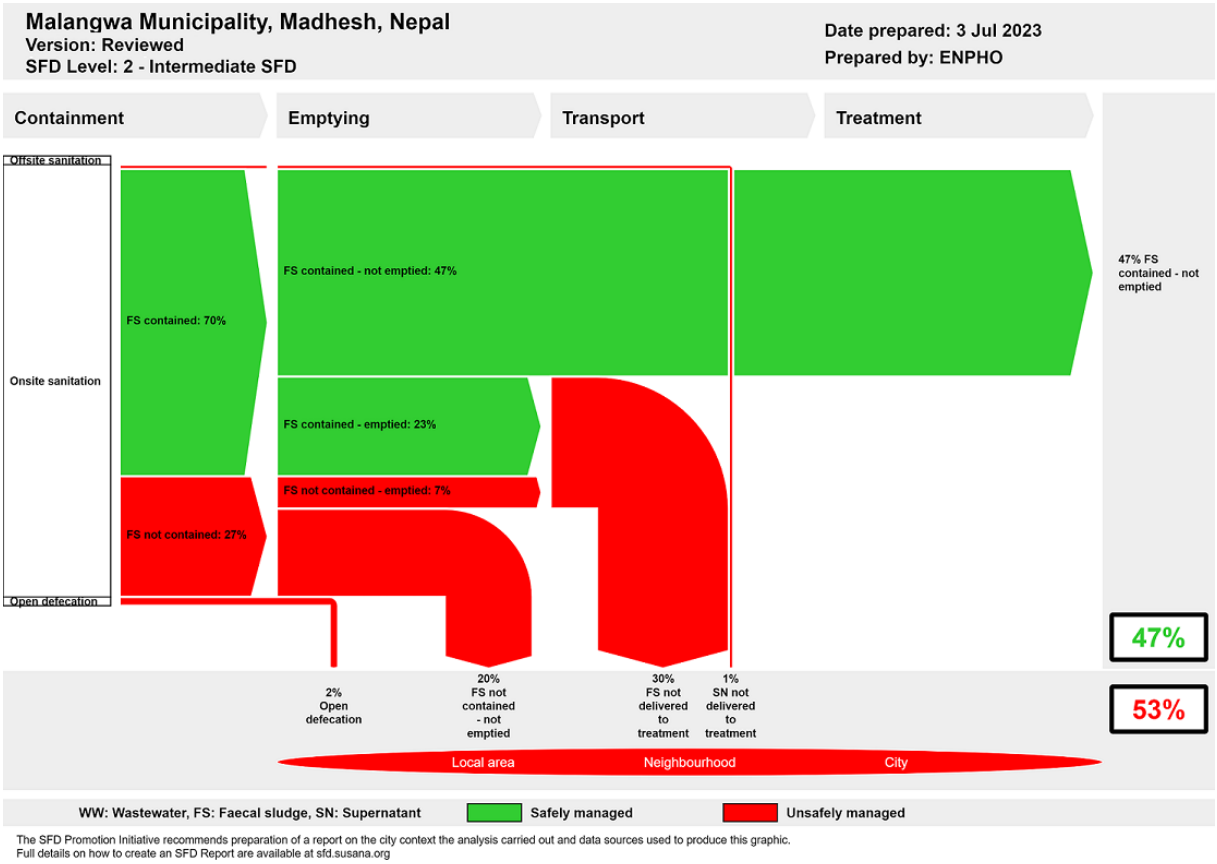

Figure 14: SFD graphic of Malangwa Municipality.

FS contained

The definition of 'FS contained' is faecal sludge contained within an onsite sanitation technology which ensures safe level of protection from excreta i.e. pathogen transmission to the user or general public is limited. These are tanks or pits that are correctly designed, properly constructed, fully functioning, and/or are causing no risk or only a 'low' risk of polluting groundwater used for drinking (SuSanA, 2018). The value is the summation of the percentage of population using fully lined tanks (sealed), no outlet or overflow (T1A3C10), lined tanks with impermeable walls and open bottom, no outlet or overflow (T1A4C10) and lined pits with semi-permeable walls and open bottom, no outlet or overflow (T1A5C10). Thus, the FS generated by 70% of the population is considered contained.

