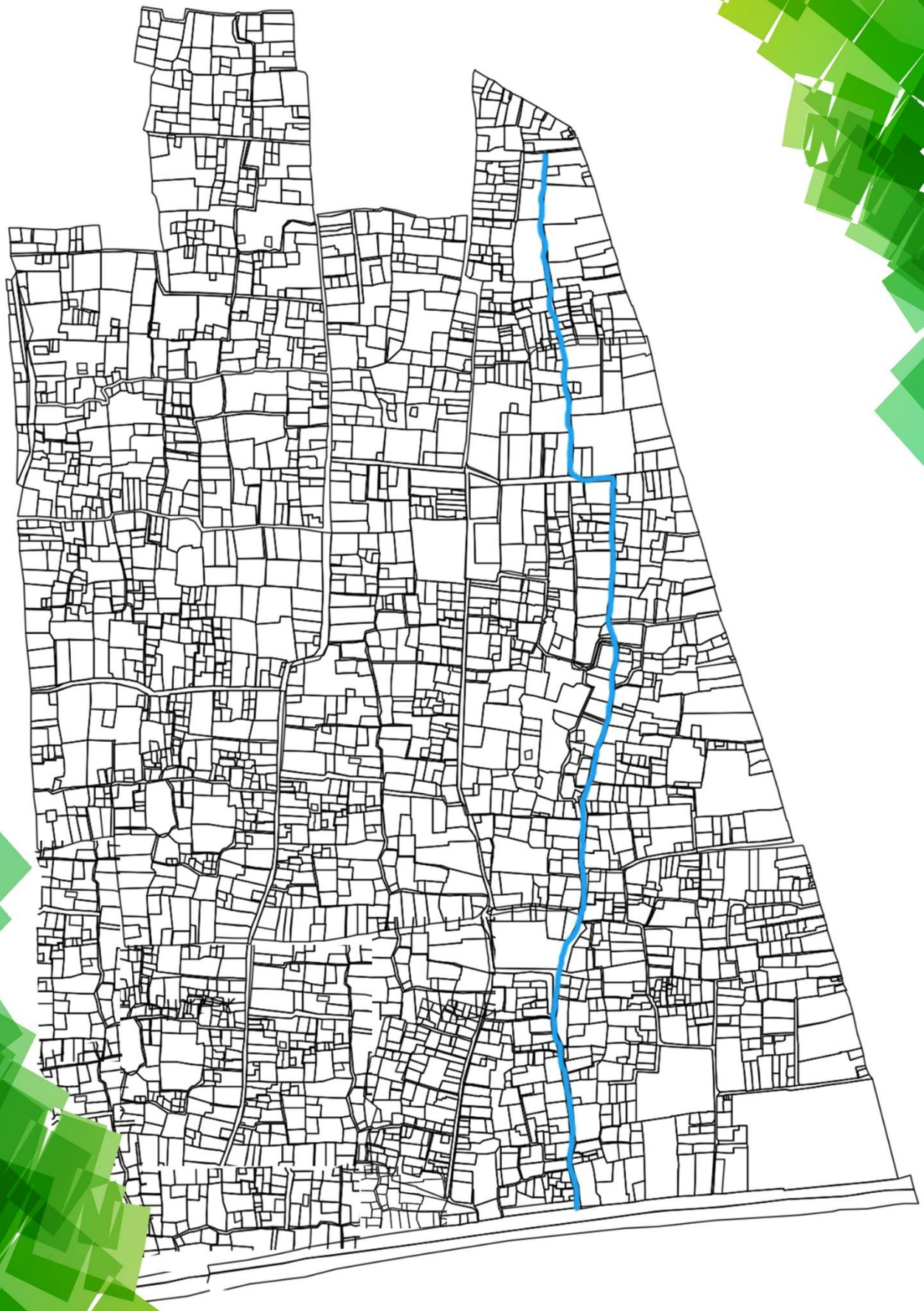

INTEGRATED SOLID & LIQUID WASTE MANAGEMENT PLAN

FOR MARTHOMA CHURCH CANAL

KILA

CALPY 2018

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Abbreviations

APL	Above Poverty Line
ASCA	Alappuzha district Septic Tank Cleaning Contractor Association
BIS	Bureau of Indian Standard
BOD	Biological Oxygen Demand
BPL	Below Poverty Line
C& D waste	Construction and demolition waste
CDD	Consortium for Dewats Dissemination
CPHEEO	Centre Public Health and Environmental Engineering organization
CTARA	Centre for Technology Alternatives for Rural areas
DEWATS	Decentralized Waste Water Treatment System
DRDO	Defence Research and Development Organization
E- waste	Electronic waste
FRP	Fiber Reinforced Plastic
FSTP	Fecal Sludge Treatment Plant
GoI	Government of India
HDPE	High Density Poly Ethylene
HH	Household
IEC	Information Education Communication
IITB	Indian Institute of Technology Bombay
IRTC	Integrated Rural Technology Centre
JICA	Japan International Corporation Agency
KILA	Kerala Institute of Local Administration
KLD	Kilo Litter per Day
KMBR	Kerala Municipal Building Rule
KWA	Kerala Water Authority

LDPE	Low Density Poly Ethylene
LLDPE	Low Linear Density Polyethylene
LSGD	Local Self Government Department
MCF	Material Collection Facility
MCs	Main Canals
MRF	Material Recovery Facility
MSW	Municipal Solid waste
NSS	National Service Scheme
OBC	Other backward Class
ODF	Open Defecation Free
ODK	Open Data Kit
OSM	Open Street map
OSS	Onsite Sanitation System
PET	Poly Ethylene Terephthalate
PP	PolyPropylene
PPP	Public Private Partnership
PS	Polystyrene
PVC	Poly Vinyl Chloride
RA	Research Associate
RL	Reduced Level
SBM-G	Swachh Bharat Mission-Gramin
SC/ST	Scheduled Castes/Scheduled Tribes
SCs	Sub Canals
SLWM	solid and liquid waste management
SPI	Society of the Plastics Industry
SS	Suspended Solids

SWM	Sold waste Management
TSS	Total Suspended Solids
ULB	Urban Local Boby
UNEP	United Nations Environment Programme
WATSAN	Water And Sanitation
WC	Water Closet

SECTION I
SOLID WASTE MANAGEMENT

Chapter 1. Solid Waste Management

1.1 PILOT AREA

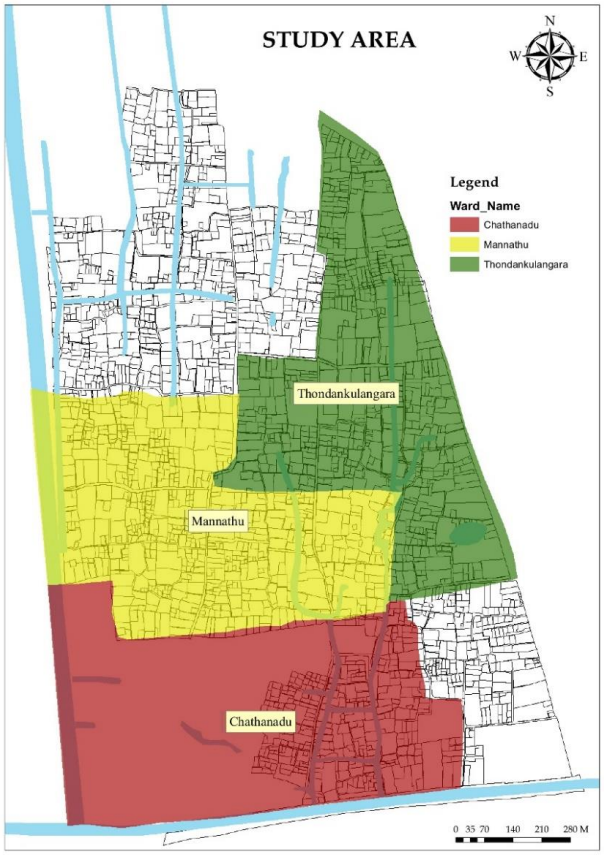

Figure 1.1 Map showing study area

Marthoma Church Canal which is having a length of about 1.51 km starting from Kaichoondi mukku junction and ending in Vadai canal at YMCA junction near Marthoma Church. Marthoma Church sub canal was chosen for pilot phase due to its homogeneous character (residential area) and it is a socially sensitive area. It passes through three wards namely, Chathanadu (ward 48), Mannathu (ward 20) and Thondankulangara (ward 22). For viability reasons, we have decided to conduct survey in the entire area of 3 wards comprising of about 3000 households.

1.2 RESEARCH METHODOLOGY

The overall research methodological approach for this study was mixed methodology. Both quantitative and qualitative approaches were used. Secondary data was collected from different sources such as articles, research papers, maps and detailed project reports (DPRs) from the Alappuzha Municipality. Primary data was collected mainly through surveys and interviews.

Two surveys were conducted as part of this study. Survey I was conducted to identify the current practices of waste management and also willingness to install new systems. It was conducted along with the liquid waste management survey. Liquid waste and solid waste questions were both included in the survey questionnaire. Survey I was conducted through the CANALPY interns along the canal stretch and it covered all the households in the 10ms along both sides of the canal. Survey II was part of a solid waste campaign, which was looking into various technological options and for knowing about the people's willingness to install new systems. Survey II was a sample survey, conducted in three wards excluding canal stretch, with the help of NSS volunteers from 3 local colleges in Alappuzha. They were divided into 3 groups, each of 20 teams. In the group, at least one member should have a smart phone. Work was divided among 10 Research Associates of KILA, 18 civil engineering interns and kudumbasree workers were also distributed equally for helping the survey process. The surveys were done in three wards, Chathanadu, Mannathu and Thondankulangara.

In addition to survey, key stakeholders such as municipal officials, sanitation workers, and service providers were interviewed. Existing services and proposals of waste management were obtained through interviews of Alappuzha Municipal officials. Data regarding the operation of community level aerobic composting unit were obtained through interviews of municipal sanitation workers. For obtaining the details about various technological options for solid waste management, an IRTC service provider was also interviewed.

Conducting the surveys:

The steps followed for conducting the surveys are given below:

a) Identified volunteers for survey and divided them into groups of two members each, preferably with one male and one female member in each group.

b) For spatial representation of the surveys and for planning the logistics the study area was divided into polygons based on the distance based of the road networks. Google My Maps was also used as a tool for representing the polygons in a public domain.

c) Prepared the questionnaire for the survey taking into consideration the socio-economic survey data of households collected during Winter & Summer Schools and after analyzing them. Open Data Kit (ODK) was used for preparing the survey forms.

d) Prepared a shelf of technology options for households and community level management of solid waste with their specification, cost, space requirements, operation and maintenance etc.

e) Prepared brochures showing the various technological options need for solid waste management etc. to be used during training of volunteers and surveys.

f) Trained the volunteers on conducting household level survey using the survey questionnaire in ODK. Also, the details of various technological options in waste management and make them aware of the good waste management practices.

g) Divided the volunteers into groups of two members each, preferably with one male and one female member in each group. 20 groups were assigned to each polygon.

h) Conducted socio economic surveys of households by the volunteers with objectives of spreading awareness on best practices and various technological options in solid waste management.

Chapter 2. Situational Analysis of Solid Waste Management in Pilot Area

2.1 Study Approach

In order to find out the present solid waste management scenario of pilot area detailed surveys were conducted. The survey was conducted in two phases i.e.,

Phase 1: Canal stretch (Conducted along with liquid waste management survey)

Phase 2: Entire three wards (Chathanadu, Mannathu, Thondankulangara).

Table 2:1 General details of Phase 1 survey

Total no of houses in the canal stretch	235
No of houses surveyed	201
APL	135
BPL	6
Total population	747
No of Adults	592
No of children	148
House ownership	Own – 166 Rented - 35

Table 2:2 General details of Phase 2 survey

Total no of houses	3000
No of houses surveyed on day 1	242
No of houses surveyed on day 2	516

2.2 GENERATION OF SOLID WASTE

2.2.1 Calculation of solid waste generated in the study area

As per a study done by National Environmental Engineering Research Institute (NEERI), per capita waste generation ranges between 0.2 kg and 0.6 kg per day in Indian cities. As per this study, cities with population between 0.1-1 million produce 0.25 Kg per capita per day, the corresponding number for cities with population between 1-5 million is 0.27-0.35 Kg per capita per day and for cities with population over 5 million is 0.5 Kg per capita per day.

The population of Alappuzha municipality is 176164 (Census, 2011) and thus we can take the per capita waste generation as 0.25 kg per day. The quantity of waste generated in the three wards is estimated in table 3.5.

Table 2:3 Calculation for Solid Waste Generation in the wards in pilot area

Sl.No.	Ward	Population	Estimated solid waste generation (Kg/day)
1	Chathanadu	3102	775.5
2	Mannathu	3496	874
3	Thondankulangara	3813	953.25

2.2.2 Generation of sanitary waste

In the pilot area, most of the households are using sanitary pads rather than cloth napkins. Only four households are using cloth napkins and about 69 households do not use any type of sanitary napkins. From the number of bed-patients we can identify the quantity of sanitary napkins generated from the household level. There are only 5 households having bed patients.

