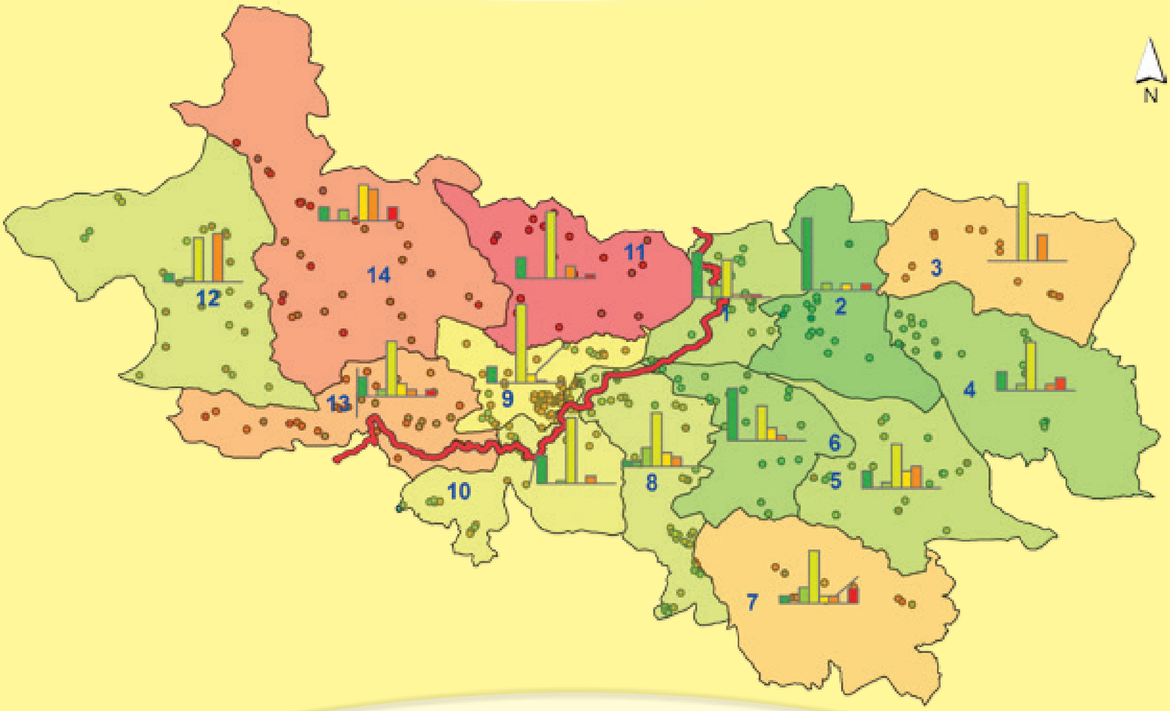
“Municipalities Network Advocacy on Sanitation in South Asia (MuNASS)” Project



Sanitation Situation Report of Waling Municipality

Volume IV

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UCLG ASPAC
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Smart Waling

Municipal Association of Nepal 2050

ENPHO
Creating Eco Societies

Sanitation Situation Report of Waling Municipality
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Executive Summary

The "Municipalities Network Advocacy on Sanitation in South Asia (MuNASS)" project, focuses on capacity building, implementing national policy and strategy on sanitation particularly focusing on Fecal Sludge Management (FSM) and Non-Sewered Sanitation System (NSSS) in line with Sustainable Development Goal (SDG)-6. The project belief sustainable sanitation to all can be only achieved when the local government, a major implementing body at the ground are capable for planning, developing and implementing effective sanitation strategies. As a part of capacity development, the study on sanitation situation was conducted to assist local government making effective planning and implementation for it. The random households and institutional sampling was conducted with detail questionnaire survey focused on sanitation service chain.

The majority of households (47.7%) have installed lined tank with impermeable walls and open bottom to store faecal sludge generated in the house. Remarkably, 20.7% of households have connected the toilet waste into an anaerobic biogas digester designed to treat organic solid waste, animal manure and faecal sludge. While still 20.5% rely on either single pit or unimproved pit to store faecal sludge. Similarly, at institutional level, lined tank with impermeable walls and open bottom (52.5%) followed by fully lined tank (28.7%) were popular. In both cases, the size of the containments were not designed according to number of users and emptying frequency. The average size of the household containment was 11.7 m^3 with minimum and maximum ranging between 0.7 m^3 and 49 m^3 respectively.

It was revealed that only 4% of the household's containments have been emptied at least once after the installation and remaining were never emptied. Manual emptying practice was predominant mechanism for emptying, though few of households received mechanical emptying services from private desludging service provider. The mechanical emptying service could be increased as almost 61% of households has access to road network within 10 meters from their house. Lack of faecal sludge treatment plant in the municipality and its neighboring safe disposal practice of faecal sludge has been observed as major challenge for effective management of the faecal sludge. Currently, the emptied and transported FS by private desludging service provider is being disposed directly into the farm lands.

Thus in an overall, 77% of FS was being safely managed considering 58% of FS accumulated in the containment which have been never emptied. While only 19% of FS connected to household anaerobic biogas digester was treated and safely managed. In volumetric, at present approximately 530 cubic meter of FS per year was being emptied from the containment and disposed haphazardly. Hence, the municipality should immediately act on to install FSTP to prevent the haphazard disposal of FS.

Abbreviations

CBS	Central Bureau of Statistics
ENPHO	Environment and Public Health Organization
FS	Faecal Sludge
FSM	Faecal Sludge Management
MuAN	Municipal Association of Nepal
MuNASS	Municipalities Network Advocacy on Sanitation in South Asia
NSS	Non-Sewered Sanitation System
ODF	Open Defecation Free
PPE	Personal Preventive Equipment
SDG	Sustainable Development Goal
SFD	Shit Flow Diagram
UCLG ASPAC	United Cities Local Government Asia Pacific
WSMTDWSUO	Waling Small Town Water Supply and Sanitation User's Organization

Acknowledgment

We offer our sincere acknowledgement to Mr. Dillip Pratap Khand, Mayor and Ms. Kalpana Tiwari, Deputy Mayor of Waling Municipality, together with all ward chairpersons and staffs of the municipality for continuous support and valuable feedback during the study. We sincerely thank Mr. Dipendra Malla, a focal person of the MuNASS Project in Waling Municipality for coordinating and mobilizing volunteers for the study.

We would like to acknowledge United Cities Local Government - Asia Pacific (UCLG ASPAC) for financial support of the project Municipalities Network Advocacy on Sanitation in South Asia (MuNASS) and Municipal Association of Nepal (MuAN) for coordination with the municipality. We would like to appreciate Dr. Roshan Raj Shrestha, Deputy Director of Bill and Melinda Gates Foundation (BMGF), Dr. Bernadia Irawati Tjandradewi, Secretary-General of UCLG ASPAC, Mrs. Asih Budiati, Regional Project Manager of UCLG ASPAC and Mr. Satish Jung Shahi, Communication, Outreach and Knowledge Management Officer of UCLG ASPAC for their valuable guidance and support. Similarly, we are very much obliged to Mr. Ashok Kumar Byanju Shrestha, Chairperson, Mr. Kalanidhi Devkota, Executive Director and Mr. Muskan Shrestha, Sanitation Advocacy Specialist respectively from MuAN for their gracious support.

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1. Introduction

1.1 Background

The "Municipalities Network Advocacy on Sanitation in South Asia (MuNASS)" project is implemented to enhance capacity, implement national policy and strategy on sanitation particularly focusing on Fecal Sludge Management (FSM) and Non-Sewered Sanitation System (NSSS) in line with Sustainable Development Goal (SDG) - 6. A limited number of functioning sanitation facilities and appropriate sanitation technologies are main constraint towards achieving the goal. It has increased potential threats towards environmental pollution and human health hazard. Thus, it is always a better to act on preventive approach rather than curative action.

In Nepal, 70% of the population rely on non-sewered sanitation systems. The system is good option owing to economical and geological realities of Nepal. Thus, proper management of the system could ensure better health hygiene of the people. The project belief sustainable sanitation to all can be only achieved when the local government, a major implementing body at the ground are capable for planning, developing and implementing effective sanitation strategies. As a part of capacity development, the study on situational status of FSM was conducted to assist local government making effective planning and implementation for it.

1.2 Objectives

The main goal of the study is to support local government with decision making and planning for better sanitation facilities and services. The major objectives of the study are :

» To understand the current FSM status of the municipality
» To produce evidence-based data and information for effective FSM planning, assist in preparing Detail Project Report of FSM, support advocacy and awareness-raising initiatives.

1.3 Limitation of the Study

Limitations are :

» The study is entirely focused on non-sewered sanitation system.
» The study did not cover the sanitation status of the industries as there is national provision for industries to manage waste generated in it.
» Assessment of existing policies and institutional set up was not conducted as there is separate activity within the project regarding preparing a municipal policy on FSM.
» Also, financial assessment such as cost-effectiveness on FSM interventions was not performed as it is a totally non-profit oriented project and responsibility of government to provide safe sanitation.

1.4 Study Area

Waling municipality, a historically and religiously popular city is located at Syangja district in Gandaki province. The municipality was formed in 2054 B.S. and divided into 11 wards. It was restructured according to the federal structure of the nation in 27th Falgun, 2073 B.S. The neighboring village development committees namely *Jagat bhanjyang*, *Malangkot*, *Kalikakot*, *Keware bhanjyang*, *Sirsekot*, *Thumpokhara*, *Pelakot*, *Tindobato*, *Sorek*, *Chhangchhangdi*, *Majhakot* and ***Yaladi*** were either totally or partially merged and divided into 14 wards.