FS not contained

The definition of 'FS not contained' is faecal sludge contained within an onsite sanitation technology which does not ensure safe level of protection from excreta i.e. pathogen transmission to the user or general public is likely. These are tanks or pits that are incorrectly designed, or poorly constructed, or poorly functioning, and/or are causing a 'significant' risk of polluting groundwater used for drinking (SuSanA, 2018).

The value is obtained from the summation of the percentage of population using septic tanks connected to open drain or storm sewer (T1A2C6), fully lined tanks (sealed) connected to an open drain or storm sewer (T1A3A6), lined tanks with impermeable walls and open bottom, connected to open ground (T1A4C8), lined tanks with impermeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution (T2A4C10) and lined pits with semi-permeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution (T2A5C10). Thus, the FS generated by 27% of the population is considered not contained.

FS contained - emptied

The proportion of FS contained - emptied is the summation of the proportion of FS emptied from fully lined tanks (sealed), no outlet or overflow (T1A3C10), lined tanks with impermeable walls and open bottom, no outlet or overflow (T1A4C10) and lined pits with semi-permeable walls and open bottom, no outlet or overflow (T1A5C10). Thus, the proportion of FS contained and emptied is 23%.

FS not contained - emptied

The proportion of FS not contained - emptied (7%) is FS that is not contained in onsite sanitation technologies and emptied either mechanically or manually.

FS not delivered to treatment

The municipality does not have a treatment facility to treat faecal sludge. So, all the FS emptied from contained and not contained containments is disposed of into farmlands and open drain. The proportion of FS not delivered to treatment (30%) is the summation of FS contained - emptied and FS not contained - emptied.

Supernatant (SN) not delivered to treatment

The proportion of supernatant is obtained from containments connected to open drain or storm water sewer. The total proportion of supernatant (SN) not delivered to treatment is 1%. Since the municipality lacks a proper sewer network and treatment plant, the supernatant is disposed of directly into water bodies untreated.

Open Defecation

Malangwa Municipality was declared as an open defecation free municipality on January 28, 2019. However, 2% of the households are practising open defecation (KII_1, 2023).

3. Service Delivery Context

3.1. Policy, Legislation and Regulation

3.1.1. Policy

The Constitution of Nepal 2015 in Article 35 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 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 (GoN) has passed Drinking Water and Sanitation Act in 2022 through Ministry of Water Supply. The act elaborates right to clean water as to receive affordable, sufficient, and quality drinking water regularly as well as access to sanitation as affordable access to quality sanitation services (MoWS, 2022a).

Historically, the National Sanitation Policy (1994) was the guideline for the planning and implementation of sanitation programs. The policy had promoted sanitation issues together with issues on water supply in rural communities. Also, Rural Water Supply and Sanitation National Policy (RWSSNP) 2004, has set a new target to provide safe, reliable, and affordable water supply with basic sanitation facilities. The policy focused on delivering quality services on water and sanitation 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 addressing emerging issues and challenges in the rural and urban areas. Thus, National Water Supply and Sanitation Policy (NWSSP) was formulated in 2014 by the 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 Water

Sanitation and Hygiene (WASH) plan with the local leadership to ensure the WASH services for all (MoWS, 2022b).

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, 2011 was developed for coordinated planning and implementation of National Sanitation Campaign. The campaign strengthened institutional set-up 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).

Together with a national commitment to pursuing and achieving the Sustainable Development Goals (SDGs) by 2030, National Planning Commission formulated targets and indicators for coordinated efforts to achieve the goals. This commitment has been reaffirmed in key policy documents, such as the current 15th Development Plan. Furthermore, Nepal has undertaken various initiatives to localize the SDG indicators by developing the SDG Status and Roadmap, which includes baselines and targets for 2030 (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 (FSM) 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 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, 2017a). 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.