Table 2:4 Usage of sanitary napkins/diapers in pilot area

Sl. No	Sanitary napkins/Diapers	No: of households
1	Cloth napkin	4
2	Diaper	3

3	Sanitary pad	115
4	Diaper, Sanitary pad	8
5	Diaper, Sanitary pad & Cloth diaper	2
6	Nil	69

2.2.3 Generation of plastic waste

In order to characterize and quantify plastic waste generated in households, we decided to conduct a plastic waste auditing and brand auditing. A total amount of 58.6kg plastic waste was obtained from 130 households.

Table 2:5 Plastic waste analysis

Total number of samples audited	**130**
Total weight of plastic audited	**58690.5g**

By analyzing the frequency of buying parcel foods & grocery shopping, we calculated the amount of extra non-biodegradable waste produced in a household. If linked with the socio-economic data of the households generating the plastic waste, interesting insights could be obtained. This could not be done using this present study, as the socio-economic data was not collected.

Table 2:6 Frequency of buying parcel foods

Sl. No	Frequency	No: of households
1	Daily	3
2	Weekly	19
3	Twice a week	12
4	Once in two weeks	9
5	Once in a month	88
6	Not buying	70

Among the 201 households surveyed in the canal stretch, majority (44%) are buying parcel food once in a month and 49% of households are doing grocery shopping once in a week.

Table 2:7 Frequency of grocery shopping

Sl. No	Frequency	No: of households
1	Daily	37
2	Weekly	99
3	Twice a week	21
4	Once in two weeks	15
5	Once in a month	27

2.2.4 Small scale enterprises in Households

Different kind of enterprises produces different types of wastes. Also, there is a possibility to produce large amount of solid waste. 11 small-scale enterprises are there in the canal stretch. Among them majority are giving their waste to material collection facility and few of them are indulging in burning.

2.3 SEGREGATION OF SOLID WASTE

2.3.1 Segregation of waste

Based on the present study, among the 201 households surveyed in the canal stretch, about 150 households (75%) practices segregation of waste, out of these 106 households are APL and 44 households are BPL.

Table 2:8 Waste segregation

Sl. No.	Type of waste segregated	No. of households
1	Kitchen waste, plastic, paper, hazardous	48
2	Kitchen waste, plastic waste	43
3	Kitchen waste, paper, plastic	30
4	Plastic	24
5	Plastic, paper	2
6	Kitchen waste, paper	2
7	Kitchen waste	1

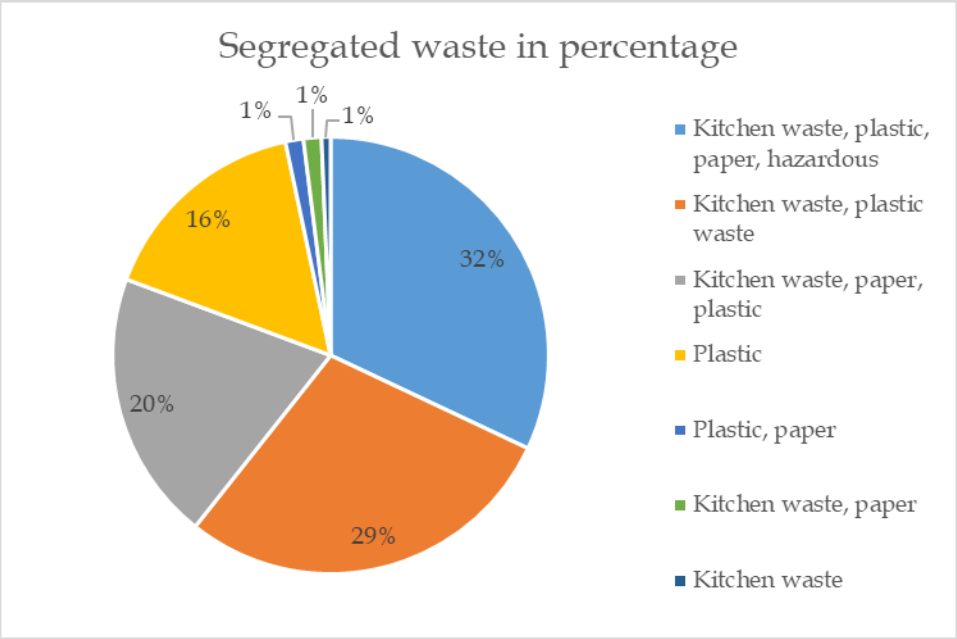

Figure 2.1 Graphical representation of waste segregation

2.4 COLLECTION OF SOLID WASTE

Alappuzha municipality promotes "Your Waste Your Responsibility" for biodegradable waste and thus there is no door to door collection for wet waste. For non-biodegradable waste, there are plastic collection drives.

2.4.1 Plastic collection

Of the total municipal waste in Alappuzha, plastic makes up 4-5 percent. All the wards in the municipality conduct plastic collection drives once in 2 to 3 months. Most of the plastic waste is collected by the representative of the Clean Kerala Company, formed under the LSGD of the Gov. of Kerala.

2.4.2 Proposed Plastic Collection Points

From the data analysis of survey conducted in three wards, it is found that majority of households, (67%) are giving their plastic waste to Material Collection Facility. To collect the plastic waste from the households, 21 plastic collection points were identified for the three wards.

The identified points are mainly adjacent to the sub-arterial and local roads. Even before finalizing the collection points we assure the coverage meet up to the need. From the reconnaissance survey and personal interview, the collection point threshold is not work beyond 200m distance. So in this project the identified points are confined at distance of 150m threshold for the convenient access for the beneficiaries.

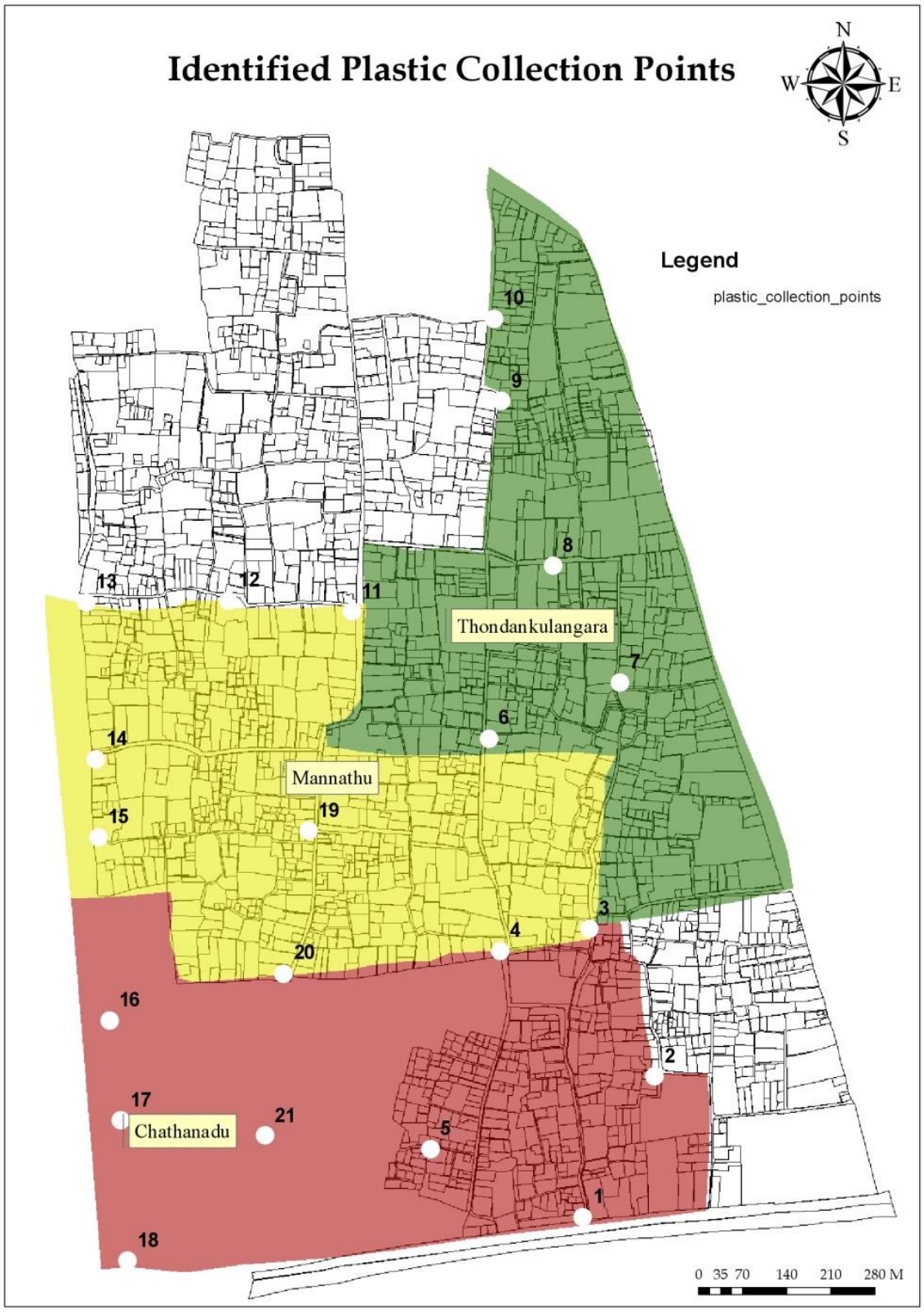

Figure 2.2 Plastic collection points

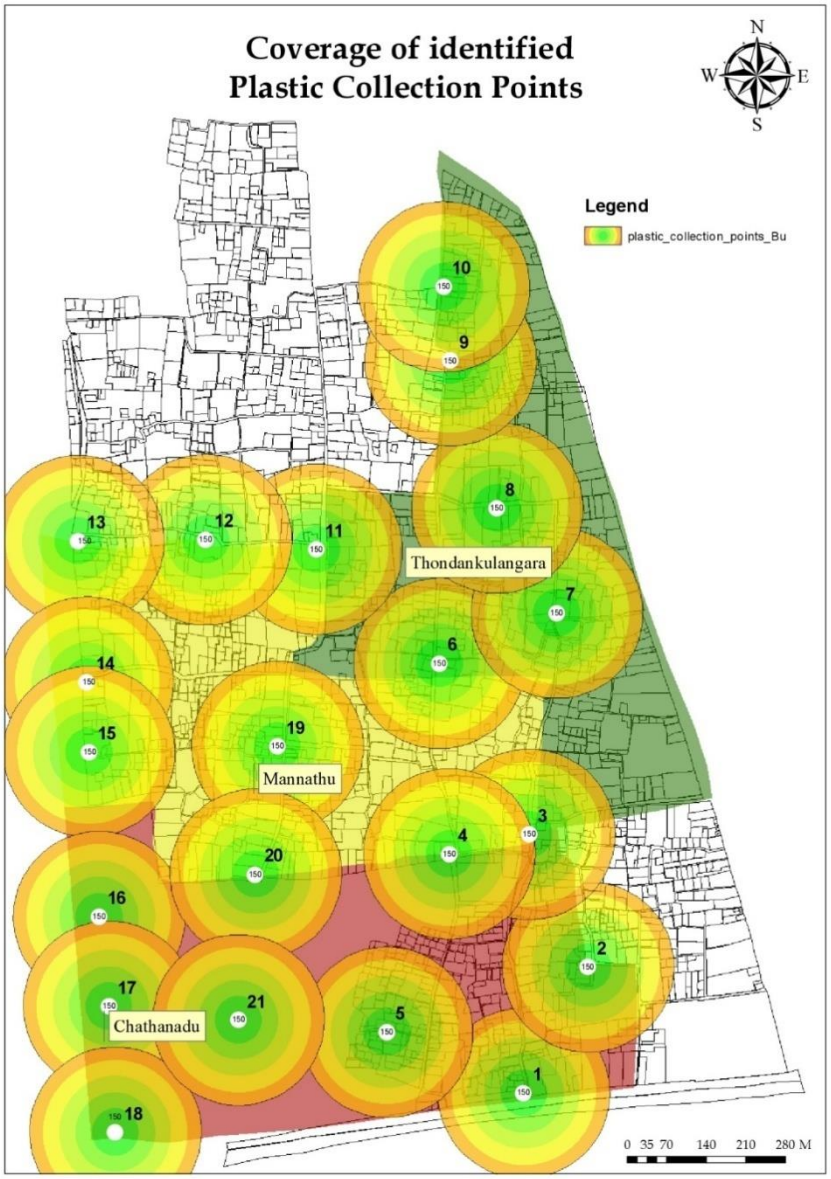

Figure 2.3 Coverage of identified plastic collection points

2.4.3 Swap shop

The concept Swap Shop, based on the principle of Reuse in waste management, aims at providing a public system for exchanging reusable goods that could be useful to others. In Alappuzha municipal area, there is a swap shop operating in municipal bus stand. Among the total households, 38 households were aware of the swap shop and the remaining 163 households do not know about the system. The interns gave an idea about

the swap shop to the people whom they surveyed. 179 households (89%) are interested in using swap shop and the remaining 22 households are not interested.