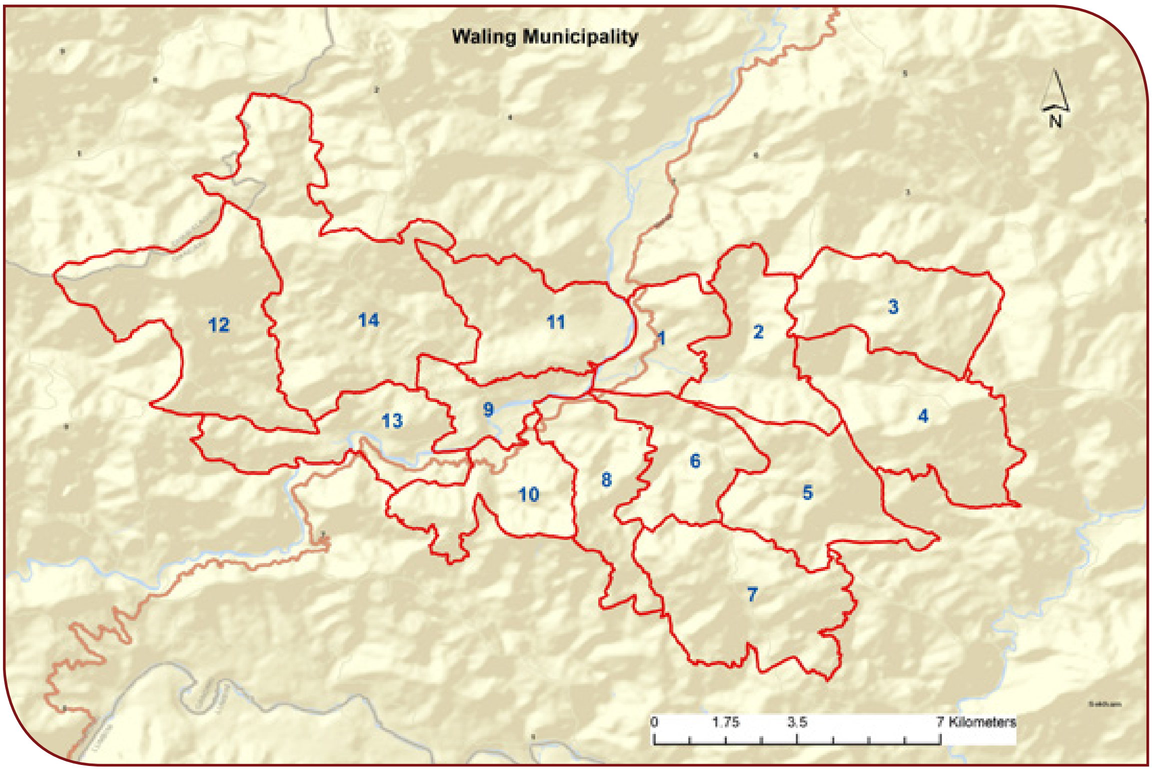

Figure 1 : Map of Waling Municipality with ward boundaries

Geographically, the municipality is located between the latitude of 83° 41'36" to 83° 50'18" and 28° 3' 2" to 27°55'26" longitude at the elevation between 731 meters and 1596 meter from mean sea level. It is extended in 128.40 square kilometres (Waling Municipality, 2018). It shares its boundary with Bhirkot Municipality at the North, Galjyang Municipality and Chapakot Municipality at the South. Similarly, it is bounded by Biruwa VDC and Chapakot Municipality in the East and Galjyang Municipality and Parbat District in the West as shown in Figure 1.

The municipality is resided by 45,608 populations in 11,366 households. The average family size is 4.06 which is less than the national average family size of 4.6 (CBS, 2016). The average population density was 277 per square kilometre. Ward number 9, an urban cluster and ward number 1 has the highest and the lowest population density respectively. The ratio of female to male population was 100:86. The survey revealed that 8% of the population is below 5 years of children.

2. Methodology

The methodologies adopted in the study are in a literature review of secondary data, in-depth questionnaire survey at household and institutional level on existing sanitation status. Also, the key informant survey on FSM key stakeholders is conducted followed by direct observations of the existing sanitation situation.

2.1 Household Survey

The random household survey was conducted in all wards of the municipality through the mobilization of volunteers selected by the municipality. The household survey was conducted using a mobile application "KoBoCollect" after providing orientation. Two days orientation training was conducted to make volunteer understand the objective of the survey, technical terms regarding sanitation, use of the mobile application and conducting a random sample survey.

2.1.1 Determining Sample Size

The number of households to be sampled in the municipality was determined by using Cochran (1963:75) sample size formula $n_o = \frac{Z^2pq}{e^2}$ and its finite Population Correction for the Proportion $n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}}$.

Where,

Z^2	1.96	At the confidence level of 95%
p	0.5	Assuming that about 50% of the population should have some sanitation characteristics that need to be studied. (This was set at 50% since this percentage would yield the maximum sample size since the percentage of the population practicing some form of sanitation is not clearly known at the intervention sites)
q	1-p	
e	±5%	Level of precision or sampling error
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 as one stratum. The sample size required in each ward is calculated as,

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

Thus, a total of 377 households were sampled at the interval of 29 from 10,917 households distributed in 14 wards with proportionate stratification random sampling as shown in Table 1.

Table 1: Proportionate Stratified Sample Distribution in each ward

Ward	Households	Sample
1	837	28
2	527	16
3	346	12
4	511	17
5	562	19
6	740	24
7	499	14
8	1,209	45
9	1,670	60
10	717	30
11	673	25
12	619	24
13	900	33
14	1,107	30
Total	**10,917**	**377**

2.1.2 Sampling Procedure

To have a more consistent way of identifying, selecting and interviewing the allocated number of households across each ward, a systematic sampling approach was followed and random households are selected for the survey. The steps used are as below:

» Calculate the ward sampling interval, i.e. the total number of households divided by number of households to be sampled.
» Select a random start between 1 and sampling interval using excel function RANDBETWEEN (1, sampling interval).
» The random start identifies the first households to be interviewed, the second household will be number (random start + sampling interval)
» Repeatedly add sampling interval to select subsequent households.
» As a rule, for replacement of households that are not available or not consent to the interview, the first household on the left-hand side of the absent household was selected.

2.2 Institutional Survey

Door to door method was applied for Institutional survey. All institutions within the set criteria for selection were surveyed. The selection criteria are:

» Educational and financial institutions operated in either its own building or rented building are selected but operating in a single room or flat not selected.
» All hotels with the provision of residential facilities are selected.
» Health care centre with the provisions of the bed is selected, i.e. small clinics were not selected.

» Government/ Non-government Offices are selected.
» Commercial Buildings are selected.

In total 209 institutions were surveyed and descriptions of surveyed institutions are shown in Table 2.

Table 2: Descriptions of Surveyed Institutions

Ward	Financial Institutions	Hotel/ Home Stay	Educational Institutions	Government /Non-government Office	Health Care Center	Total
1	5		1	1		7
2	2		2		1	5
3			2	1	1	4
4	1	1	3		1	6
5			2	2		4
6			2	3	1	6
7			3		1	4
8	16		2	1	1	20
9	3	1	3	3	1	11
10	1	3	2			6
11	1		3		2	6
12			5	1		6
13	6		2		1	9
14			5	1	1	7
Total	**35**	**5**	**37**	**13**	**11**	**101**

2.3 Key Informant Interview

Mr. Padam Prasad Pandey, Officer from Sanitation Section of Waling municipality office was interviewed to understand existing sanitation policies of the municipalities, the planning process for developing a sanitation program and on-going programs. Mr. Bhola Shah, a private desludging entrepreneur of Bhola Sanitary, Waling was interviewed to get information on desludging services in the municipality.

2.4 Data Collection Process

The data was collected by using the KoBoCollect application, which was uploaded into mobile phones through the mobilization of the local enumerators. ENPHO engaged its own staff as supervisors to undertake this survey. The supervisors engaged local enumerators to conduct the household and institutional survey. Enumerators were trained on a questionnaire survey and using KoBoCollect. During the training, enumerators have familiarized themselves with questionnaire contents, the flow of questions, mobile data collection devices, and test runs all the devices.

2.5 Data Processing and Analysis

After the fieldwork, all the e-forms submitted in the KoBo dashboard were adequately checked for accuracy and completeness before analysis. The data was cleaned and verified for inconsistency, missing values and errors. After data cleaning, the second step of analysis involved the generation of syntax commands to ensure that variables are transformed appropriately for ease of analysis.

The data processing and analysis entailed the following steps:

» Downloading the data from the KoBoCollect in excel and performing exploratory analysis to check for accuracy, completeness, relevance and consistency of the critical data elements;
» Performing data cleaning using a set of manipulation commands to ensure that data are aligned to the data analysis plan and the agreed reporting template;
» Descriptive analysis entailed computing frequency distributions; means and cross-tabulations

The data cleaning process is one of the important steps in data processing before its analysis. Data cleaning entails a set of procedures aimed at assessing the sampling protocol adherence, completeness of collected data, accuracy, consistency and relevance of each of the data elements under consideration as well as actual correction of the data with errors for improved data quality.

The process of data cleaning ensures that the errors in data arising from missing data, outliers and other out of range issues are handled in time for better quality results. Following the completion of data collection, the data was cleaned and verified before the analysis and interpretation of data.

3. Sanitation Status

The municipality was declared open defecation free (ODF) zone on 14th of May 2013. Also, all VDCs merged to the municipality had been declared ODF zone from 2011 to 2013 (MuAN, 2017). Thus literally, all the households in the municipality have access and use either own or shared toilet for the defecation. However, it was revealed that 1.06% of households do not own toilet. Also, approximately 1.1% of households has not constructed containment and wastes from toilet is directly discharged either into open land or open drains.