In 2014, Malangwa Municipality, in collaboration with the WASH coordination committee and civil society, made a commitment to the Sararaphai Ghoshana Patra (Sanitation Declaration). The primary objective of this commitment was to attain open defecation free status within the municipality. Through the collective efforts of multiple stakeholders, an effective sanitation campaign was implemented, resulting in the successful achievement of the set targets (Malangwa Municipality, 2014). However, there has been a lack of sustained campaigns aimed at further improving the sanitation status of the municipality.

The municipality has endorsed Waste Management Act, 2023 to ensure the right to live in clean environment. The act intended to establish the partnership with private sector, non-government organizations, community-based organizations and civil society for effective management of waste along with raising the awareness among people. The act has included some important aspects for the safely managed sanitation (Malangwa Municipality, 2023):

- Enhancement of containment strategies, specifically the installation of septic tanks and holding tanks.
- Strict measures are in place to prevent toilet-to-drain connections, with associated fines for violations.
- Private desludging service providers are required to undergo an annual registration and renewal process within the municipality to ensure their services align with waste management regulations.

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

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

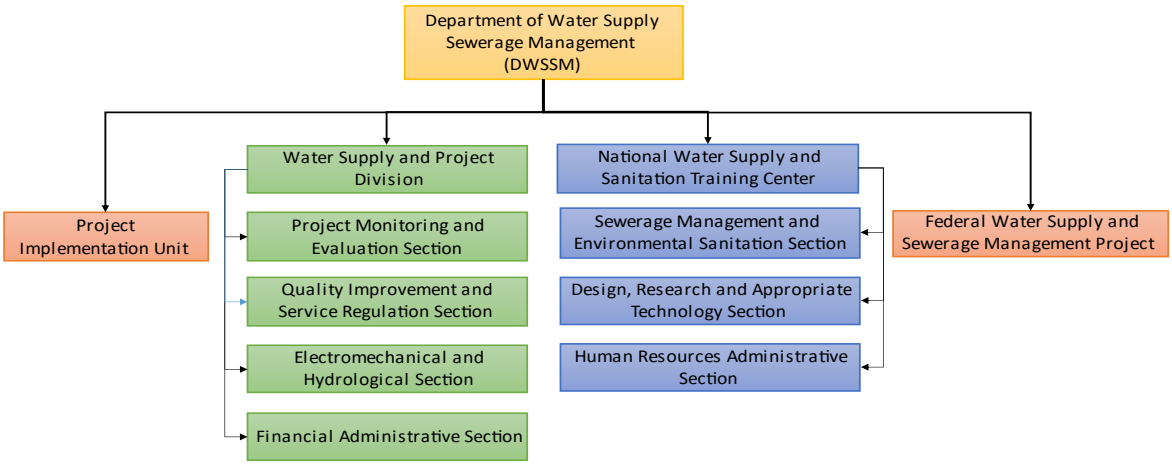

Figure 15: Organizational Structure Department of Water Supply and Sewerage Management.

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

At Provincial Level

Ministry of Physical Infrastructure Development: Ministry of Physical Infrastructure Development of provincial government in Madhesh province 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:

- Inter local government projects
- Beneficiaries between 5,000 to 15,000 in terai region, 3,000 to 5,000 in hilly region and 500 to 1,000 in Himalayan region.

At Local Government

Municipal council: The sanitation related activities within municipality has been conducted by Environment and Sanitation Sub-Section (KII_1, 2023). Figure 16 shows the organizational structure of the municipality.