2.5 DISPOSAL/ TREATMENT

2.5.1 Existing Biodegradable Waste Management Practices in Canal Stretch

Among the 201 households, 24 households (12%) have on-site waste management systems. 117 households (58%) are dumping their waste into land and about 34 households (17%) are dumping their waste into canals. 12 households (6%) dispose their waste into the community level Aerobic composting unit. 14 households (7%) dispose their waste by other means like burning, depositing to nearby drains etc.

Majority of onsite waste management systems are installed in APL households. Among the 9 Biogas plants installed, 6 plants are in good working condition and the remaining 3 plants are not working due to faulty system. Among the 6-pipe compost installed, 3 of them are working. The issues reported by the people regarding these systems are bad smell and fly nuisance.

Table 2:9 Existing on-site waste management practices in canal stretch

Sl. No.	Existing on-site waste management system	No. of households	
		APL	BPL
1	Biogas plant	8	1
2	Pipe compost	4	2
3	Kitchen bin	7	1
4	Ring compost	1	0

2.5.2 . Existing Biodegradable Waste Management Practices in Three Wards

The data regarding existing biodegradable waste management practices was collected from the three wards. A sample of 242 households was surveyed.

Among the 242 households, 38 households (16%) have on-site waste management systems. 146 households (60%) are dumping their waste into land and about 10 households (4%) are dumping their waste into canals. 21 households (9%) dispose their waste into the community level Aerobic composting unit. 27 households (11%) dispose their waste by other means like burning, depositing to nearby drains etc. Out of the total households disposing their waste into the community level aerobic composting unit, 33% are BPL families and 67% are APL families. Out of the total households dumping their waste into land, 39% are BPL families and 61% are APL families. Out of the total households dumping their waste into canals, 70% are BPL families and 30% are APL families.

Table 2:10 Existing on-site waste management system in three wards

Sl. No.	Existing on-site waste management system	No. of households	
		APL	BPL
1	Biogas plant	10	1
2	Pipe compost	8	2
3	Kitchen bin	11	3
4	Ring compost	2	0
5	Bio bin	1	0

Among the 11 Biogas plants installed, 5 plants are in good working condition, 5 plants are in average working condition and 1 plant is not working due to faulty system. All the 6-pipe compost installed are in working condition.

2.5.3 Findings

From the analysis, got an idea about the existing solid waste management practices in the area and those includes biogas, kitchen bin, pipe compost, ring compost and bio bin. Regarding the existing solid waste management practices, a total of 443 households has been covered and among that 62 households have on-site waste management systems. The chart shows the percentage of households having on-site solid waste management systems. The list of households having on-site waste management system is given in Annexure II.

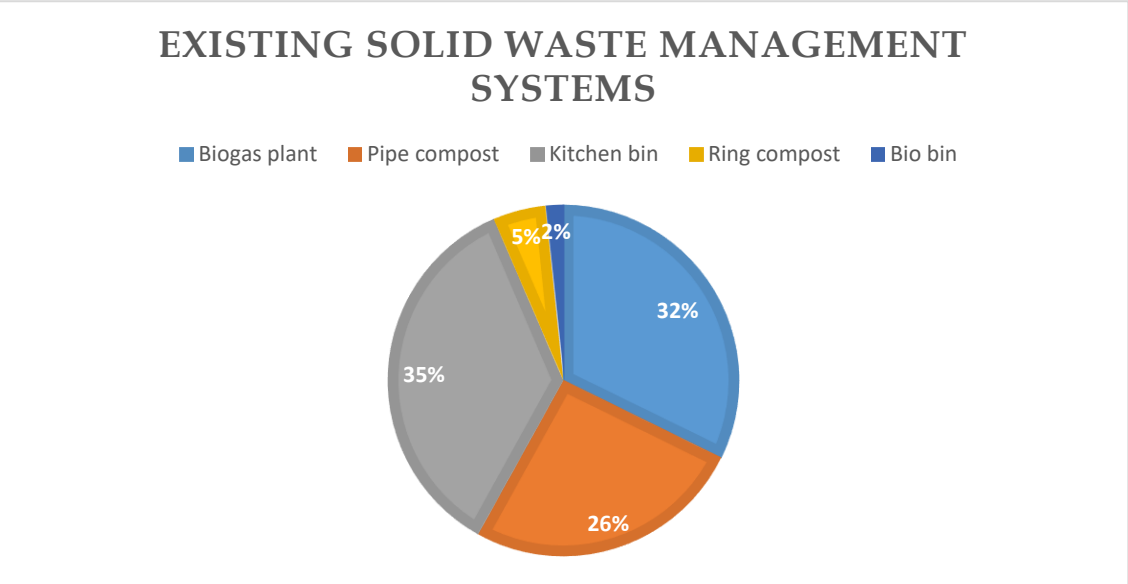

Figure 2.4 Graphical representation of existing solid waste management systems

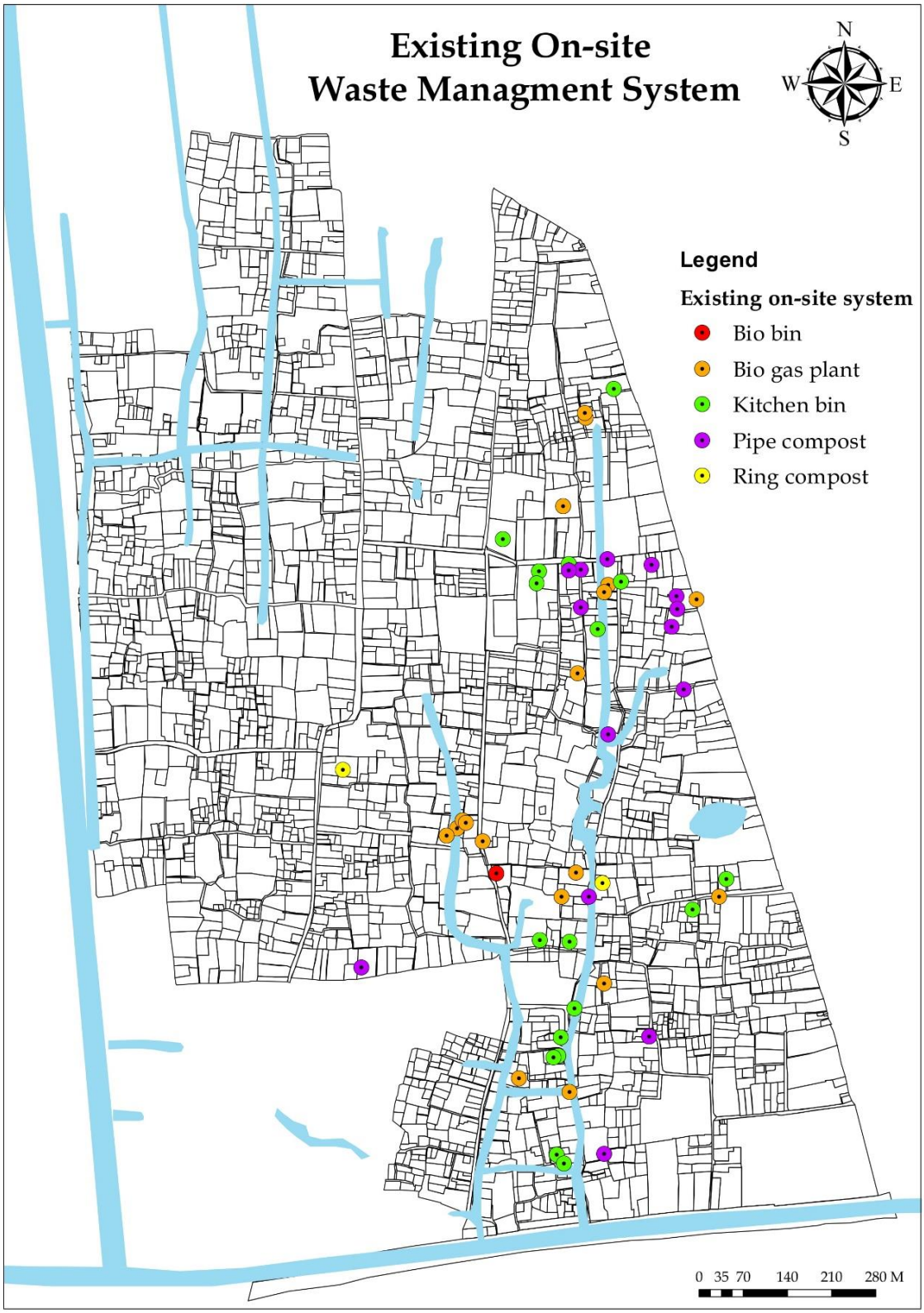

Figure 2.5 Map showing existing on-site waste management systems

2.5.4 Location of Community Level Aerobic Composting Unit

Accessibility of community level system is an important factor in deciding the location. Following table shows the preferred distance to locate the community level Aerobic composting unit.

Table 2:11 Preferred distance

Sl. No.	Preferred distance	No. of households
1	0-500m	87
2	Above 500m	43

21 households suggested to locate Aerobic composting unit in Municipal Graveyard and 14 households suggested YMCA.

2.5.5 Dry Leaves Management

Majority of the households (89%) are burning dry leaves in their premises. 64% of the total households (201) are willing to give the dry leaves to Aerobic composting unit. It is estimated that about 125kg of dry leaves from households are reaching Aerobic composting units on a weekly basis.

2.5.6 Plastic Waste Management

Majority of households, ie., 136 households (67%) are giving their plastic waste to Material collection facility. 54 households are burning, 3 are dumping into the canals and 4 households are littering their plastic waste. Out of the total households giving their plastic to MCF, 72% are APL families and 28% are BPL families. Out of the total households burning their waste, 57% are APL families and 43% are BPL families.

Table 2:12 Plastic waste disposal practices

Sl: No	Disposal practices	No of Households	
		APL	BPL
1	Giving to Plastic collection facility	98	38
2	Burning	31	23
3	Littering	1	3
4	Dumping into canals	2	1

2.5.7 E- Waste Management

From this data, we will get an idea of how Electronic wastes are managed. Majority of the households (61%) are giving their E-waste to scrap dealers.

Table 2:13 E-waste management

Sl. No	E-waste management	No: of Households	
		APL	BPL
1	Scrap dealer	122	59
2	Dumping in land	4	5
3	Dumping into canal	3	1
4	Others	6	1

2.5.8 Management of Sanitary Pads/Diapers

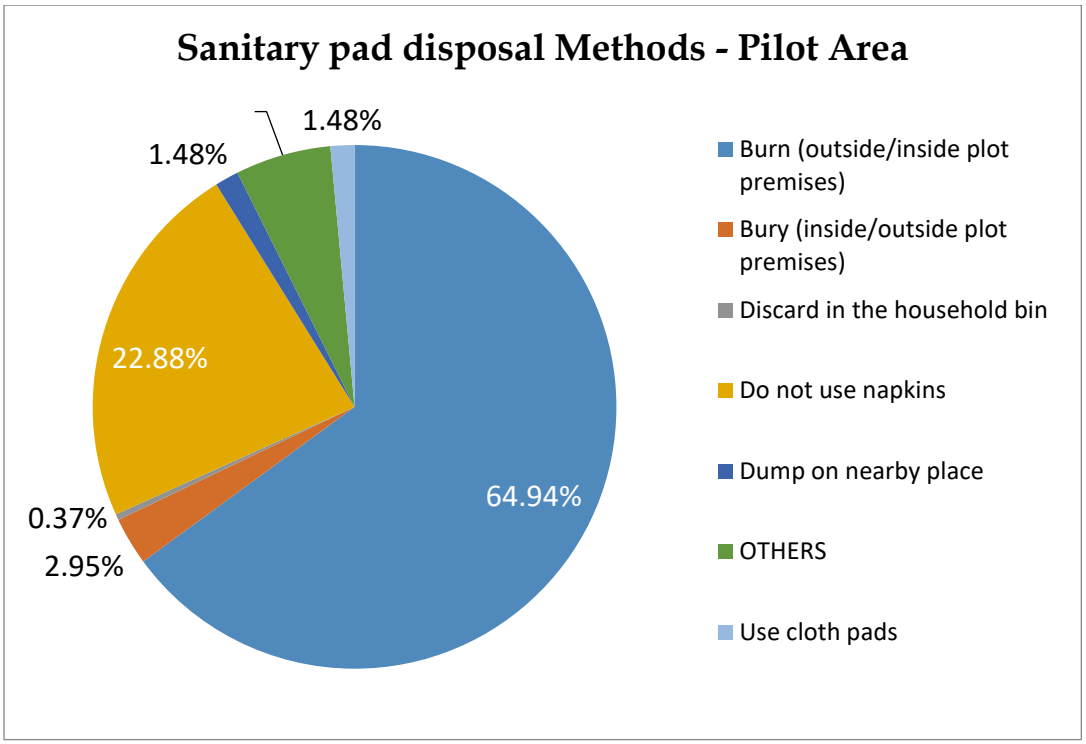

Figure 2.6 Sanitary napkin disposal methods in Pilot area

From the survey done in the canal stretch, it is found that majority (59%) of the households are burning the sanitary napkins, while others are either burying, dumping in the households or discarding them in the bins

Table 2:14 Management of sanitary napkins

Sl. No	Disposal methods	No: of households
1	Burning	118
2	Burying	6
3	Discard on household bins	7
4	Do not use napkins	46
5	Dumping on nearby place	4
6	Others	20

We also collected data about willingness to transport it to the incinerator to be installed at community level. 152 households (76%) are willing to use the incinerator, if installed.