3.1 Types of Containments

3.1.1 Types of Containments at Household Level

A toilet in 20.7% of households has linked to an anaerobic biogas digester which receives the excreta and flushing water directly from the toilet. The anaerobic biogas digester is designed for the integrated treatment of toilet products, animal manure, kitchen and garden waste. The slurry from the biogas digester is directly applied into farmland by 19.23% and remaining is co-compost or dry before application.

A containment constructed with bricks and cement wall, plain cemented concrete flooring and totally lining without outlet or overflow system is termed as a fully lined tank. The containment is constructed to safely hold the faecal sludge for a certain duration of time and emptied regularly. It is installed in 6.1% of the households, mostly located at urban clusters. Similarly, a septic tank, basically a containment and primary treatment unit at household was constructed in only 0.5% of households as shown in Figure 2, in the same area. While 47.7% of households have a lined tank with impermeable walls and open bottoms constructed to allow seepage to lower the emptying frequency. Single pits and unimproved pits were popular among households located in rural area of the municipality. Almost 9% and 11.4% of

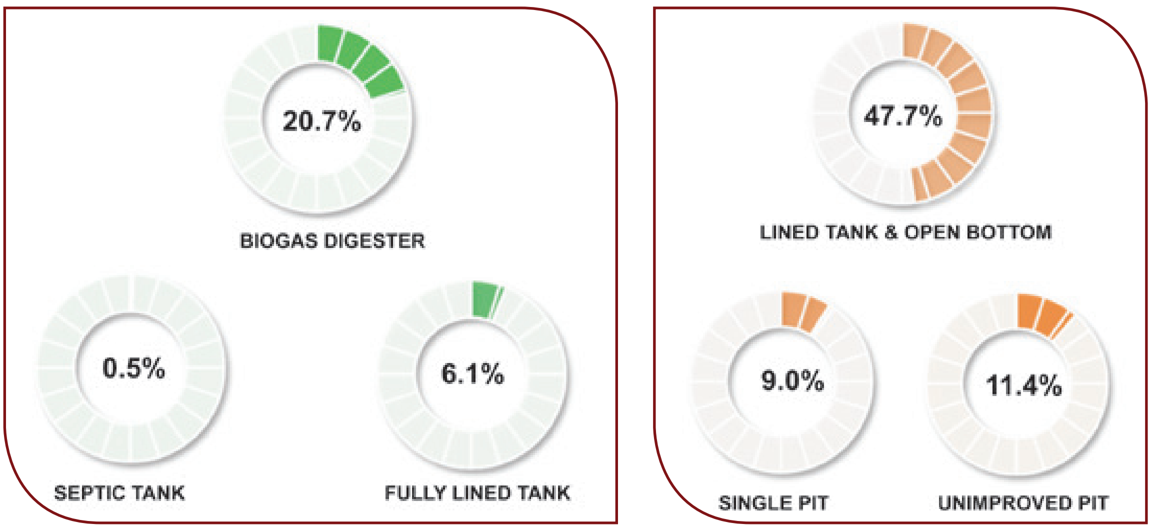

Figure 2: Percent of various types of household containments

households have constructed such containment. While in 2.4% of households have damaged containment. Geographical locations of households with various types of containments is shown in Annex 1.

3.1.2 Types of Containments at the Institutional Level

Approximately, 6% of toilets in institutions are connected to drainage system though municipality has not developed sewer network in the area. Lined tank with impermeable walls and open bottom (52.5%) were installed in majority of institutions followed by fully lined tank (28.7%). Majority of these institutional toilet have pour flush system while 15% have cistern flush system. Unlike household containments, 42% of these containments receive gray water from hand washing basins. While, few institutions established in rural area have anaerobic biogas digester and both single pits and unimproved pits as shown in Figure 3.

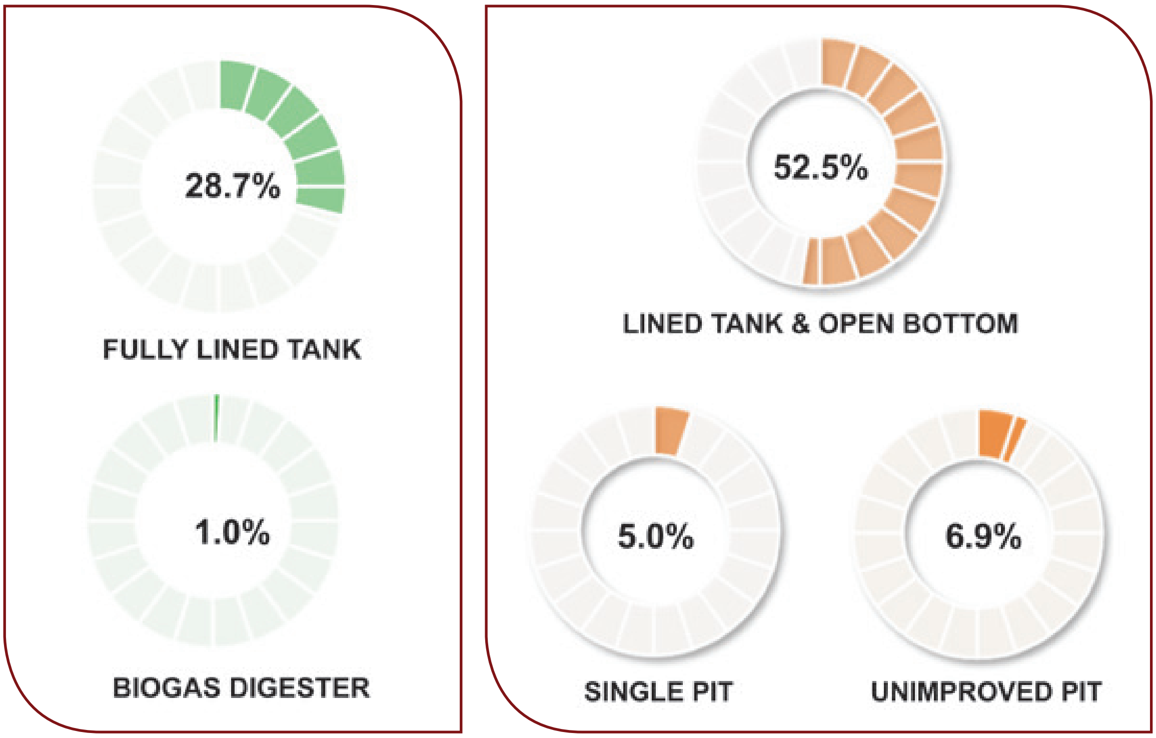

Figure 3 : Percent of different types of containments in institutions

3.2 Sources of Drinking Water

Surface water sources has been taped for providing drinking water to majority of households in the municipality. Waling Small Town Water and Sanitation User Organization (WSMTWSUO) have been supplying safe drinking water in ward number 1, 8, 9 and 10 through almost 2000 private taps. The short descriptions of sources of the water in WSMTWSUO is presented in Table 3.

Table 3 : Descriptions on Sources of drinking water

S.N.	Source	Location	Capacity
1	Surkhudhi Spring	Waling 9	14
2	Bhumre Satdhara	Waling 9	17
3	Lalupate Spring	Waling 6	4
4	Madhi Khola	Waling 10	5
5	Triyasi	Waling 1	1.8
6	Rambachha	Waling 1	3
7	Khaharye	Waling 1	1

Source: (Waling Small Town Water Supply and Sanitation User's Organization, 2018)

Community level drinking water supply schemes have been developed in the areas not served by Small Town Water Supply and Sanitation System. However, almost 1.6% of households rely on groundwater for drinking water. The quality of water supplied by the WSMTWSUO is within the national standard for drinking water. The water quality report is attached in Annex 2.

3.3 Size of Containments

Size of containments is highly variable except with anaerobic biogas digester. Anaerobic biogas digester has been subsidized by the Government of Nepal and constructed accordance to its guideline. The volume of the anaerobic biogas digesters are 6 m^3 and 8 m^3. Figure 4 shows the histogram of the size of the containment. The minimum and maximum size is 0.7 m^3 and 49 m^3 respectively. The average size is 11.7 m^3 with 0.55 standard error of mean and standard deviation of 9.3. The skewness value is 0.98 indicating skewed at right. Also, kurtosis value is 0.6 that implies there are significant outliers with respect to average size. Thus, the average size could not be generalized for all the types of containment.

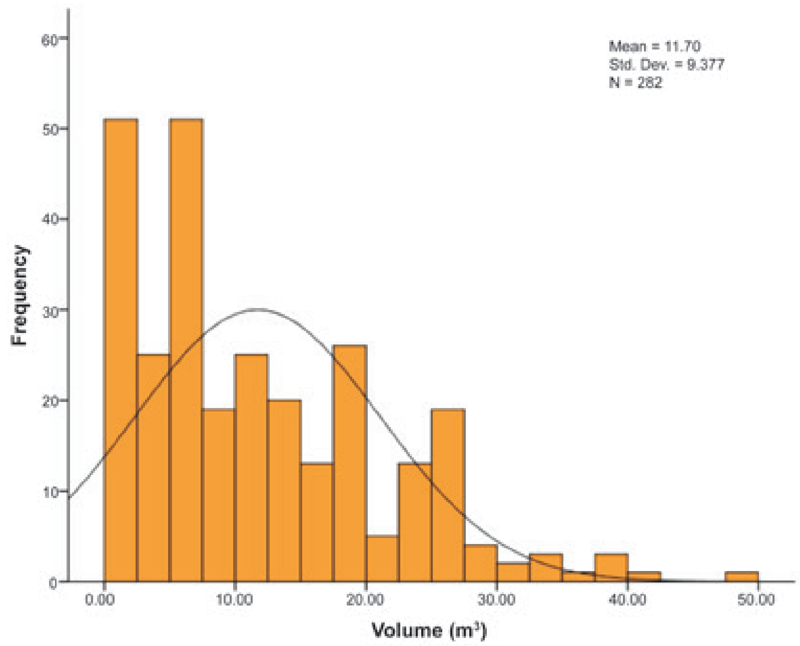

Figure 4: Histogram of sizes of containments

3.3.1 The relation between Size of Containment and Number of User

Figure 5 shows the graph on relation between the size of the containment and the number of the user. Pearson's Coefficient of the Correlation value (r) is – 0 .083 with a probability value (p) 0.167 and coefficient of determination (r^2) 0.007. This implies that there is no any significant relationship between the size of the containments and user.