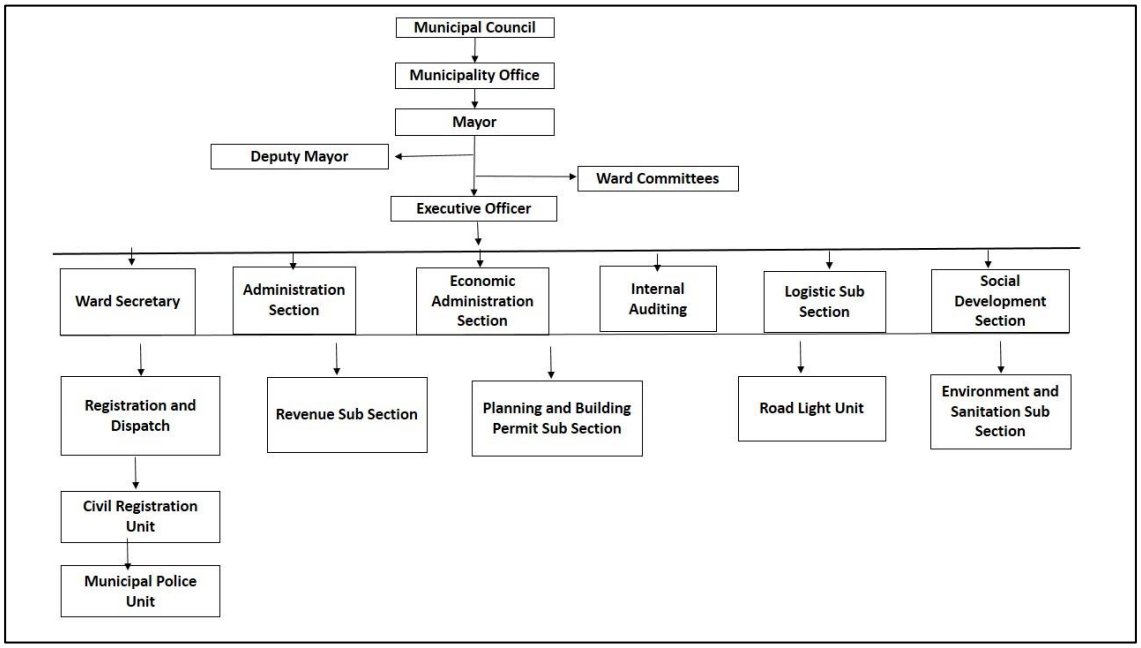

Figure 16: Organizational Structure of Malangwa Municipality.

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

Table 4: Sanitation Service Level and its Components.

S.N.	Service Components	Service Level		
		High	Medium	Basic
1	Health and Hygiene Education	✓	✓	✓
2	Household Latrine	✓	✓	✓
3	Public and School Toilets	✓	✓	✓
4	Septic tank sludge collection, transport, treatment, and disposal	✓	✓	✓
5	Surface drains for collection, transmission, and disposal of 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	✓	✓	✓

4. Stakeholder Engagement

4.1. Key Informant Interviews (KIIs)

Key Informant Interviews are qualitative in-depth interviews with people who know what is going on in the community. The purpose of key informant interviews is to collect information from a wide range of people who have first-hand knowledge about the concerned topic. KIIs were conducted with environment and sanitation related stakeholders. The KIIs were conducted with municipal officials, local elected bodies, water supply service provider, desludging service providers and public toilet service provider (Figure 17). Face-to-face interviews were conducted to get the required information. The information was collected with key stakeholders about the status of sanitation services and water supply schemes. List of key informant stakeholders from the municipalities along with their organization and purpose are as shown in Table 5.

Table 5: List of key stakeholders for KIIs.

KII code	Name	Designation	Organization	Purpose	Date
KII_1	Raj Kumar Adhikari	Information Officer	Malangwa Municipality	Sanitation Status of Malangwa Municipality	27 February, 2023
KII_2		Public toilet operator	Private Sector	Status of public toilet	27 February, 2023
KII_3	Jitendra Kumar Mahato	Desludging service providers	Private Sector	Faecal sludge desluding service	27 February, 2023
KII_5	Ganesh Shah	Administration Chief	Nepal Water Supply Corporation, Malangwa Branch	Water supply, coverage, treatment, water quality	27 February, 2023
KII_6	Ranjit Khadka	Account Chief	Nepal Water Supply Corporation, Malangwa Branch	Water supply, coverage, treatment, water quality	13 July, 2023


Figure 17: Key informant interviews with municipal official and desludging service providers.