Paper carry bags can be provided to dispose sanitary napkins and the same can be taken to the incinerator while disposing wet waste in aerobic bins.

2.5.9 Proposal for New Solid Waste Management Systems in Individual and Community Level

The data regarding willingness to install new on-site waste management system and also to use community level Aerobic composting unit was collected. Among the total households (201) covered in canal stretch, about 131 households (65%) are interested in installing new on-site waste management systems like Biogas, Bio bin etc. Out of this, 84 households are APL and 47 households are BPL. 181 households are interested to use community level Aerobic composting units, out of this 119 households are APL and 62 are BPL.

And for the entire three wards, 758 households were surveyed. Among that 388 households (51%) are willing to install and use new waste management practices.

Table 2:15 Technological options

Sl. No.	Technological options	No. of households	
		BPL	APL
1	Biogas plant	30	39
2	Bio bin	47	103
3	Aerobic composting unit	70	100

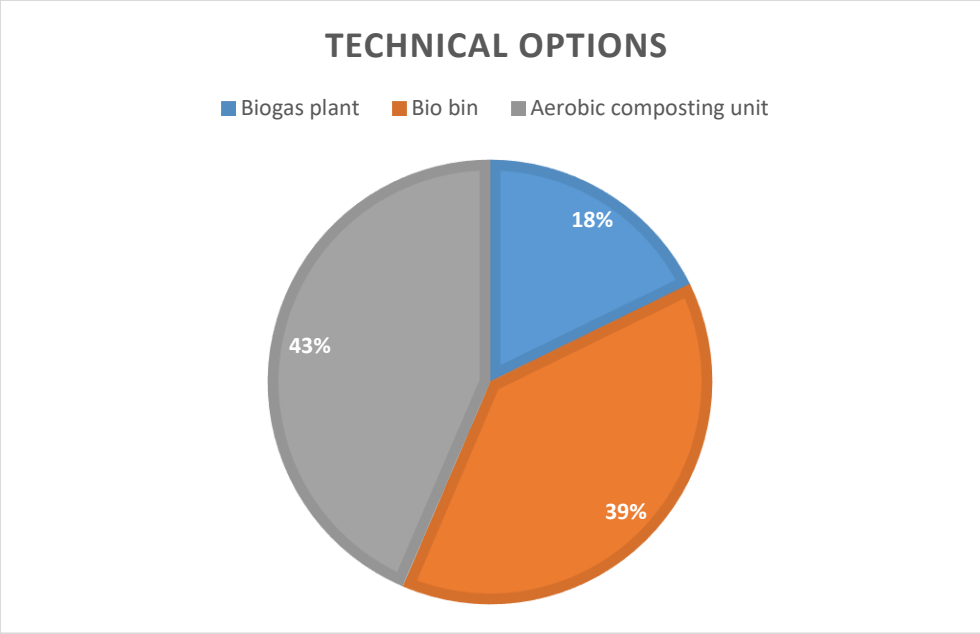

Figure 2.7 Graphical representation of willingness to install new system

2.5.10 Proposed Projects by the Municipality for Solid Waste Management

Alappuzha Municipality has proposed some projects to deal organic and inorganic waste. The different methods and its estimate is given in the table below.

Table 2:16 Proposed projects by municipality

Sl No	Description	Methods	Nos	Capacity	Unit Cost	Total Cost
1	**Household level SWM Plants**	Bio bins	1000	2kg/Day	1800	Rs. 1800000
INSTITUTIONAL LEVEL						
2	**Community Level SWM plants**	**Methods**	**No Of Bins**	**No Of Locations**	**Capacity**	**Total Cost**
		Aerobic Compost Units	125	25	2Tonne/Bin	Rs. 15000000
3	**Non-Biodegradable Waste Management**	**Methods**	**Area**	**No Of Locations**		**Total Cost**
		Material Collection Facility **(MCF)** (Various Wards In Municipality)	6250 sqft	25		Rs. 8313600

Technological options for managing solid waste can be provided to the beneficiaries after sorting the willingness list and proposed projects by the municipality.

2.5.11 Proposed Location for Aerobic Units in Pilot Area

Based on the land availability in the canal shed, we have identified three locations for installing community level aerobic units in our study area viz., Municipal Graveyard, Municipal Colony and Mannathu ward. Ideally all these three locations should have Aerobic units and the effect of installing all these bins are represented in a GIS map which

is shown below. In the maps below, the dots indicate the households sampled. The whiter the dots, the closer is an aerobic unit to that household. Similarly, as the distance from an aerobic unit increases, the dots become darker. From the previous surveys it was identified that distance from the aerobic units was the chief reason why the people are not using them for disposal of their household waste.

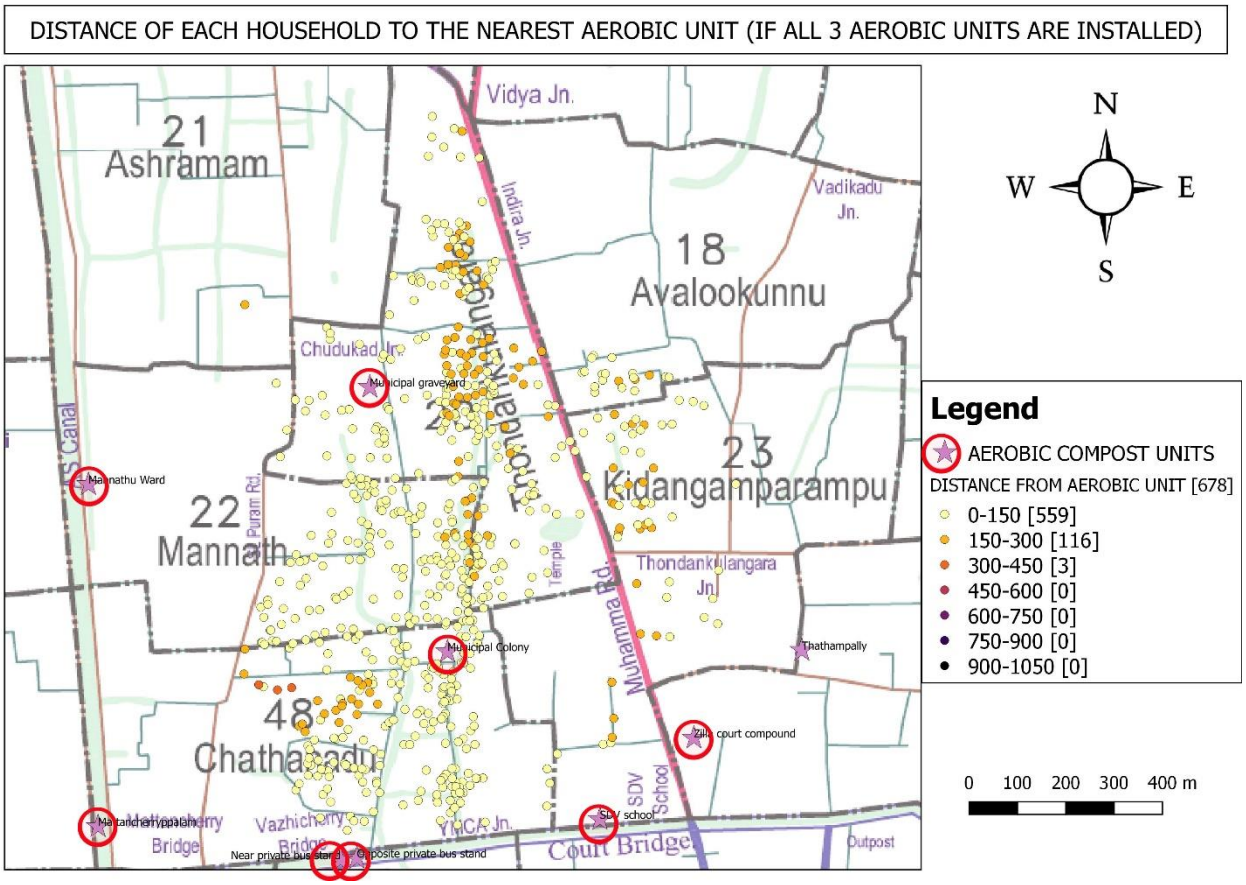

Figure 2.8 Map showing coverage of new bins

With the help of GIS, we can identify the ideal location for installing Aerobic unit from the selected three locations. Out of the three locations identified, which aerobic unit will be of maximum use for the households in the sample area is to be found out. The effect of installing these aerobic bins separately in the study area is shown in the following maps. This process could be followed to identify the most desirable location for setting up an aerobic unit.