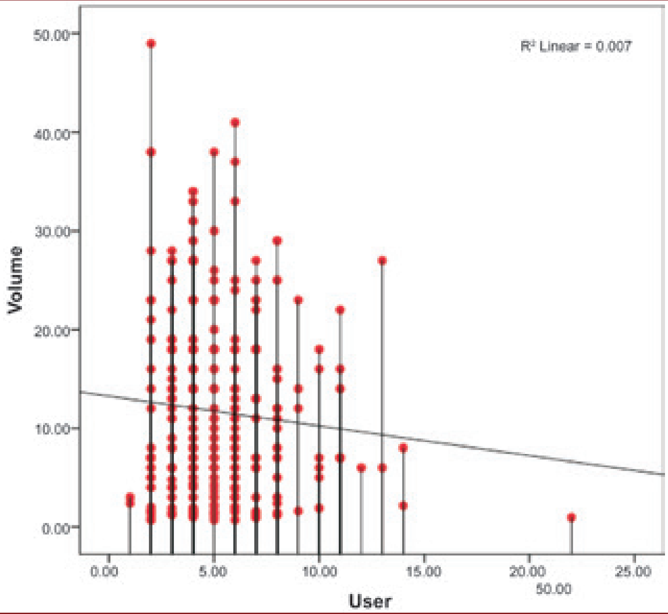

Figure 5 : Graph on relationship between size and user

3.3.2 Size of Rectangular Containment

Figure 6 shows the histogram of the size of the rectangular containments. The average size of the containment is 13.86 m^3 with a standard error of the mean at 0.588 and a standard deviation of 8.9. The minimum and maximum sizes are 1 m^3 and 49 m^3 respectively. The skewness value is 0.94 which implies right hand skewed and kurtosis is 0.62 indicating significant outliers.

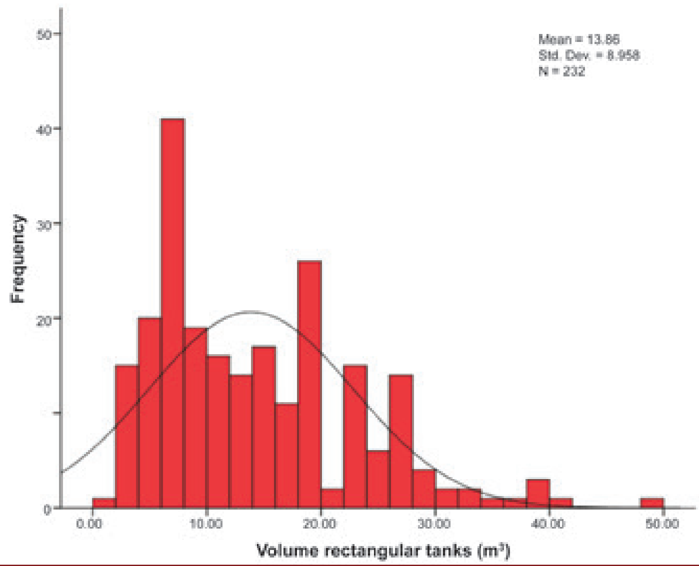

Figure 6 : Histogram of size of rectangular containments

3.3.3 Size of Circular Containment

Figure 7 shows a histogram of the size of circular containments with a skewness value of 1.9 and kurtosis of 3.6 which indicates right hand side skewed without significant outliers. The average size is 1.7 m^3 with 0.13 standard error of mean and standard deviation of 0.92. The minimum and maximum sizes are 0.7 m^3 and 4.78 m^3 respectively.

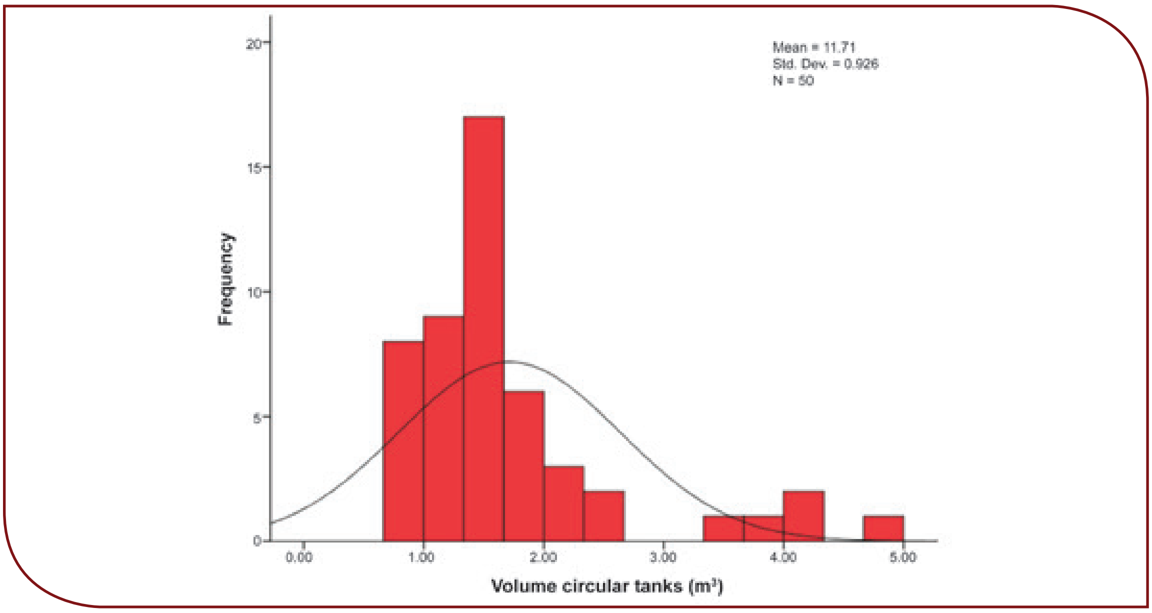

Figure 7: Histogram of circular containments

3.4 Emptying and Transportation

Emptying is one of the major components of the sanitation value chain. It ensures the proper functioning of containment basically for the septic tank which function well until the volume of sludge is one-third of the total volume of the tank. Also, in other containment, regular emptying prevents overflow of the sludge and blockages. However, anaerobic biogas digester was designed assuming treated slurry will automatically overflows from the outlet chamber which can be used as manure. Thus, anaerobic biogas digester has been excluded in the analysis. Emptying onsite sanitation systems are influenced by accessibility from the road, design of the containment, promotion and marketing of emptying services and social practices (Mikhael, 2015).

3.4.1 Accessibility to Containment for Emptying

Approximately, 61% of households have containment located within the distance of 10 m from road where mechanized vacuum tanker mounted on the truck or tractors can easily steer on. Among these, only 52% were located at the same level with the road which could ease mechanized pumping of the faecal sludge. The type of vehicles accessible to surveyed households in the municipality is shown in Annex 3. Regarding the design for easy emptying, 52% consists of proper manhole or access port. However, 35% were either plaster or tiled above the containment that demands additional effort for emptying.

Similarly, all the institutional containments have easy access to road connectivity and 80% were located within the distance of 10 m. However, only 40% were at the same level to the road and 61% were located at the vertical distance of 1 m and 4 m. 52% were provided with proper manhole or access port to ease emptying while 60% were completely plastered.

3.4.2 Emptying Practices and Frequencies

Both at household and institutional level, majority of containments have never been emptied since installation. Only 4% of containments have been emptied recently within the time period of five years. Self-manual emptying was popular at household level where sludge was dumped into their own farm land. Among the emptied containments, their emptying frequency is shown in Figure 8. It shows that variable frequencies among the types of containments.

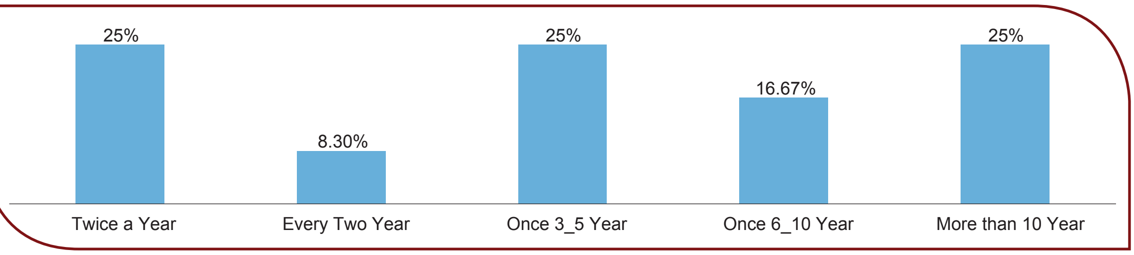

Figure 8 : Graph on emptying frequencies of containments

3.4.3 Relationship between Size of Containment and Emptying Frequency

Figure 9 shows graph on relationship between sizes of the containments and their emptying frequency. Pearson's correlation coefficient (r) is – 0 .355 with a probability value (p) 0.257 and coefficient of determination (r^2) 0.126. It implies there exists negative relationship but, statistically it is not significant.