4.2. Sharing and Validation of Data

On 2 June, 2023, an SFD validation workshop was organized at municipality hall of Malangwa Municipality, Sarlahi. The results of assessment on sanitation status in municipality were presented to Deputy Mayor, elected officials and relevant stakeholders. In the workshop, the results including sanitation status of the municipality, containment types in the municipality, emptying, transport, treatment and re-use or disposal practice of faecal sludge in the municipality were presented and discussed. Altogether, 28 participants including the Mayor, ward chairpersons, other members from municipal executive council, sectoral staffs etc. actively participated on the workshop and provided the valuable suggestions.

Mr. Nagendra Prasad Yadav, Mayor of Malangwa Municipality agreed on the sanitation status of the municipality and shared that the municipality will prioritize the sanitation in fiscal year planning (Figure 18). Mr. Gehnath Gautam, CAO of municipality agreed on the lack of the policies and regulations within municipality for proper management of faecal sludge. The list of participants with their designation is attached in Appendix 5.

Figure 18: SFD Sharing and Validation Workshop in Malangwa Municipality.

4.3. Household Survey

In each ward of the municipality, a random household survey was conducted. The two-day orientation was provided to local enumerators chosen by municipality representing each ward. They were oriented on each component of the sanitation service chain, starting from user interface to reuse/ safe disposal along with the use of mobile application for data collection. They were mobilized in the community level to gather data from households and institutional level. The list of the enumerator has been attached in appendix 3. The data were collected using the *KoboCollect* application.

Determining Sample Size

The sample size for the household survey in Malangwa Municipality was determined by using Cochran (2963:75) sample size formula $n_0 = \frac{z^2 pq}{e^2}$ and its finite population correction for the proportions:

$$n = \frac{n_0}{1+\frac{(n_0-1)}{N}}$$

Where,

n_0		Sample size
z	1.96	z value found in z table at 95 % of the confidence level
p	0.5	Assuming that about 50% of the population should have some sanitation characteristics that need to be studied (this was set as 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)
q	1-p	
e	± 5 %	desired level of precision or sampling error
n		Reduced sample size
N		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 one stratum. The sample size required in each ward of the municipality was calculated as $n_h = \frac{N_h}{N} \times n$ where, N_h is total population of each ward of municipality.

Thus, 370 households out of 10,033 households distributed in 12 wards were sampled using proportionate stratification random sampling. The number of ward wise sample size has been attached in appendix 4. The distribution of sampling points in the municipality are shown in Figure 19.