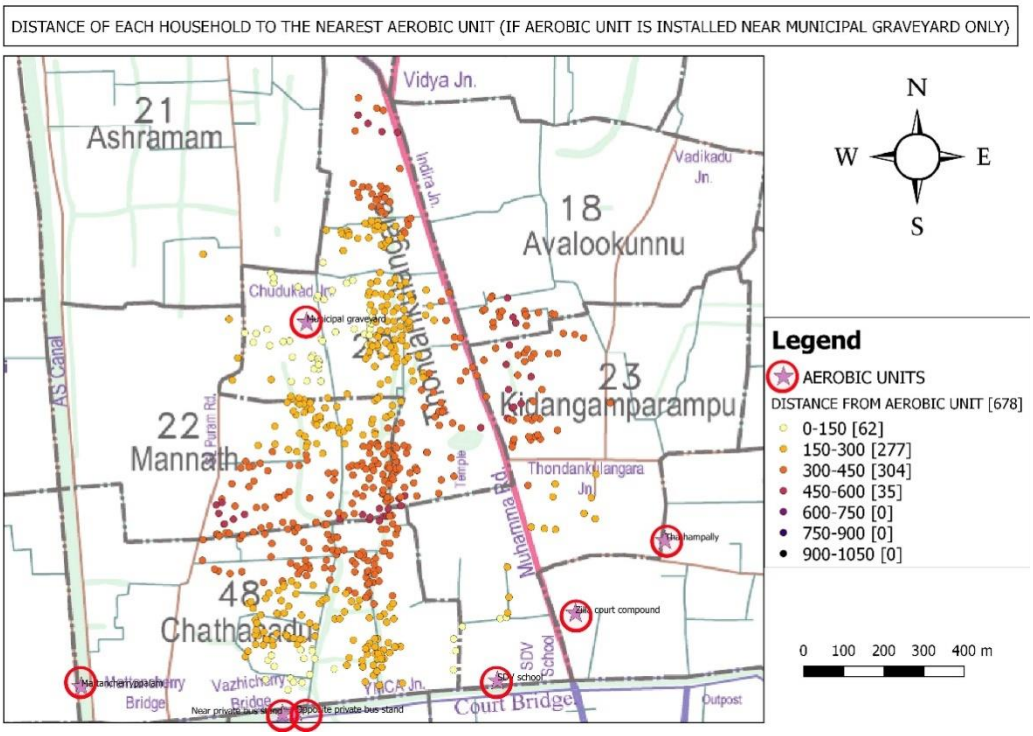

Figure 2.9 Map showing coverage of bin in Municipal Graveyard

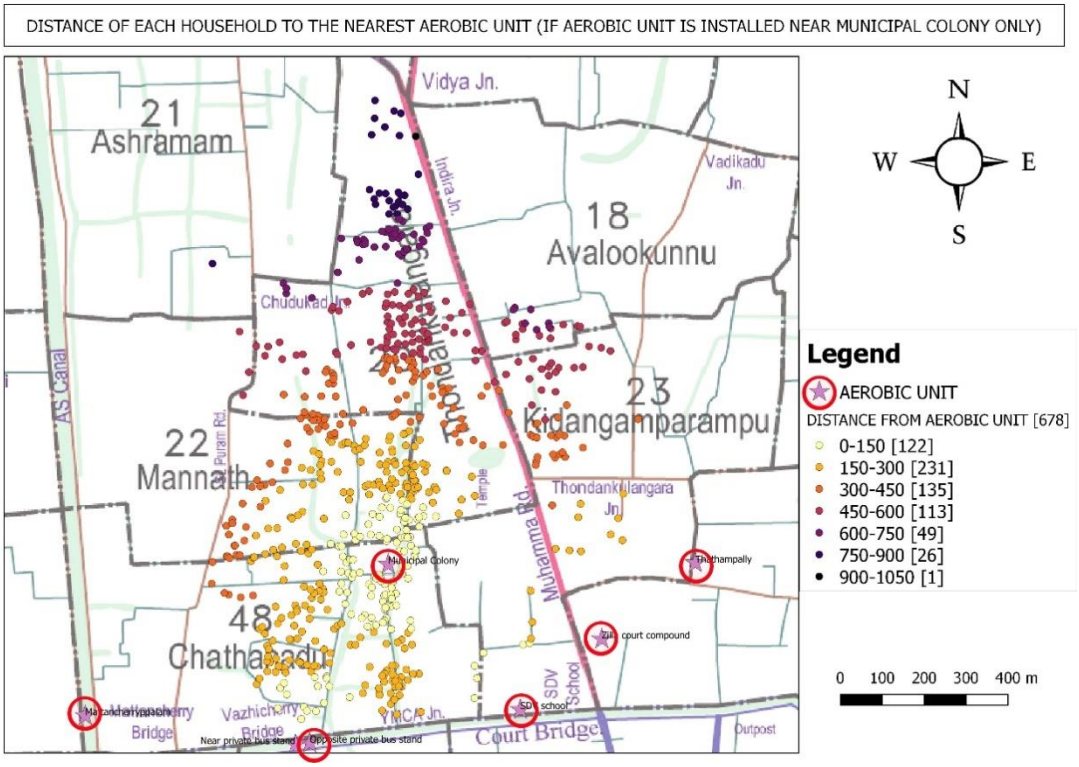

Figure 2.10 Map showing coverage of bin in Municipal Colony

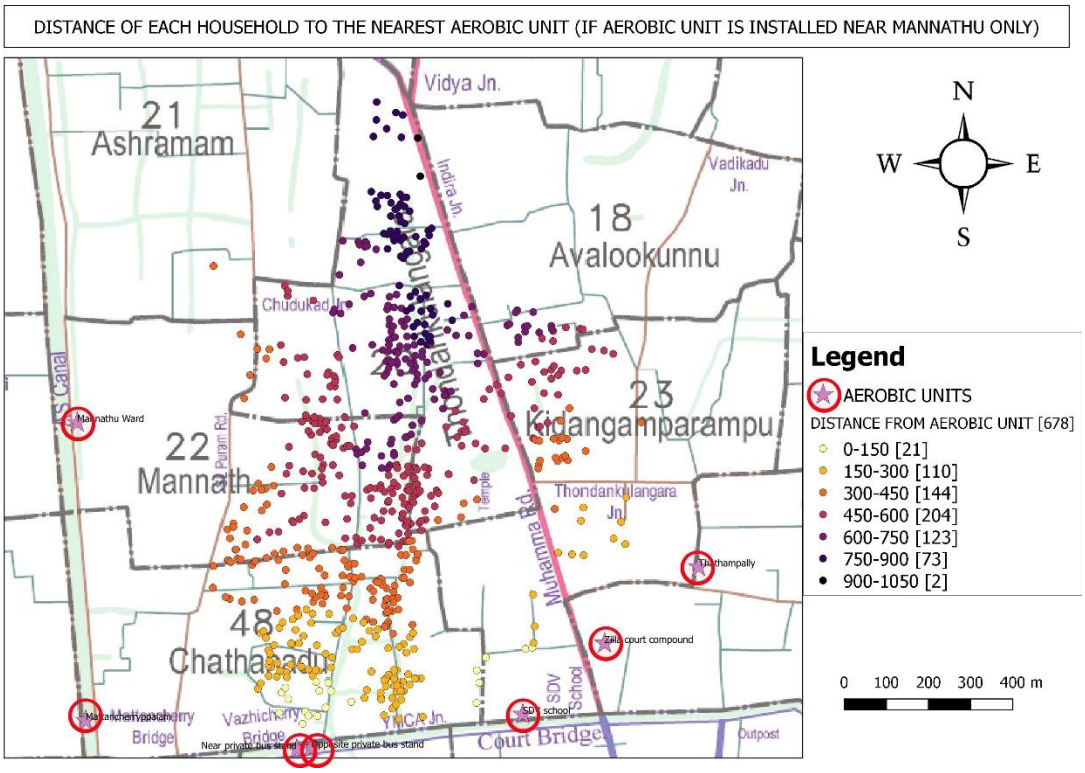

Figure 2.11 Map showing coverage of bin in Mannathu

Among the three new locations identified, two locations i.e., Municipal Graveyard and Municipal Colony are in the canal shed area. From the maps, it is found that Municipal Graveyard is more ideal for installing Aerobic composting unit since this location is more accessible to all the households in our sample.

Chapter 3. Action Plan

An action plan is a document that lists what steps must be taken in order to achieve a specific goal. The purpose of an action plan is to clarify what resources are required to reach the goal, formulate a timeline for when specific tasks need to be completed and determine what resources are required. Before begin an action planning process, the strategic framework for the work of project should be in place.

Action plan is based on time frame. Three type of action plan are adopted and they are:

Short term actions: The action which needs to be done immediately can be listed as short term actions. Ideally these are the actions which are targeted to be completed within 3 months.

Medium term actions: Typically, actions which require fair amount of pre planning or the ones for which funding options and legal provision are required are listed in medium term actions. They have to be targeted to be completed within 6 months.

Long term actions: Actions which require short-term and medium-term actions to be completed before initiating implementations can be listed here. They have to be targeted to be completed within 1 year.

Action plan of each sector is tabulated in the following table.

Table 3:1 Action Plan for Solid waste management

Action	Responsible Authority	Time Frame		
		Short term	Medium term	Long term
ORGANIC WASTE				

Finalize the beneficiary list for installing new onsite waste management systems, based on the estimate prepared by the municipality and socio-economic status	CANALPY Team	✓		
Install new on-site systems to beneficiaries	ULB		✓	
Conduct survey through Harithakarmasena to analyse the condition of the existing waste management systems installed in households	CANALPY Team	✓		
Repair the non-functional on-site waste management systems	IRTC		✓	
Finalize the locations for installing new community level aerobic bins	ULB	✓		
Install new community level aerobic bins at finalized locations	ULB		✓	
Investigate the possibility of pre-composting at homes before it is given to community level composting units thereby improving its efficincy	CANALPY Team		✓	
Provide training in implementation and monitoring of the systems to be installed to the members of Canalkara committee	CANALPY Team		✓	

Assign responsibility for the follow-up support in maintenance of new as well as existing systems	ULB		✓	
INORGANIC WASTE				
Conduct a detailed study on the capacity of Plastic shredding units installed in the municipal area	CANALPY Team	✓		
Conduct a detailed study on the SWAP shop operating in the municipal area.	CANALPY Team	✓		
Organize IEC campaign among the people of pilot area on plastic collection system	CANALPY Team	✓		
Fix the user fee for collecting plastic waste	ULB	✓		
Assign responsibility of conveyance of collected plastic waste from the collection points to the municipality	ULB	✓		
Commission new plastic shredding units as per need	ULB		✓	
Investigate the possibility of extended producer responsibility of plastic waste.	CANALPY Team		✓	
Explore the technological options and methedology for managing E-waste, Biomedical waste & Hazardous waste	ULB			✓

Organize IEC campaign among the people of pilot area on managing E-waste, Biomedical waste & Hazardous waste	ULB			✓

SECTION I
SOLID WASTE MANAGEMENT

Chapter 4. Liquid Waste Management

4.1 INTRODUCTION

Domestic liquid waste is considered to have two components, viz; waste originating from kitchen and bathroom together called as grey water and waste originating from toilets called as black water. In cities of the developed world, both these streams of wastewater are collected together through sewers and treated at a centralized sewage treatment plant (STP). Critiques also call it 'end of the pipe' solution. However, such centralized systems are expensive to build, which is more pronounced in small cities and towns due to economies of scale. In India, the city governments have to rely on grants from the State and Union government to finance such expensive infrastructure. Only two cities in Kerala, viz; Thiruvanthpuram and Kochi have established sewer systems and yet they serve only part of the respective city.

Smaller towns like Alappuzha rely mostly on on-site systems (OSS) like septic tanks and pits. Besides being less capital intensive, they separate black and greywater at source. This is a big advantage since managing and treating them separately is much simpler than treating the mix. Various standards like BIS, CPHEEO also suggest that they be managed separately (BIS, 1995; CPHEEO & JICA, 2012).

In either case, the sanitation service chain includes user interface, collection, conveyance, treatment and disposal/reuse and can be represented as shown in Figure 4.1. The National Urban Sanitation Policy (NUSP) requires city governments to manage the entire chain for the entire city.

Figure 4.1 The sanitation service chain

To have a proper liquid waste management system in place, it is invariably important to understand the chain starting off with the individual user or household. Analysis of the current practices and infrastructure will aid in developing a contextual understanding of current liquid waste management practices. This situational analysis helped in developing a comprehensive liquid waste management plan for Alappuzha. The current section attempts to highlight the various activities that were carried out in connection with liquid waste management in past one year. These activities have eventually culminated into an action plan discussed at the end of this report

Chapter 5. Methodology

In order to propose a suitable liquid waste management plan for the pilot area, it is essential to understand

a) The physical characteristics of the Marthoma Church sub canal,
b) the socio-economic characteristics and liquid waste management practices of the households, and
c) To check the feasibility of various technological options for treatment of liquid waste and fecal sludge in the current context.

The strategy employed for attaining the aforementioned objectives is detailed in the flow chart below (Figure 5.1)

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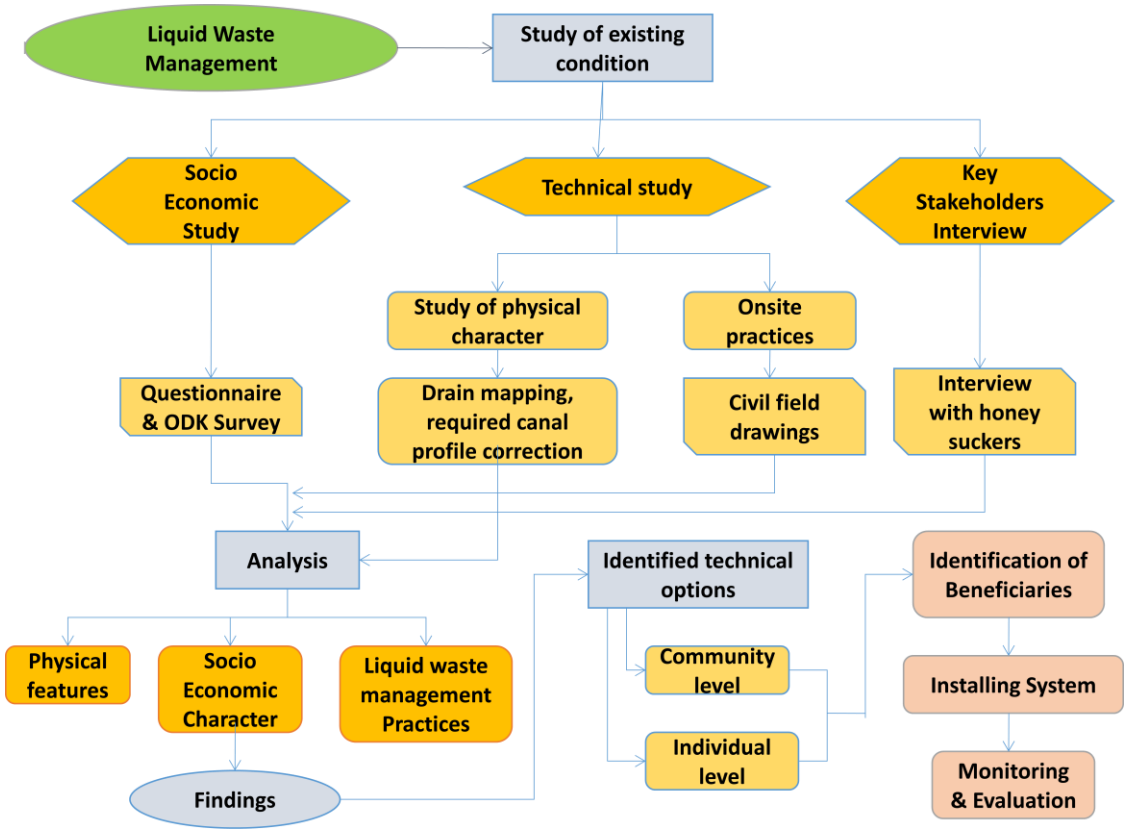


Figure 5.1 methodology flow chart of liquid waste management

5.1 SOCIO ECONOMIC STUDY

The main objective of this study was to identify the liquid waste management practices and socio-economic characteristics of households who are involved directly or indirectly in polluting the Marthoma Church sub canal due to their unscientific liquid waste management practices. This was done in two phases – in May 2018 during the IITB- KILA Summer School 2018 and in November 2018. Findings from the report of IITB- KILA Summer School 2018 indicate that the majority of the waste water discharges into the canal is from the adjacent houses near the canal. Hence it was decided that consequent studies can focus on two rows of houses on both the sides of the canals. The unit of analysis was at household level.

5.1.1 Methodology

Household survey along with key informant interview was the main method used to understand the various dimensions of the problems identified in the objective. To map the household practices in liquid waste management, a structured questionnaire was used complimented with semi-structured interviews to get specific details. A questionnaire was developed on 'ODK build' and data was collected using a mobile app called 'ODK collect'.