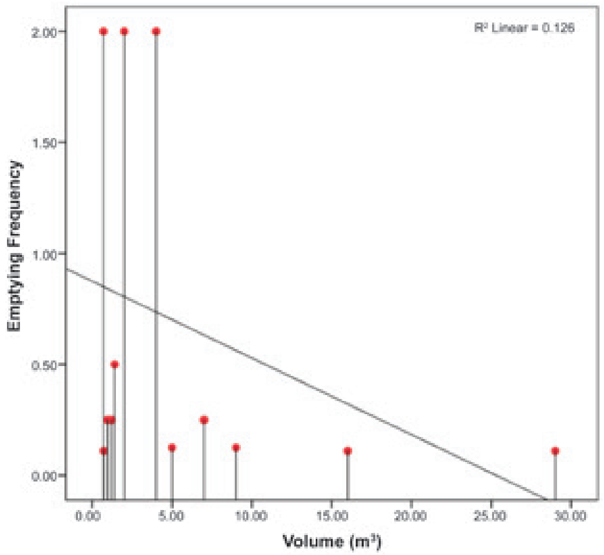

Figure 9 : Graph on relationship between emptying frequency and size of containment

3.4.4 Characteristics of Never Emptied Containment

Almost 86% of the containments have never been emptied (bio-digester and offsite sanitation excluded) since their installation as none of these were filled or overflowed. The average volume of these never emptied containments with its average users and age of containment is as shown in Table 4. It shows that the majority of never emptied containments have relatively larger size except with single pits.

Table 4: Descriptions on Average Size and Number of User of Never Emptied Household Containments

S.N.	Types of Containments	Average Size (m^3)	Average no. of Users	Average Age of Containment (Year)
1	Septic Tank	23	5	7.5
2	Fully Lined Tank	17.5	5.2	6
3	Lined Tank and Open Bottom	14	5.1	6.6
4	Single Pits	1.8	5.5	6.3
5	Unimproved pit	6	5.12	5.5

Also, the age of these containments is shown in Table 5. It shows that almost 47.9% of the containments were installed only either 2 years ago or within 5 years ago. Thus, it is possible that these never emptied containments have never filled while there may be unauthorized open emptying of the remaining containments.

Table 5: Descriptions of Types of Never Emptied Household Containment and its Age

S.N.	Containment	Constructed Time Period				Total
		0 – 2 years ago	3 – 5 years ago	6 – 10 years ago	> 10 years ago	
1	Septic Tank	0.37%	0%	0%	0.37%	0.74%
2	Fully Lined Tank	0.74%	3.69%	2.58%	1.48%	8.49%
3	Lined Tank and Open Bottom	10.33%	20.66%	17.34%	15.87%	64.21%
4	Pits	1.48%	2.95%	5.17%	1.85%	11.44%
5	Unimproved pit	3.32%	4.43%	34.80%	2.58%	15.13%
	Total	**16.24%**	**31.73%**	**29.89%**	**22.14%**	**100%**

3.4.5 Emptying and Transportation Services

Bhola Sanitary Service, a private entrepreneur has been providing desludging service in the area since 2015. The service is extended to neighboring municipalities from Sangjya Muncipality to Galjyang. The entrepreneur owns a two tanker with a capacity to carry 5,000 liters per trip as shown in Figure 10. These tankers are manufactured locally in Butwal Industrial State and are assembled into a tractor. In an average three trips of faecal sludge per month is emptied and transported by the entrepreneur. The service charge ranges from NPR 6,000 to NPR 10,000 as per trip. A faecal sludge from rectangular containment with higher concentration of water is charged less as it is easier to pump out compared to thick FS of the pits. A driver and a helper is mobilized during the service and both are paid NPR 2,000 per trip. Both the labours lack Personal Preventive Equipment (PPE) and education on health hygiene.

Figure 10: Desludging tanker operated by private service provider

3.5 Treatment and Disposal/Reuse

The municipality does not have Faecal Sludge Treatment Plant (FSTP). The FS emptied and transported by the private desludging vehicle is disposed into open farmland as shown in Figure 11 though municipality has strictly prohibited for such action. So, the private entrepreneur has initiated providing service to those who have options for safe disposal.

Figure 11: Direct disposal of emptied FS into open farmland

3.6 People's Perceptions and Knowledge on FSM

People's perception of emptying, disposal and its consequences were assessed. Also, their perception of improved management of FS was measured.

3.6.1 Perception of Preferred Emptying Mechanism

Figure 12 shows perception of the preferred emptying mechanism of containments after it gets filled. Majority of household's that have never emptied their containment preferred self-emptying while 26% of households would contact either municipality or private service providers. Whereas 14% perceived they do not have any idea and 9% would abandon the containment.

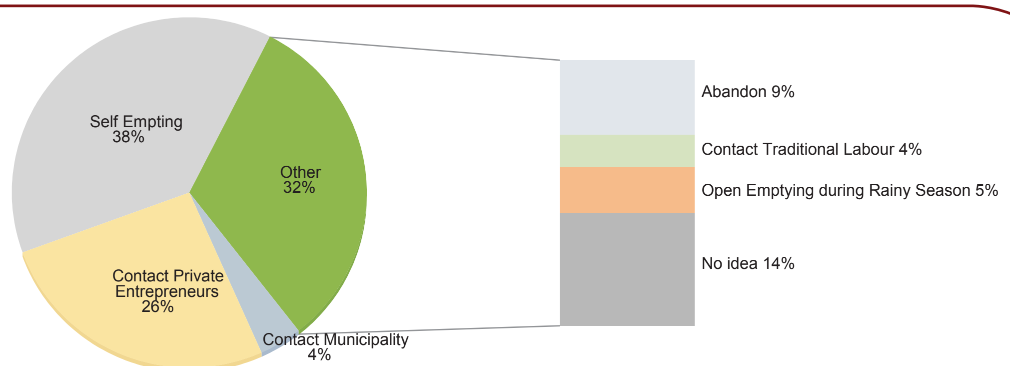

Figure 12 : People's perception on preferred emptying mechanism

3.6.2 Perception of Current Practices of FSM

Figure 13 shows the perception of local people on current FSM practices in the municipality. It shows that the majority of the households believed FS transported by private entrepreneur is being taken to treatment plant. Similarly, 28% of households applies FS into farmland while 12% disposed into either open land, forest, water bodies or drains. Also, 24% of households have never emptied their containments.

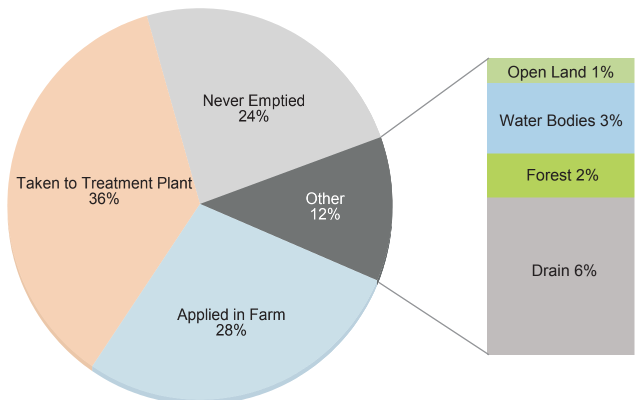

Figure 13 : People's perception on current FSM practices

3.6.3 Perceptions of Improved FSM

Figure 14 shows the perception of improved FSM, which shows that the majority of people preferred the construction of the treatment plant. Also, they insist for strict law and punishment for disobeying the rule. 25% of people claimed encouraging reuse option would improve current practices of FSM despite the majority of households using FS in farmland.