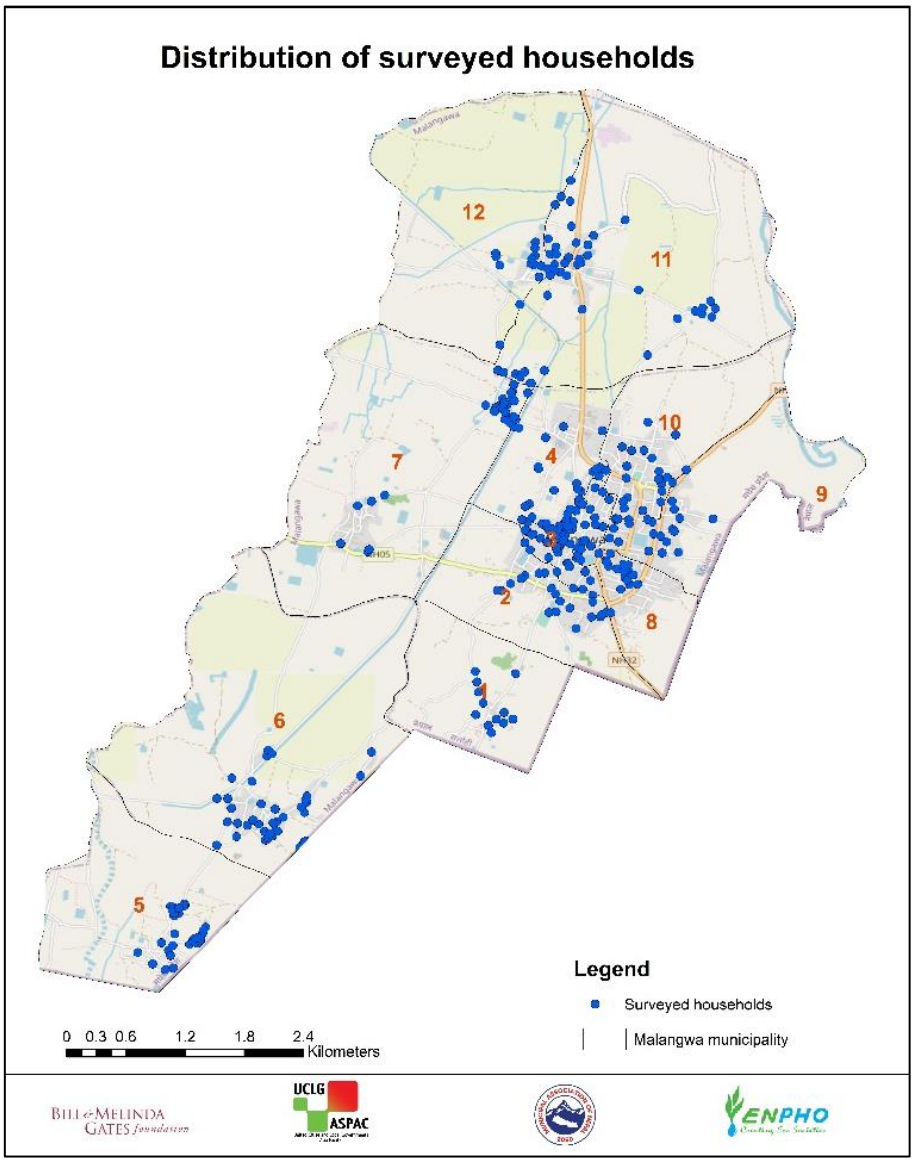

Figure 19: Distribution of sampling points in all wards of Malangwa Municipality.

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 municipality.

We offer our sincere gratitude to Mr. Nagendra Prasad Yadav, Mayor, Ms. Shakuntala Devi Shah, Deputy Mayor, Mr. Gehnath Gautam, Chief Administrative Officer, Mr. Raj Kumar Adhikari, Information Officer, entire staffs of municipality for their remarkable support during the study.