Design of the Questionnaire- The questionnaire evolved after a series of pilot and actual surveys over the last year. The following table shows the different elements of the questionnaire and the relevant information which each element provides.

Table 5.1 Elements of the Questionnaire Survey.

Parameter	Utility of the parameter in this study	Relevance in the Action plan
Family composition	To calculate per-capita water consumption To calculate quantity of waste water generated	Helps to design the size of system to be implement
Source of water	To determine the method of quantification of water consumption To know the probability of pollution	Aids in design of the system

Current liquid waste disposal practices	Existing situation analysis	To suggest suitable technological options
Age of septic tank	For correlating with cleaning frequency of septic tank to understand the operational efficiency of septic tank	To assess need for replacement of the system
Bottom sealed or not	To know whether there is seepage	
Material used for construction		
Shape of septic tank	To check whether it is a septic tank or leach pit	
No. of chambers in septic tank		
Presence of vent pipe	To know whether the design is as per BIS	
Outfall condition		
Frequency of cleaning	To know whether optimal anaerobic biodegradation process is taking place in the septic plant To estimate faecal sludge generated in a household	
Agency employed to clean the septic tank	To know whether the agency is empaneled with the municipality To know the collection, transportation and disposal mechanism	Helps in the proposal of FSTP and design of plant
Frequency of using toilet cleaners	To know the efficacy of anaerobic biodegradation process in the septic tank	Can be included in the Canal Shed Committee campaign
Width of approach road	To check accessibility for installation of new system	Helps in transportation of materials
Land occupied by existing system	To design size appropriate system for retro-fitting and quantification of demolition waste	Aids in design of new system and estimation of quantity of demolition waste
Land available for new system.	To design size appropriate system and to install temporary toilets.	Helps in design of system
Willingness to install a new system	To estimate the total number of systems to be retro-fitted or replaced	To finalize the beneficiary list

The questions asked in the survey are attached in Liquid Waste Management Questionnaire.

Data Collection through Household Survey: Data Collection was conducted by CANALPY interns over the course of 8 days starting from the 27th October 2018. The interns were given training on the data collection tool (ODK collect) with a detailed explanation of the questionnaire including the way to approach the households by the KILA Research Associates team. The purpose of survey, the larger objectives of the Canal rejuvenation project and evolution of CANALPY was explained at the beginning by the CANALPY team. The interns were divided into 9 two-member teams. Each team was assigned a certain stretch of the canal and was asked to approach the two rows of households situated along the canals. The finalized forms containing household data were then sent by students from their mobile app (ODK collect) to a host google drive. The data thus collected was later collated and analyzed on excel and QGIS/ArcGIS to identify the trend of liquid waste management practices and overall socio- economic background of the inhabitants. This data was later used in technology selection and prioritization in technology implementation

5.2 TECHNICAL STUDY

To understand the characteristics of the canal and check the feasibility of installation of appropriate technological options to manage liquid waste, it is imperative to conduct an in-depth technical study. The study undertaken over the course of 10 months starting off in December 2017 focused on tracking and mapping the Marthoma Church sub canal, understanding it's physical features, noting the status of onsite systems in the households and ascertaining the feasibility of installation of proposed technical options if needed.

5.2.1 Study of Physical Characteristics of the Canal

1. **Delineation of canal shed -**

Preparation of Base Map: The first step was creation of a base map of the canal system in Alappuzha. The map collected from the Municipality did not have the complete network of sub canals. Hence an exercise was undertaken during IITB – KILA Winter

School 2017 to map all the drains and sub – canals of Alappuzha. Drain maps were prepared for 14 main inlets (sub canals/drains) to the Vadai and Commercial canals. An open source application called OSM (Open Street Map) Tracker was used to map the drains. Encroachments and eutrophicated stretches with the canal sheds and pollution hotspots were marked on GIS platform, methodology for this activities are detailed out in Winter School Report 2017.

Drain maps to canal sheds: The drain maps transferred into GIS platform. The order of the drains was also marked while tracking which were depicted using different colours. The approach roads/ways were also tracked for future needs. Using elevation tool, the canal-sheds along the drains were delineated. The different canal-sheds were demarcated using the Elevation plugin in QGIS software. The boundaries of each of the canal sheds were drawn connecting the highest points around each canal.

2. **Mapping Physical Features of the Canals -**

Length, width, encroachments: Apart from mapping the canals the exercise also measured the physical features of the canals including their length, variation in width along the canals and marked encroached areas. The details regarding the same have been recorded in the Summer School report.

Estimating Variation of Reduced Level (RL) Of Canal Centre Bottom with Length: Encroachments as well as accumulation of solid waste dumped in intermittent intervals in the canal have led to reduced level of the canal bottom. The sub canals vary abruptly in their width along their topographical layout and it has been observed that much of this variation, more precisely reduction in width is due to encroachment in the canals. This has considerably affected flow of water in the canals and results in flooding during the monsoon and silting during non-monsoon seasons. Data pertaining to the variation of canal width and RL (Reduced Level) of centre of canal bottom along with length was collected during IITB -KILA Summer School 2018. The methodology for the same can be found in Summer School-2018 report.

3. **Household level mapping of On-Site Sanitation Systems**

The next phase of data collection was a household level plot mapping aimed towards identifying the status of onsite systems currently functioning in the households, discharge points of households, measuring plot dimensions and dimensions of existing systems and demarcating space for alternate systems if needed.

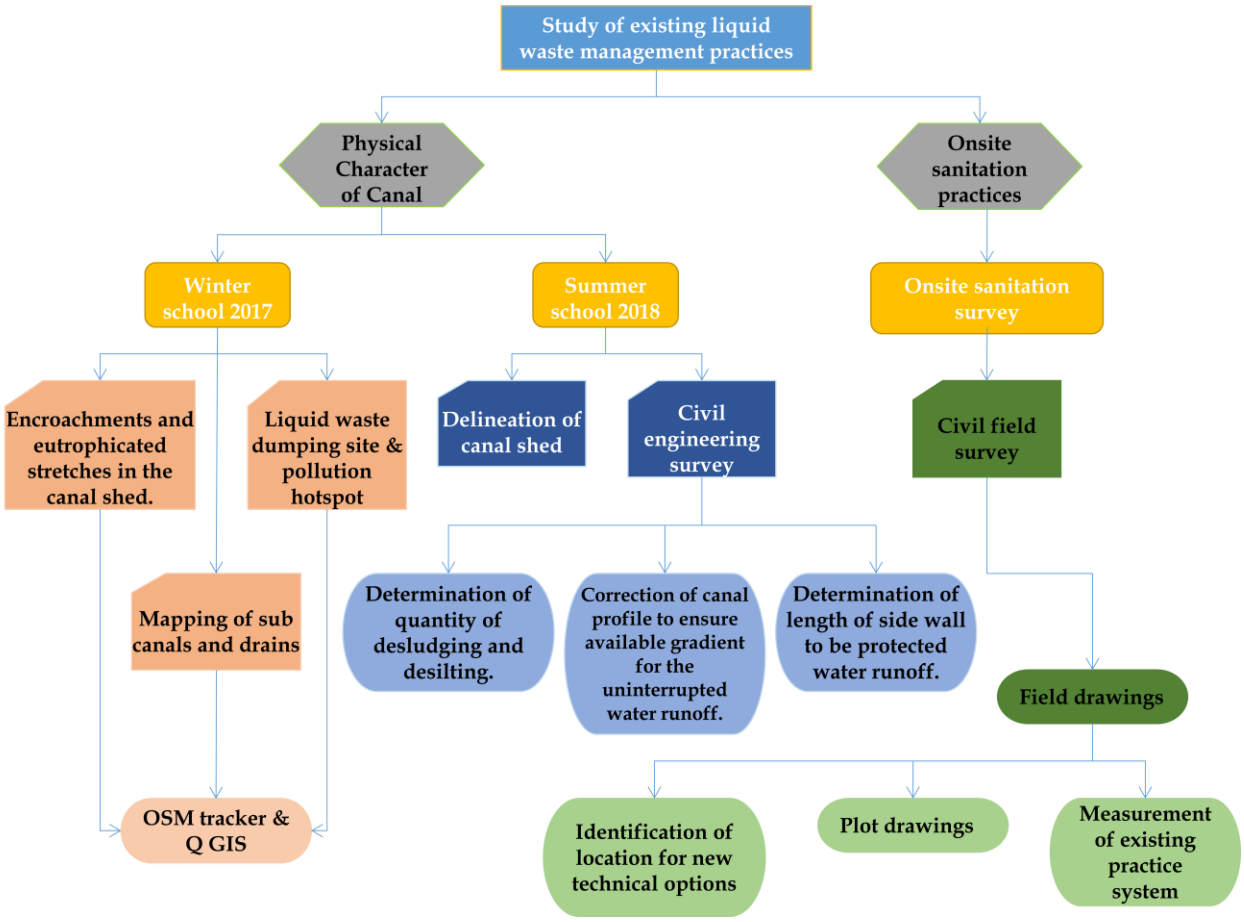


Figure 5.2 methodology flow charts for technological options for onsite sanitation system

5.2.2 House Hold Level Plot Mapping Survey

The survey was conducted simultaneously with the socio-economic survey. They were given four-day training on drawing site plan and service plan of each plot by KILA Research Associates team. This was in addition to the earlier sessions on the socio-economic questionnaire and project background. The training included both class room sessions and site visits.

The team was provided with a survey kit which had the following items - measuring tape- 30m, water level, template of drawings, drawing sheet-A4, pen & pencil. Template of the drawings was added to aid the survey team in the measurements and to serve as a checklist. After completing the questionnaire for the socio-economic survey, the team recorded the dimensions of the plot and the existing OSS in the A4 sheets. After the survey they converted each drawing into an AutoCAD file which was later printed into A3 sheets. These sheets will be used for analysis and for construction of alternative systems if needed.

The following are the design parameters which were considered during the site visit

1. Approach Road:
2. Distance between boundary wall and house (setback)
3. Position of well within the plot.
4. Position of septic tank
5. Distance between well and septic tank
6. Distance between approach road and plot boundary
7. Levels from the ground to the inlet and outlet of black and grey water.
8. Position of water meter within the plot
9. Position of storm water drain (covered/ uncovered)
10. Household water supply distribution diagram
11. Slope of terrain

These parameters give a comprehensive overview of the plot dimensions, open spaces, built-up areas, position of existing septic tank and vegetation (trees and plants). The output of the following parameters can be used to find out the most appropriate position for technical options.

The template used for field drawing is attached in Annexure V

5.3 KEY STAKEHOLDERS INTERVIEW

Key stakeholder interviews were conducted to fill data gaps and triangulate data from surveys and to understand the local knowledge about the existing liquid waste and the fecal sludge management practices in the pilot area. Stakeholder mapping was done to-

1. Ascertain the type of OSS system prevalent in Alappuzha

2. Understand the faecal sludge management practices of the households

Winter School report findings indicated the presence of soak pits (6.4%) instead of septic tanks (91.8%) in households. To corroborate these findings and gather further information a series of interviews were conducted with masons and sanitary onsite system sellers in Alappuzha.

Interview helped to understand the collection method, amount, and disposal methods of fecal sludge. The following chart shows the adopted methodology.