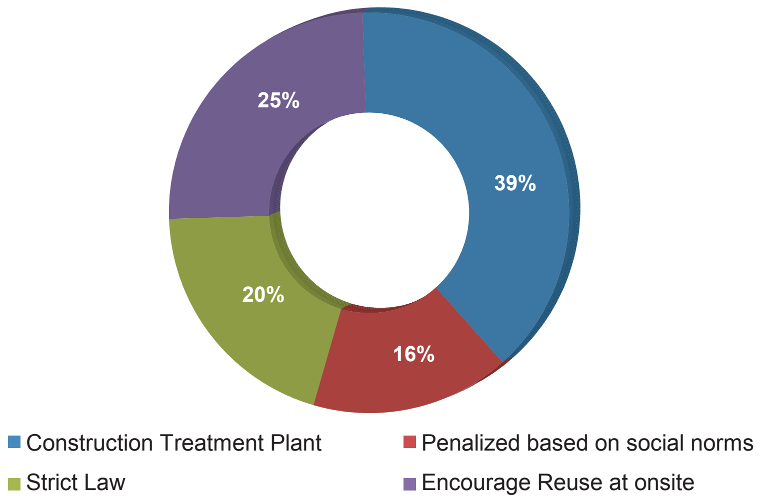

Figure 14 : People's perception on improved FSM

4. Situational Assessment of FSM

4.1 Shit Flow Diagram

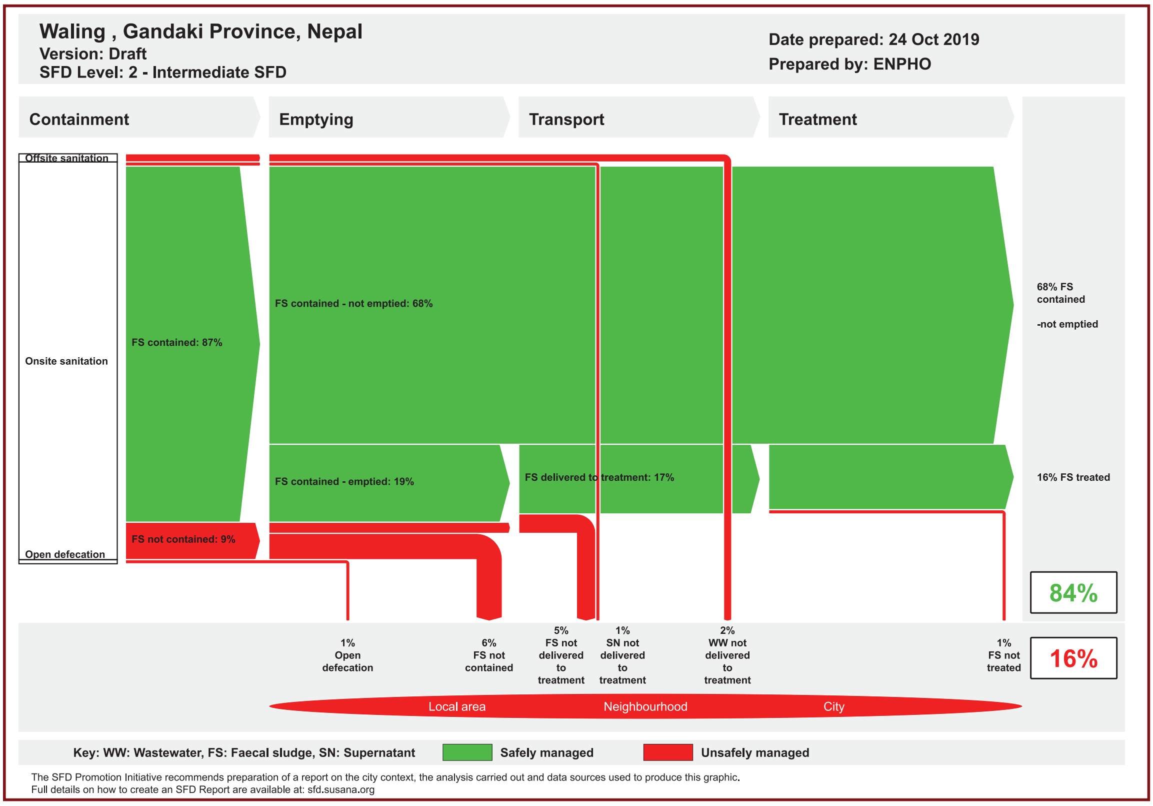

Figure 15 : Shit Flow Diagram of Waling Municipality

The overall status of the flow of faecal sludge is represented by the Shit Flow Diagram (SFD) as shown in Figure 15. Interesting, 17% of FS collected in an anaerobic biogas digester has been treated while 68% of FS collected in the fully lined tank and lined tank with open bottom without significant risk to groundwater is considered safely managed until it is emptied and rest being disposed of haphazardly to the environment. It increased threat on groundwater contamination resulting degradation of human health upon consumption of contaminated water.

4.2 Quantification of Faecal Sludge

Quantification of faecal sludge depends upon many factors such as type of the containment, water content, climate, inflow and infiltration, presence of overflow pipe, user behaviours, sludge age, non-biodegradable fraction and soil characteristics (Borouckaert CJ, 2013). Quantity of FS is estimated based upon the average size of various containment and their emptying frequency obtained from primary data collected during the household survey. The calculation in Table 6 shows 17,708 m^3 of FS produced per year excluding FS from households with an anaerobic biogas digester.

Table 6: Calculation of FS Generation based on Size of Containment in Household

Containment	HHs	Average Volume of containment	Emptying frequency	Total FS in containment
Septic tank	58	14	0.1	81.2
Fully lined tank (sealed)	667	18	0.1	1200.6
Lined tank with impermeable walls and open bottom	5213	14	0.2	14596.4
Single Pit	985	1.7	0.2	334.9
Unimproved pit	1246	6	0.2	1495.2
			FS produced per year	**17,708**
			FS produced per day	**48.5**
			Total Number of Trips (Vehicle Capacity 4 m^3)	**12**

4.2.1 The volume of Faecal Sludge Emptied from Household

In an average only 529 m^3 of FS is being emptied in the municipality. The amount is approximately 3.5% of the calculated total volume of FS generated per year based on the size of containment and emptying frequency. Figure 16 shows the total FS generation calculated on the basis of size of containment and emptied portion. Among this, an average 448 m^3 and 81 m^3 of FS per year is being manually and mechanically emptied in the municipality. The mechanical emptying accounts to approximately two trips of tanker per month which is one trip less as responded by the private desludging entrepreneur.

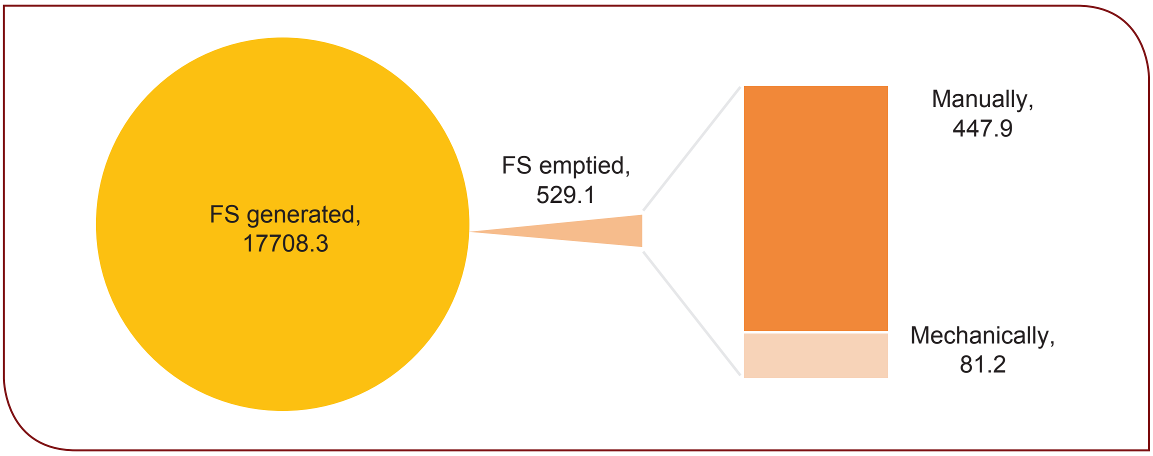

Figure 16 : Portion of total FS generated and emptied from households

4.2.2 The volume of Faecal Sludge Emptied from Institutional Containment

The volume of FS generated from institutional containments is calculated based upon the size of the containment and its emptying frequency. The calculation is shown in table 7 and in an average 554 m^3 of FS per year is generated from institutions which is equivalent to 1.5 m^3 per day.

Table 7: Calculation on FS Generated from Institutional Containment

Types of Institutional Containment	No. of Institutions	Average Volume (m³)	Emptying Frequency Factor	Total Volume of FS per year (m³)
Fully lined tank (sealed)	37	41	0.25	380
Lined tank with impermeable walls and open bottom	67	22	0.1	147
Lined pit with semipermeable wall and open bottom	7	21	0.11	16
Unimproved pit	9	0.25	0.25	11
Total				**554**
Total FS generated per day				**1.5**
Total number of Trip per week (5m3 capacity of tanker)				**10**

However, only around 37 m^3 of FS per year is being emptied from institutional containment which is 7% of the total FS generated. Table 8 shows the volume of FS being emptied mechanically from various types of institutional containment.

Table 8: Calculation of FS Emptied from Institutional Containment

Containment	Mechanical Emptying (m^3/year)
Fully Lined Tank	20
Lined Tank and Open Bottom	14.5
Unimproved pit	2.5
Total FS generated per year	**37**
Total no. of trip per year (5m^3 capacity of tanker)	**7.5**

5. Conclusion and Recommendation

The overall sanitation status of the municipality indicates the need of interventions in all sanitation value chain to improve services and technologies. Installation of anaerobic biogas digester at the household level is remarkable and has a tendency to promote whereas other existing containments are not appropriate owing to groundwater pollution except for fully lined tanks. The higher portion of containment never emptied indicates leakages or unauthorized open emptying practices into an environment with a potential threat to human health. The FS being emptied and disposed off without any treatment is a serious issue. In the absence of regulating agency and lack of treatment plants, the problem could lead to an outbreak of an epidemic. Hence, the municipality should immediately act on to improve FSM for better environment and public health.

The specific recommendation on each of sanitation value chain for improved FSM are:

Containment

- Promote anaerobic biogas digester in the farming community having enough space for installation.
- Lined tank with impermeable walls and open bottoms should be gradually improved to fully sealed tank with respect to potential groundwater contamination.
- Finally, manage a database with information such as types of containment, size and last emptied date.

Emptying and Transport

- Regular monitoring by the municipality to discourage unauthentic discharge of FS into open drains and environment.
- Rules and regulations in place for emptying business.
- Occupational health safety of the emptying operators should be highly prioritized and discourage manual emptying practices.

Treatment

- Ideally, it is important to treat all FS generated in the municipality. However, behaviour change is a long process so it cannot be expected that all containment will be emptied regularly. So, the municipality should focus on establishing treatment plant with a capacity to treat current FS emptied and transported.
- Install and select a natural process with low skilled operational technologies.
- Prepare detail improvement plan with tangible target and interventions.

Reuse/ Safe Disposal

Since there are demand and social acceptance for fertilizer/soil conditioner out of FS, promote reuse options of FS in the treatment plants and nearby community.