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7. Appendix

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

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

7.2. Appendix 2: Microbial Contamination of Groundwater Quality of Malangwa Municipality (FWSSMP, 2023)

SN	Ward	Location	Source of Sample	Observed Value of *E. coli (CFU/100ml)*
1	1	Malangwa-1, Malangwa Sarlahi	Tubewell 250 ft	0
2	1	Malangwa-1, Malangwa Sarlahi	Tubewell 95 ft	0
3	2	Malangwa-2, Malangwa Sarlahi	Tubewell 280 ft	0
4	2	Malangwa-2, Malangwa Sarlahi	Tubewell 200ft	2
5	2	Malangwa-2, Malangwa Sarlahi	Tubewell 200 ft	0
6	3	Malangwa-3, Salhes chowk, Sarlahi	Tubewell	0
7	3	Malangwa 3, Sarlahi	Tubewell 125 ft	0
8	4	Malangwa-4. Shivsagar chowk, Sarlahi	Tubewell	90
9	4	Malangwa-4. Shivsagar chowk, Sarlahi	Tubewell	48
10	4	Malangwa-4, Malangwa , Sarlahi	Tubewell- 200ft	0
11	4	Malangwa-4, Pani tyanki chowk, Sarlahi	Tubewell -210 ft	0
12	5	Malangwa- 5 ,Dhrampur Bhadsar , Sarlahi	Tubewell	0
13	5	Malangwa- 5 ,Dhrampur Bhadsar , Sarlahi	Tubewell - 80 ft	0
14	6	Malangwa-6, Saukhaniya	Tubewell	0
15	6	Malangwa-6,Khutauna , Sarlahi	Tubewell 250 ft	0
16	6	Malangwa-6,Khutauna , Sarlahi	Tubewell	0
17	6	Malangwa-6,Khutauna , Sarlahi	Tubewell	0
18	6	Malangwa-6,Khutauna , Sarlahi	Tubewell	0
19	6	Malangwa-6,Khutauna , Sarlahi	Tubewell-100 ft	0
20	7	Malangwa-7, Musalli Sarlahi	Tubewell-200 ft	0
21	7	Malangwa-7, Musalli Sarlahi	Tubewell-200 ft	0
22	8	Malangwa-8, Sarlahi	Tubewell	0
23	8	Malangwa-8, Nagarpalika chowk Sarlahi	Tubewell	0
24	9	Malangwa-9, Sarlahi	Tubewell	0
25	9	Malangwa-9, Sarlahi	Tubewell	0
26	10	Malangwa-10, Tower chowk, Sarlahi	Tubewell -210 ft	0
27	10	Malangwa-10, Tower chowk, Sarlahi	Tubewell -210 ft	0
28	10	Malangwa, 10, sarlahi	tubewell -95 ft	20
29	11	Malangwa-11, Gamhariya, Sarlahi	tubewell-130 ft	0
30	11	Malangwa-11, Gamhariya, Sarlahi	tubewell 225 ft	0
31	11	Malangwa-11, Gamhariya, Sarlahi	tubewell 215 ft	0
32	11	Malangwa-11, Gamhariya, Sarlahi	tubewell 180 ft	0
33	11	Malangwa-11, Gamhariya, Sarlahi	tubewell 222ft	70
34	12	Malangwa-12, Gamlhariya, Sarlahi	Tubewell 225 ft	0
35	12	Malangwa-12, Gamlhariya, Sarlahi	tubewell	0
36	12	Malangwa-12, Gamlhariya, Sarlahi	tubewell 225 ft	80
37		Malangwa, Sarlahi	Tubewell 225 ft	0
38		Malangwa, Sarlahi	Tubewell	0
39		Malangwa, Sarlahi	Tubewell	20

7.3. Appendix 3: List of Participants of SFD Orientation

UCLG ASPAC | ENPHO

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

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

Program: SFD orientation
Date: 2079/11/15 - 2079/11/16
Venue: Malangwa Municipality Hall.

S.N	Name	Organization	Designation	Phone no	Signature Day 1	Signature Day 2	Ethnicity
1.	Tufan Ahmad	ward-5	Enumerator	9819668786			
2.	Sujay Sah	ward- 2	enumerator	9844074743			
3.	Amresh Adhikari	Ward-1	Enumerator	9858058172			
4.	Bishal kumar Yadav	ward-12	Enumerator	9816940106			
5.	Hemant Ku. Jha	ward-10	Enumerator	9746632836			
6.	Gyan Nath Yadav	six-6		9746803267			
7.	Bideshi Ray	ward- 07	Enumerator	9807694418			
8.	Ranjit Kumar Yadav	4	Enumerator	9807610355			
9.	Sweta Jaysawal	8	Enumerator	9812053300			
10.	Bisu chaudhary	3	enumerator	9814896336			
11.	Saban Yadav	11	"	9800527[illegible]			
12.	Sanjit Kr Karn	09	"	9865114123			

UCLG ASPAC | ENPHO

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

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

Program: SFD orientation
Date: 2079/11/15 - 2079/11/16
Venue: Malangwa Municipality Hall.

S.N	Name	Organization	Designation	Phone no	Signature Day 1	Signature Day 2	Ethnicity
1	Nagendra Prasad Yadav	Malangwa Municipality	Mayor	9[illegible]			
2	[illegible]	[illegible]	[illegible]	[illegible]			
3	[illegible]	[illegible]	[illegible]	[illegible]			
4.	Shyam Kishor Yadav	Malangwa	Engineer	9857081850			
5.	Umesh Chandra Jha	Malangwa-8	Sr. Advocate	9844093271			
6.	Lalpeshwar Ray	Malangwa Mun	EC	9844317931			
7.	Bakhtiyar Ali	Avenue TV	Sellahi	9815808798			
8	Satyendra Mishra	Malangwa-8	Sellahi	9845281016			
9.	Dharmendra Raj Yadav.	malangwa.		9844225220			
10	Ramnarayan Baidar	Malangwa	Peon	9844021882			
11	Raj Kumar Achika	Malangwa	I.F.O.	9854086891			
12	Ramphukar Roy	"	Officer	9865888815			
13	Sabina Gamal	ENPHO	APO	9843412596			