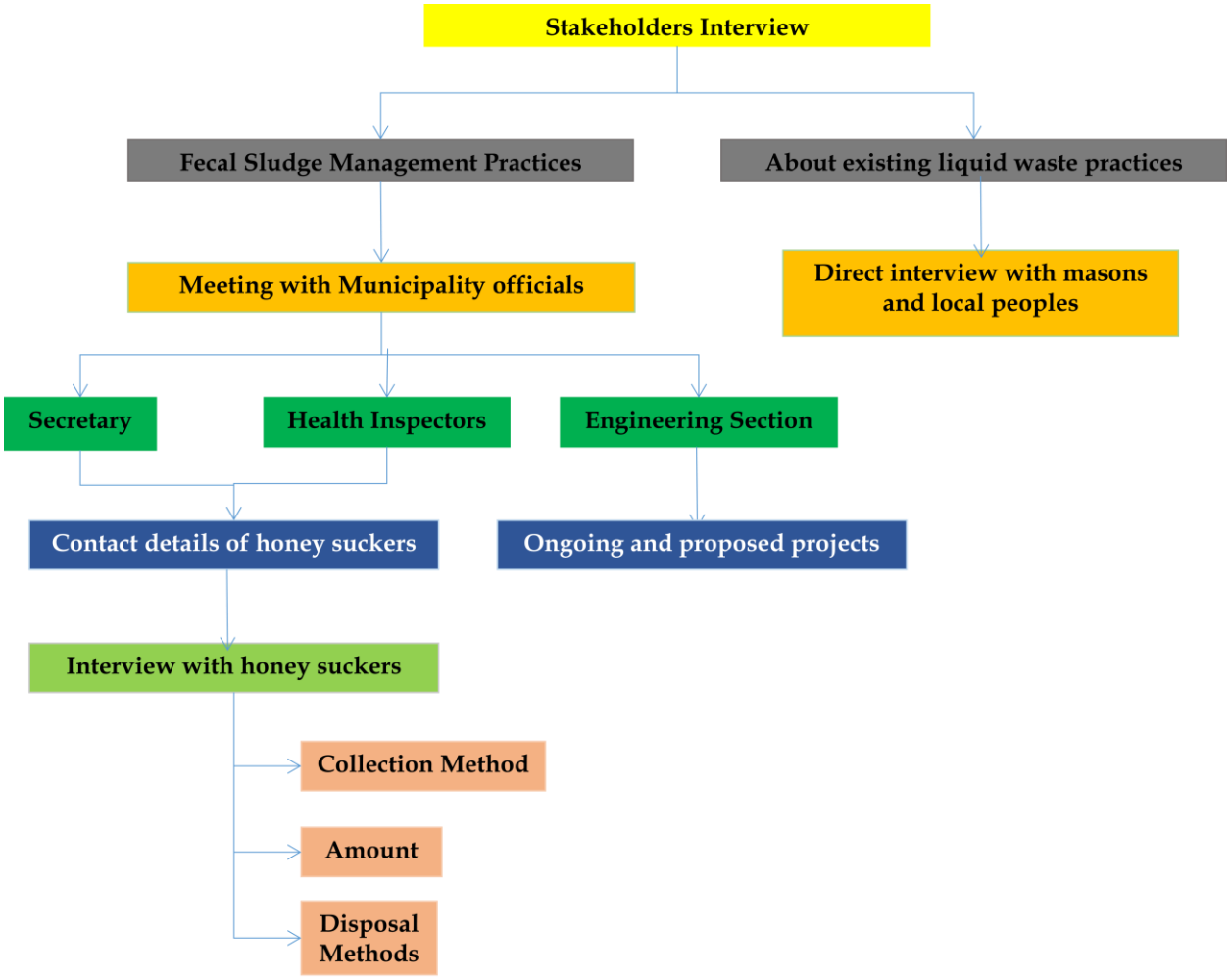


Figure 5.3 methodology flow chart for stakeholders interview

Chapter 6. Primary Data Analysis - Pilot Phase

6.1 BACKGROUND

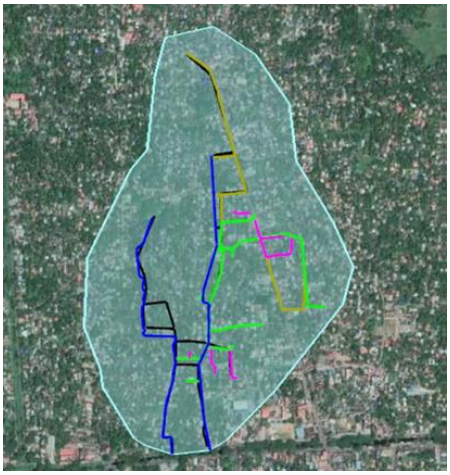


Figure 6.1 Marthoma Church Canal Shed

Table 6.1 Demographic Profile of Canal Shed

Total no. of houses in the pilot area	235
No. of houses surveyed	200
Not surveyed	35
Total population	810
No. of adults	642
No. of children	168
Household size	4.03

As explained in section (Introduction) Marthoma Church canal shed was selected as the pilot area for the study. The canal shed delineation and demarcation was performed by analyzing the drain maps created using OSM tracker during IIT Bombay – KILA Summer School 2018 (Figure 6.1).

In the pilot area, two rows on both sides of the canal has about 235 households, having a population of 810 with a sex ratio of 1005. Barring the Municipal Colony area, rest of the pilot area has a heterogeneous character with respect to the socio-economic parameters. By analyzing the landuse characteristics of the area, the predominant land use is residential and some commercial establishments are spread along the road stretches

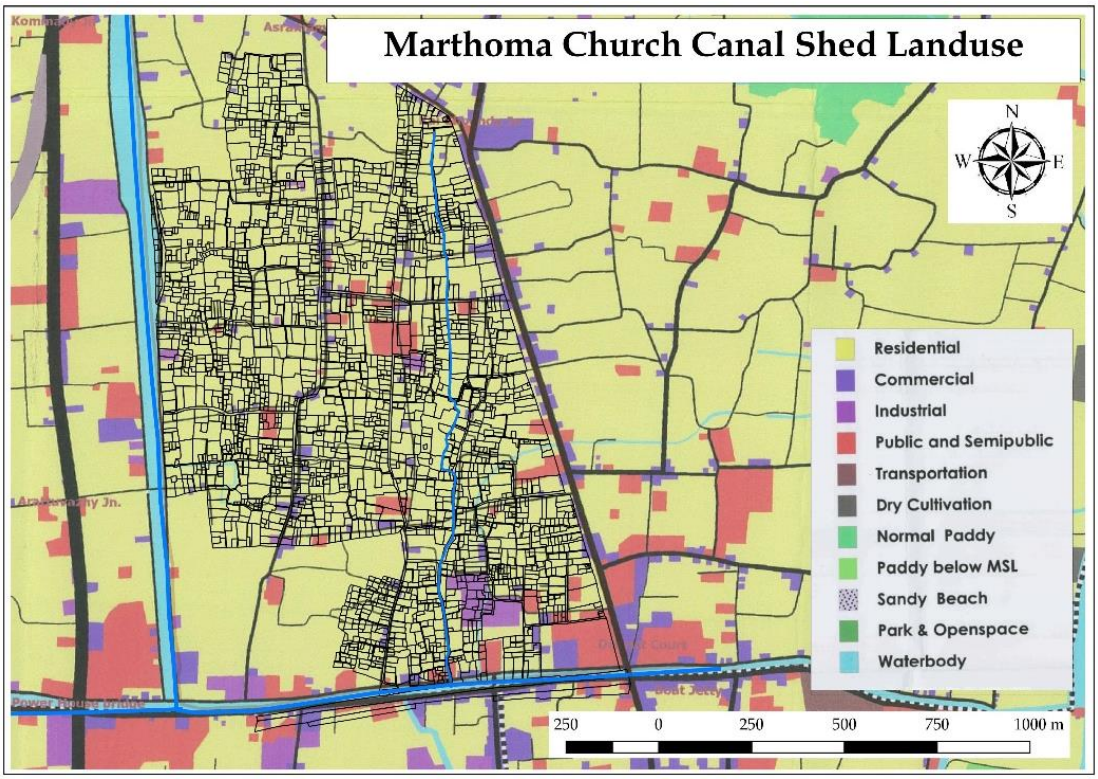


Figure 6.2 Landuse Map of Marthoma Church Canal Shed

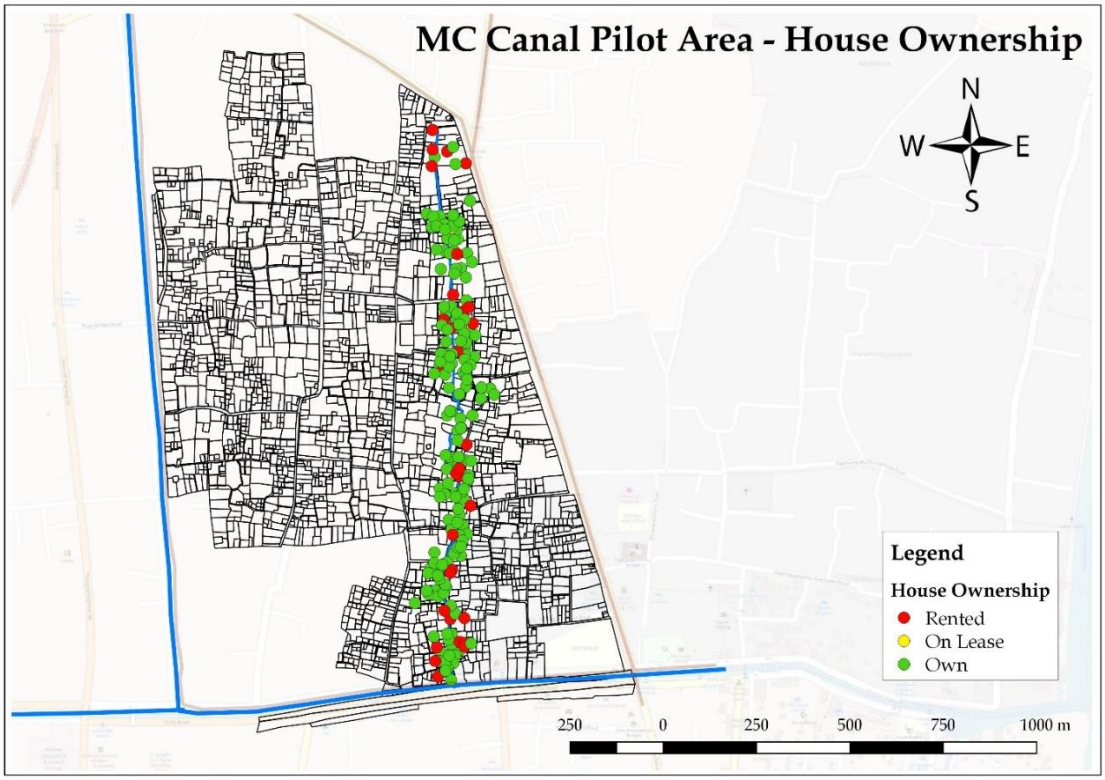


Figure 6.3 Map Showing House Ownership Status at Marthoma Church Canal Pilot Area

The data obtained from the Household Survey has been analyzed in detail to identify the trend of liquid waste management practices and overall socio-economic background of the inhabitants. This data analysis is crucial for identifying the technological options appropriate for the intervention area. For the installation of any technological alternatives for the liquid waste management practices, house ownership status could be a proxy indicator to understand the willingness of the households for the installation of new system. The house ownership pattern of the pilot area is shown in the map below (Figure 6.2). The socioeconomic survey reveals that out of 200 HHs surveyed, 166 houses are own, 34 rented and 1 leased.

The other main parameters that are considered for the data analysis are as follows.

6.2 PHYSICAL ANALYSIS

Physical Analysis includes measurements regarding length, width, profile correction, and volume of desludging. The following figure shows the variation of width with respect to length. It has been observed that much of this variation, more precisely reduction in width is due to encroachment in the canals. This has considerably affected

flow of water in the canals and results in flooding during the monsoon and silting during non-monsoon seasons.

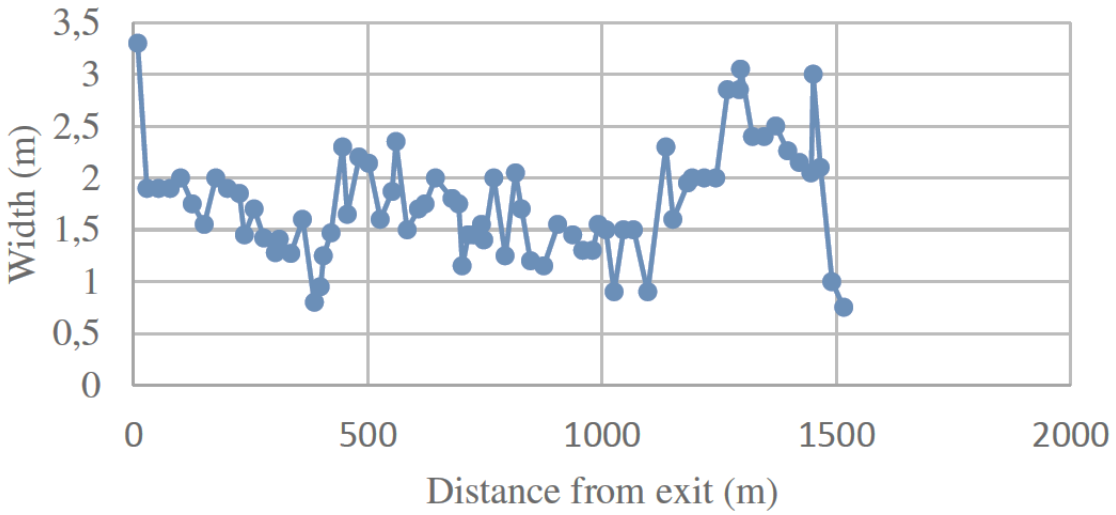


Figure 6.4 Variation of canal width Vs Length: Marthoma Church Sub Canal[1]

The current canal profile is depicted in Figure 6.5. However, this has resulted in uneven flow and there is a need for profile correction. The corrected profile can be deduced by estimating the corrected reduced level of canal centre bottom. This was done by leveling survey and the quantity of desilting to be undertaken has been calculated. An estimated value of 958 m3 is required to be desilted in Marthoma church sub Canal for ensuring proper flow. The Figure 6.6 shows the corrected profile of the Marthoma Church Sub Canal.