6. References

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7. Annexure

Annex 1: Water Quality Report

Government of Nepal
Ministry of Water supply &Sanitation
Department of Water Supply & Sewerage
Regional Monitoring & Supervision Office
Regional Water Quality Testing Laboratory, Pokhara

Tel: 061-463086

Water Quality Test Report

Sample Details:

Sample Name: Lalupate	**Sample Type: Gravity**
Location: Syanja	**Sampling point : Intake**
Sampling Method: Grab	**Sampled by: DWSS Syanja**
Contact person:	**Contact No.:**
Received date: 2074/10/11	**Completed date: 2074/10/17**

Analyzed Parameters

Physical Parameters:

S.N.	Parameters	Observed value/s	NDWQS, 2005	Analyzed Method
1.	PH at 14.9°C	7.8	6.5-8.5	4500-H⁺ B, APHA
2.	Electrical conductivity (µs/cm)	415.0	1500	2510 B, APHA
3.	Turbidity (NTU)	0.08	5(10)	3130 B, APHA
4.	Taste & odor	Unobjectionable	Unobjectionable	Perception
5.	Color (TCU)	-	5(15)	2120 C, APHA
6.	TDS (mg/lit)	203.0	1000	Instrumental

Chemical Parameters:

S.N	Parameters	Observed value/s	NDWQS, 2005	Analyzed Method
1.	Total Hardness as $CaCO_3$ (mg/lit)	180.0	500	2340 C, APHA
2.	Calcium (mg/lit)	54.5	200	3500-Ca B,APHA
3.	Chloride (mg/lit)	8.0	250	4500 Cl^- B, APHA
4.	Fluoride (mg/lit)	-	0.5-1.5	4500 F^- D, APHA
5.	Ammonia (mg/lit)	-	1.5	4500- NH_3 F, APHA
6.	Nitrate (mg/lit)	-	50	4500-NO_3^- B, APHA
7.	Cyanide (mg/lit)	-	0.07	4500-CN^- E APHA
8.	Iron (mg/lit)	-	0.3(3)	3111 B ,APHA
9.	Manganese	-	0.2	3111 B, APHA
10.	Arsenic (mg/lit)	ND	0.05	3111 B, APHA
11.	Total Chromiun (mg/lit)	-	0.05	3111 B, APHA
12.	Copper (mg/lit)	-	1.0	3111 B, APHA
13.	Lead (mg/lit)	-	0.01	3111 B, APHA
14.	Cadmium (mg/lit)	-	0.003	3111 B, APHA
15.	Zinc (mg/lit)	-	3.0	3111 B, APHA
16.	Mercury (mg/lit)	-	0.001	3112 B, APHA
17.	Aluminium (mg/lit)	-	0.2	3500-Al B, APHA
18.	Sulphate (mg/lit)	-	250	4500-SO_4^{2-} C, APHA
19.	FRC (mg/lit)	-	0.1-0.2	4500-Cl G, APHA

Microbiological parameters:

S.N	Parameters	Observed value/s	NDWQS, 2005	Analyzed Method
1.	*E. coli* (CFU/100 mL)	Nil	Nil	9222 D, APHA
2.	Total Coliform (CFU/100 mL)	-	Nil	9222 B, APHA

Remarks: Tested parameters were found to be in accordance with National Driking Water Quality Standard Guideline, 2005.

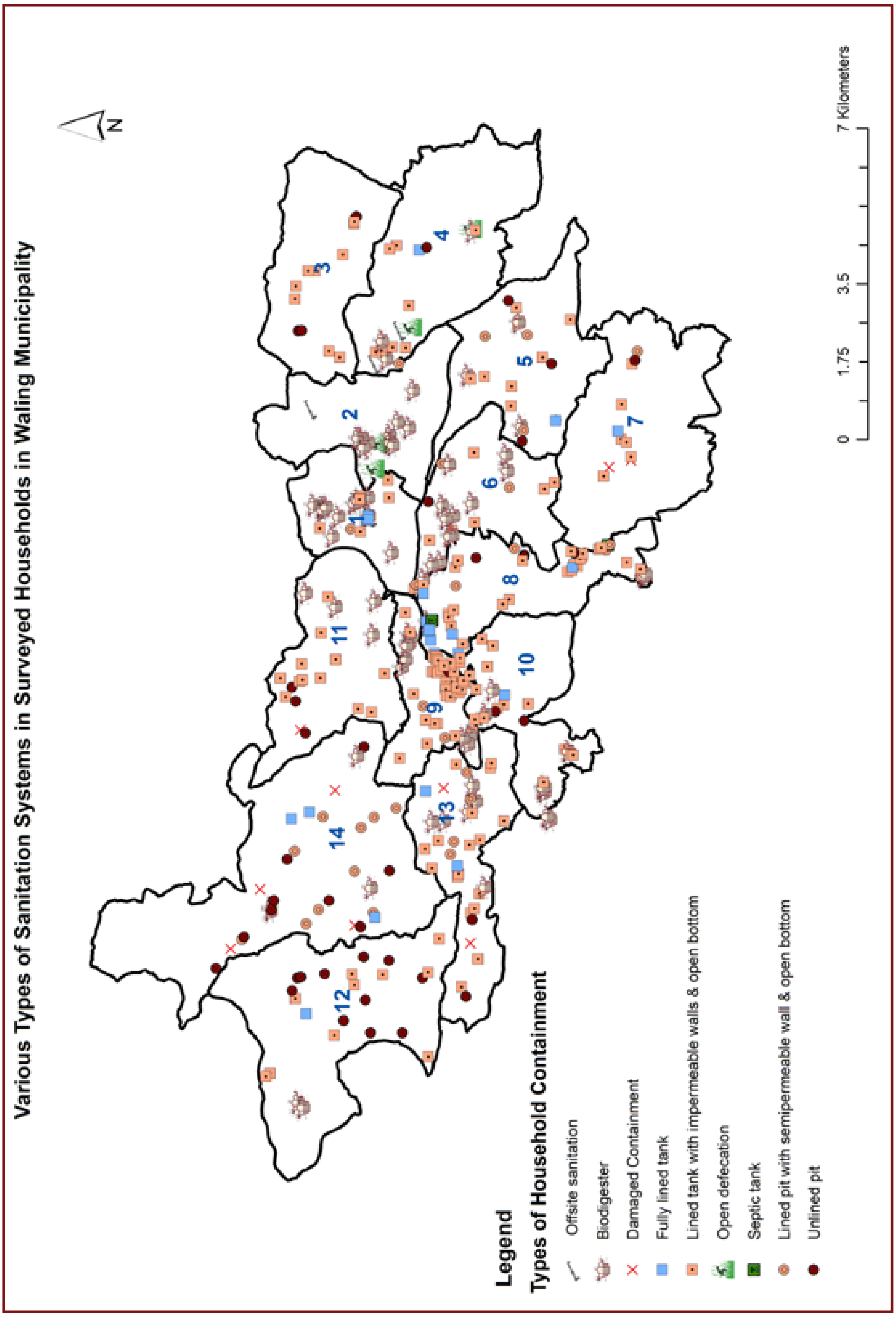
ND: Not Detected

Analyzed by

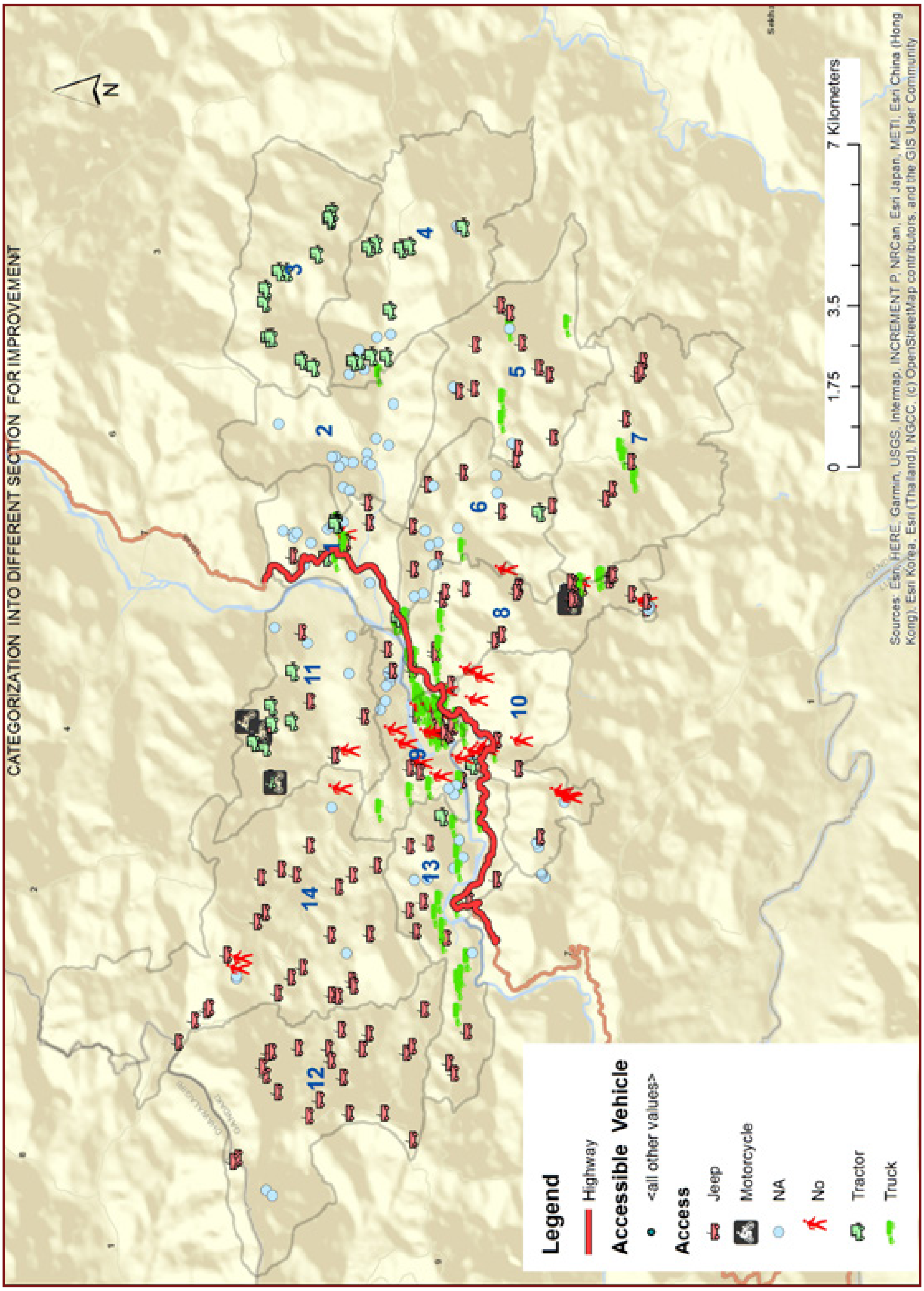
क्षेत्रीय निर्देशक

Note:

- The entire test was conducted as per the National Drinking Water Quality Standard Guideline, 2062 BS (MPPW/GoN)
- For microbiological test, the water sample in sterilized containers is only accepted.
- If the received sample water volume is inadequate, it will be rejected for analysis.
- We are not compelled to accept the water samples in leak and damage bottles for analysis.

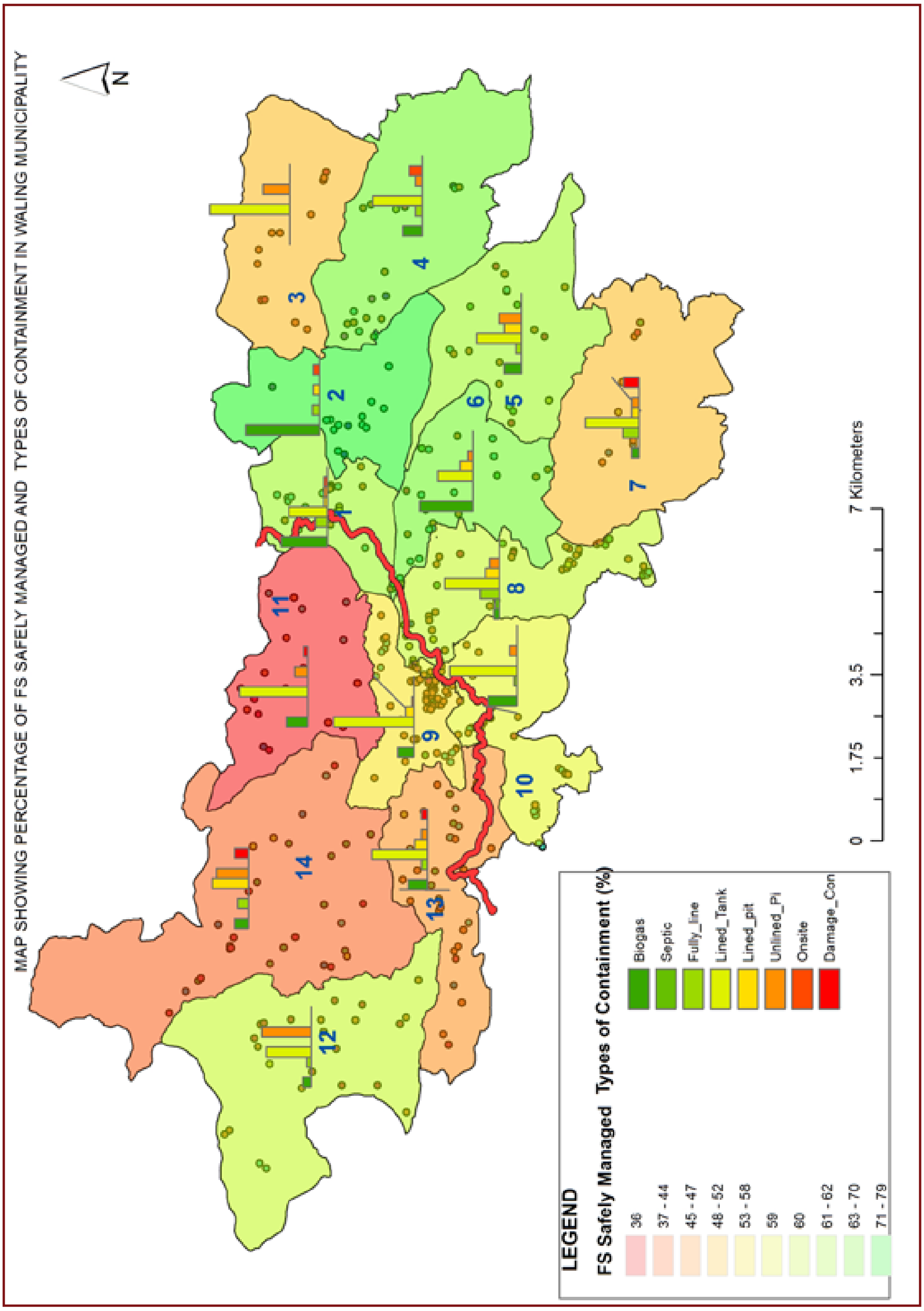


Annex 2: Various types of sanitation systems in surveyed households in Waling Municipality



Annex 3: Types of Vehicles accessible to surveyed households

Annex 4 : Percentage of FS safely managed and types of containment in Waling municipality



Annex 5: Descriptions on total households and emptying practices

Containments	Count	Percent	HHs (Population)	Count (sample)	Percent	HHs (population)	Count	Percent	HHs (population)	Count (sample)	Percent	HHs (population)
Septic tank	2	0.5%	58	0	0.0%	0	0	0.0%	0	0	0.0%	0
Fully lined tank (sealed)	23	6.1%	667	0	0.0%	0	0	0.0%	0	0	0.0%	0
Lined tank with impermeable walls and open bottom	180	47.7%	5213	6	3.3%	174	4	66.7%	116	2	33.3%	58
Twin Pits	0	0.0%	0	0	0.0%	0	0	0.0%	0	0	0.0%	0
Single Pit	34	9.0%	985	3	8.8%	87	3	100.0%	87	0	0.0%	0
Unimproved pit	43	11.4%	1246	2	4.7%	58	2	100.0%	58	0	0.0%	0

Annex 6: Calculation of FS emptied from Lined Tank with Impermeable Walls and Open Bottom

Emptying Frequency	Lined Tank with Impermeable Walls and Open Bottom											
	Manual					Average Volume	Mechanical					
	Count (sample)	Percent	HHs (population)	Volume	FS emptied per year		Count (sample)	Percent	HHS (population)	Volume	Emptying frequency factor	FS emptied per year
Three Times a year	0	0%	0	0	0	14	0	0.0%	0	0	3	0
Twice a year	0	0%	0	0	0		0	0.0%	0	0	2	0
Every Year	0	0%	0	0	0		0	0.0%	0	0	1	0
Every 2 Years	1	25%	29	406	203		0	0.0%	0	0	0.5	0
Once every 3_5 years	1	25%	29	406	101.5		0	0.0%	0	0	0.25	0
Once every 6_10 Years	2	50%	58	14	1.75		0	0.0%	0	0	0.125	0
more than 10 years	0	0%	0	0	0		2	100.0%	58	812	0.1	81.2
				Total	306.25						Total	81.2

Annex 7: Calculation of FS emptied from Single Pit

Emptying Frequency	Single Pit												
	Manual					Average Volume	Mechanical					
	Count (sample)	Percent	HHs (population)	Volume	FS emptied per year		Count (sample)	Percent	HHS (population)	Volume	Emptying frequency factor	FS emptied per year
Three Times a year	0	0%	0	0	0	1.7	0	0.0%	0	0	3	0
Twice a year	0	0%	0	0	0		0	0.0%	0	0	2	0
Every Year	0	0%	0	0	0		0	0.0%	0	0	1	0
Every 2 Years	0	0%	0	0	0		0	0.0%	0	0	0.5	0
Once every 3_5 years	2	67%	58	98.6	24.65		0	0.0%	0	0	0.25	0
Once every 6_10 Years	0	0%	0	0	0		0	0.0%	0	0	0.125	0
more than 10 years	1	33%	29	49.3	4.93		0	0.0%	0	0	0.1	0
					29.53							**0**

Annex 8: Calculation of FS emptied from Unimproved Pit

Emptying Frequency	Unimproved Pit											
	Manual					Average Volume	Mechanical					
	Count (sample)	Percent	HHs (population)	Volume	FS emptied per year		Count (sample)	Percent	HHS (population)	Volume	Emptying frequency factor	FS emptied per year
Three Times a year	0	0%	0	0	0	6	0	0.0%	0	0	3	0
Twice a year	0	0%	0	0	0		0	0.0%	0	0	2	0
Every Year	0	0%	0	0	0		0	0.0%	0	0	1	0
Every 2 Years	2	67%	39	234	117		0	0.0%	0	0	0.5	0
Once every 3_5 years	0	0%	0	0	0		0	0.0%	0	0	0.25	0
Once every 6_10 Years	0	0%	0	0	0		0	0.0%	0	0	0.125	0
more than 10 years	0	0%	0	0	0		0	0.0%	0	0	0.1	0
					117							**0**

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