7.4. Appendix 4: Ward Wise Sample Size Distribution in Malangwa Municipality

Ward	Households	Population	Proportion	Required Sample
1	272	1,669	3%	10
2	772	4,192	8%	28
3	1,280	7,736	13%	48
4	981	4,823	10%	36
5	766	4,472	8%	28
6	981	5,816	7%	36
7	1,099	6,105	10%	41
8	581	2,734	11%	21
9	805	3,824	6%	30
10	984	4,803	8%	36
11	904	5,060	10%	34
12	608	3,316	6%	22
	10,033	**54,550**	**100%**	**370**

7.5. Appendix 5: List of Participants Present in Sharing and Validation Meeting

आज मिति २०८० जेष्ठ ८ गते मलंगवा नगरपालिकामा नेपाल नगरपालिका संघको आयोजनामा वातावरण र जनस्वास्थ्य संस्था (एन्फो) को प्राविधिक सहयोग, The United Cities and Local Goverment Asia Pacific (UCLG-ASPAC) को सहकार्य तथा Bill and Melinda Gates Foundation (BMGF) को आर्थिक सहयोगमा मानव मलमुत्र प्रवाह रेखाचित्र (Shit Flow Diagram-SFD) प्रमाणीकरण सम्बन्धी अन्तर्क्रिया तथा दिसाजन्य लेदो व्यवस्थापन सम्बन्धी अभिमुखीकरण कार्यक्रममा निम्न अनुसार सरोकारवालाहरुको उपस्थिति रहेको छ।

उपस्थिति:

क्र.सं	नाम	पद	कार्यालय	फोन नं.	हस्ताक्षर
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६	[illegible]	,, ,,	,, -६	[illegible]	[signature]
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१०	नगीना राय	,,	मलंगवा न.पा.	[illegible]	[signature]
११	संजय कुमार यादव	ई०अ०	म०न०पा०	9844032052	[signature]
१२	[illegible] सिंह	S.M.O	म.न.पा.	[illegible]	[signature]
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१५	[illegible] तिमाल्सिना		—	[illegible]	[signature]
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१७	सुदर्शन अधिकारी		काठमाडौं	9860723252	[signature]
१८	धर्मेन्द्र राय		म०न०पा०	9844225226	धर्मेन्द्र

क्र.सं.	नाम	पद	कार्यालय	फोन नं.	हस्ताक्षर
१९	राजेशसिंह यादव	का.ति	३नं.वार्ड	९४१३२१९२३१	
२०	[illegible]	[illegible]	[illegible]	[illegible]	
२१.	विष्णुकान्त साह	नि.का.अ	[illegible]	९८४४३२४०१६	
२२	प्रमोद मंडल	शिक्षा प्रमुख	[illegible]	[illegible]	
२३	सुनिता कुमारी यादव	वडा अध्यक्ष वडा नं.१,१-१०	१० न.	९८५४०३६३७०	
२४	[illegible]	[illegible]	[illegible]	[illegible]	
२५	[illegible]	वडा अध्यक्ष	मलंगवा-नगरपा	९८४४०९०४९९	
२६	[illegible]	वडा अध्यक्ष	मलंगवा/नपा-२	९८०१६४६०००	
२६	मो. सलिम मिनसारी	जनप्रति.नि.	म.न.पा.कार्यालय	९८४०३५५८०	
२६.	सतनारायण मिश्र	अधिकृत	[illegible]	[illegible]	
२८	रुपक क्षेत्री	इन्जिनियर	[illegible]	९८४१५६३८५०	
२९	सबुना गामाल	क.प.अ.	[illegible]	९८४३४१२११५	

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