[1] *Source: Summer School Report 2018*

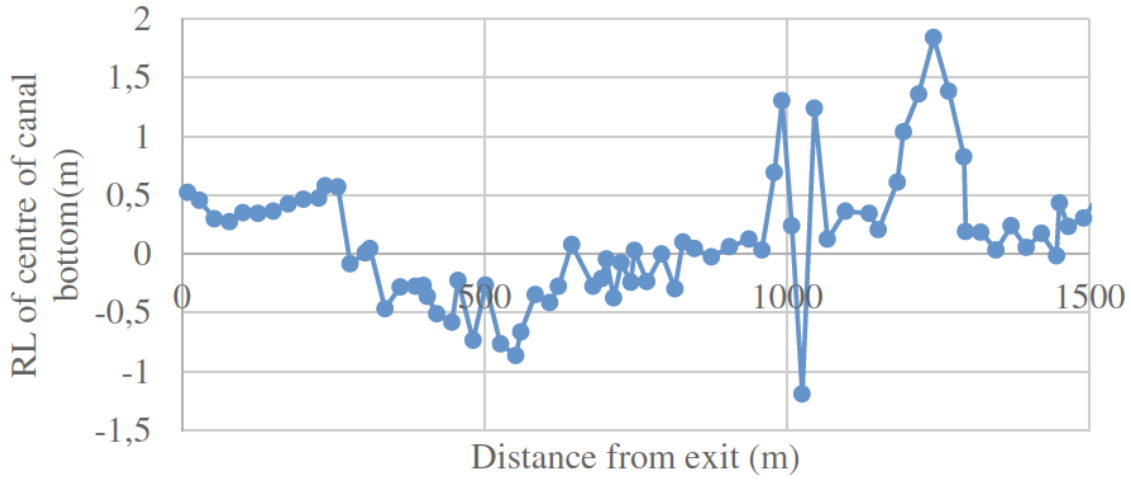


Figure 6.5 Measured Reduced Level (RL) Of Canal Centre Bottom

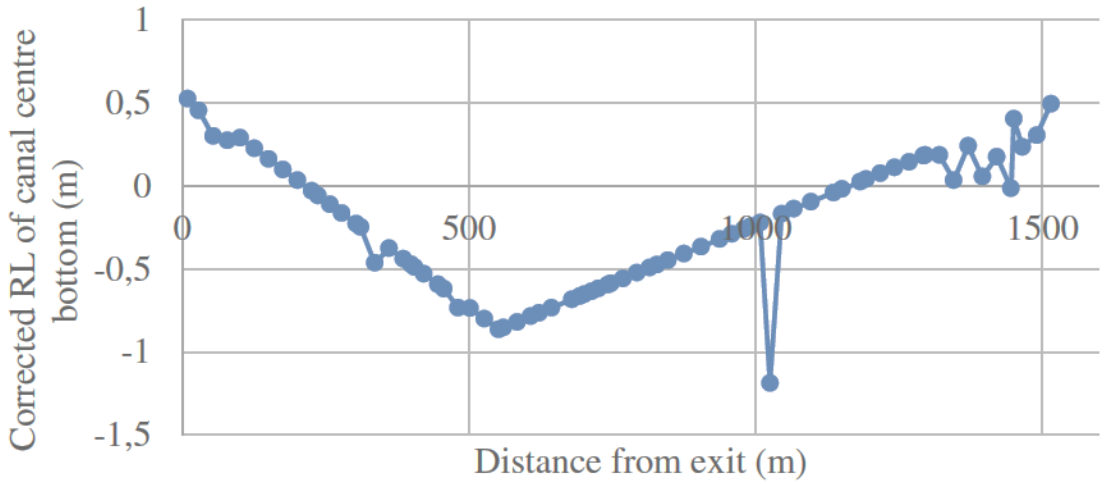


Figure 6.6 Corrected Reduced Level (RL) Of Canal Centre Bottom

6.3 SOURCE OF DRINKING WATER

The availability of drinking water is considered as a direct indicator of waste water generation. The quantity of waste water generated per person can be estimated from per capita water consumption.

6.3.1 Primary Source of Water

Due to high water table and propensity for getting water logged, open wells in Alappuzha are prone to salinity and contamination[2]. Hence residents depend on Kerala Water Authority supply for their primary requirement. However, our results indicate that a small minority is still dependent on ground water for their water demand.

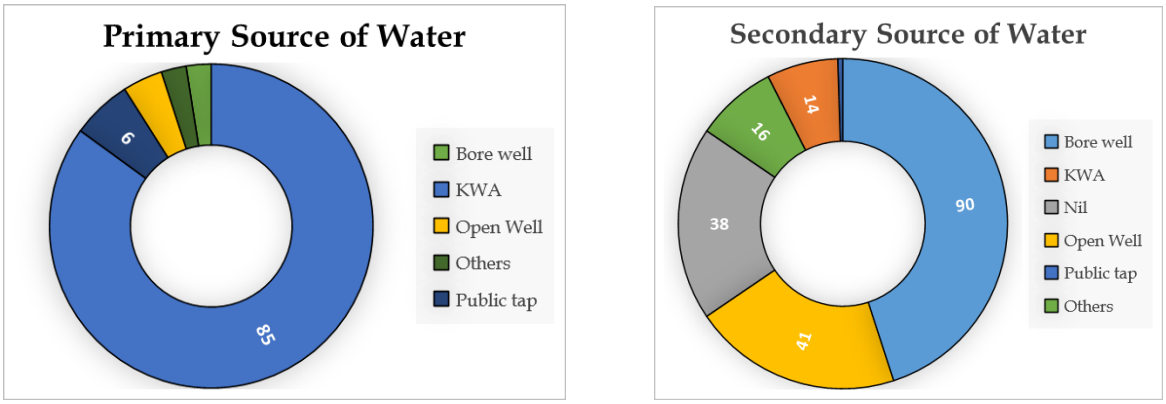


Figure 6.7 Source of Water in Pilot Area

The survey reveals that about 91% of the households rely on KWA (Household connection and Public Taps) as primary drinking water source. About 65.5 % of the households use ground water as secondary water source, with KWA being their primary source.

[2] *Source: Alappuzha Development Plan Draft 2031*

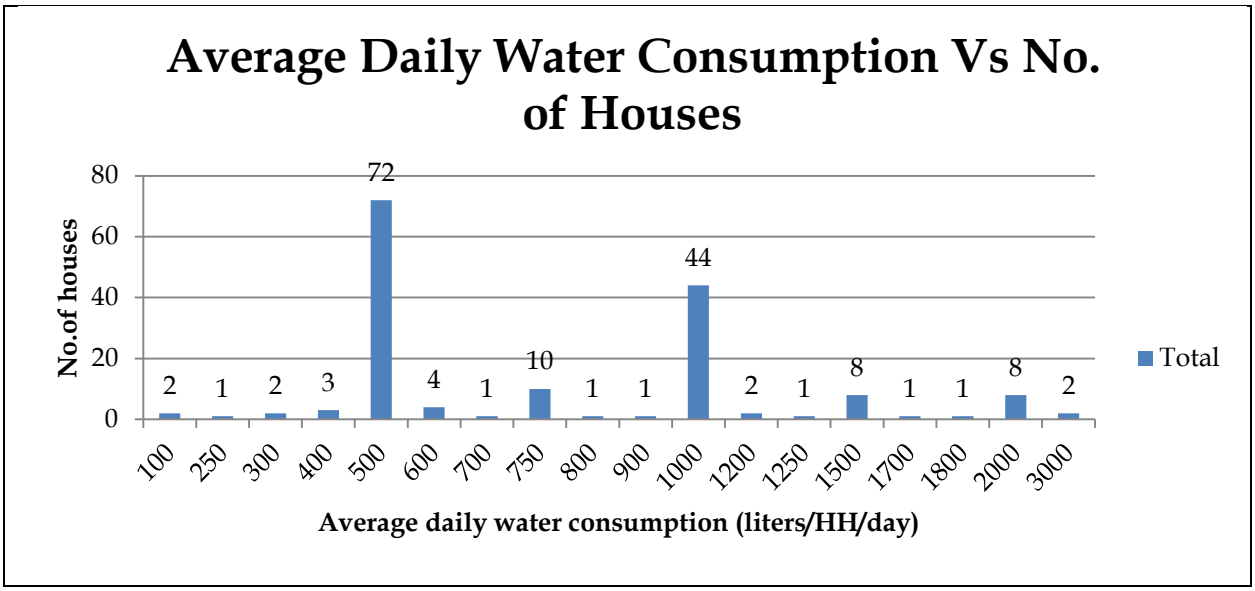


Figure 6.8 Average Daily Water Consumption Vs No. of Houses

The quantity of water used per HH can be determined by taking overhead tank capacity and frequency of pumping. The figure shows the variation of daily water consumption of HHs in the Pilot Area. From the figure, 44 HHs uses a maximum of1000 liters per day and 75 HHs uses 550 liters per day. Two families use a minimum of 100 liters per day. Out of this 80% of the water can be assumed to be converted to wastewater. The data on volume of wastewater generated per household can be used for designing alternate Onsite Sanitation Systems if the current systems are found to be unsatisfactory.

6.4 LIQUID WASTE MANAGEMENT PRACTICES

The domestic liquid waste management has three key components: waste from the toilet (solids and water) which are termed as black water and waste from the kitchen and bathroom referred to as grey water. As per various standards like BIS, CPHEEO the black and grey water should be managed separately[3]. The typical measure of managing toilet waste in bigger cities is through centralized network of sewer systems and treatment units. In smaller cities like Alappuzha the dependence is higher on onsite sanitation systems (OSS) such as septic tanks or Soak Pits. The kitchen and bathroom waste water

[3] *Bureau of Indian Standards, (1993). Indian Standard. Code of Practice for Installation of Septic Tanks. Part-I: Design Criteria and Construction. Second Revision (IS:2470), New Delhi.*
CPHEEO & JICA, (2012). Manual on Sewerage and Sewage Treatment. Part A: Engineering. Final Draft.

are mostly either released on the ground or managed through Soak Pits. In the pilot area, out of 200 HHs surveyed in the pilot area, 2 HHs depend on community toilet and 198 HHs have Individual Household Latrines.

6.4.1 Black Water Management

In Alappuzha two methods are generally in practice for management of black water namely septic tank and soak pit. According to BIS 1993 and Kerala Municipality Building rules (1999) it is mandatory that every household is either connected to a sewerage network or has a septic tank in their premises. From the 200 HHs surveyed, only 2 HHs are depending on the community toilet (Figure 6.9) and all others have individual household latrines. However, our findings show that only 29.5% of the households have a septic tank and the rest of the households dispose the black water into soak pit.

Figure 6.9 Community Toilet Block at Municipal Colony

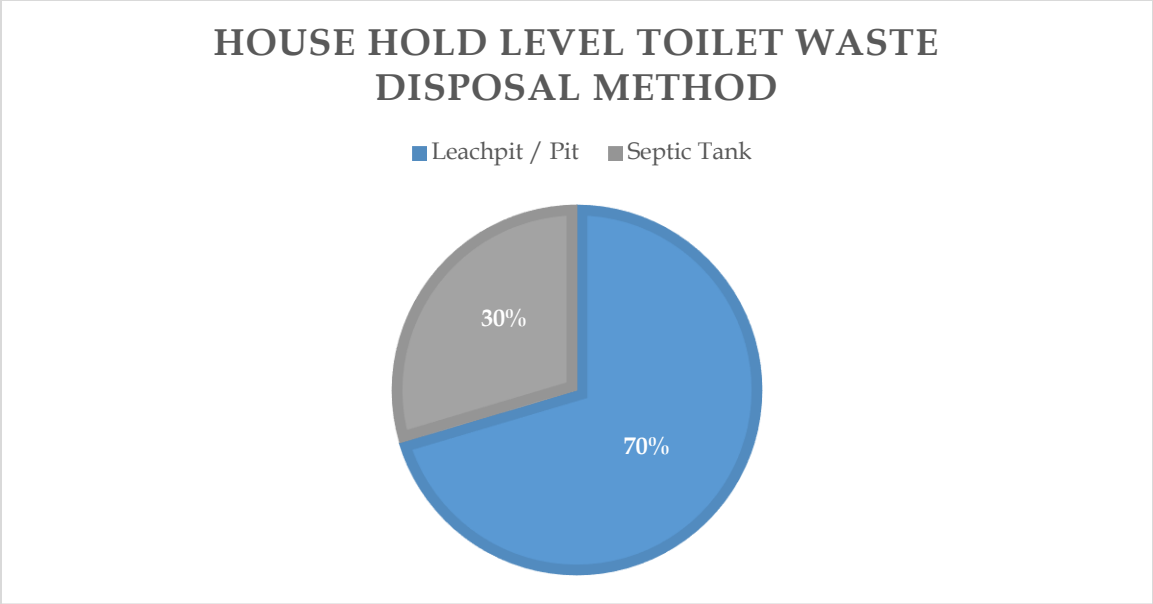


Figure 6.10 House hold level Toilet Waste Disposal Method

According to Bureau of Indian Standards, a septic tank is considered to be scientific septic tank if the structure is water tight, with a sealed bottom and an outfall, and does not receive wastewater from other sources (Bureau of Indian Standards, 1993, pp3-5). Summer School data reveals that almost 70% of the surveyed septic tanks were actually leach pits. Figure 6.11 and Figure 6.12.

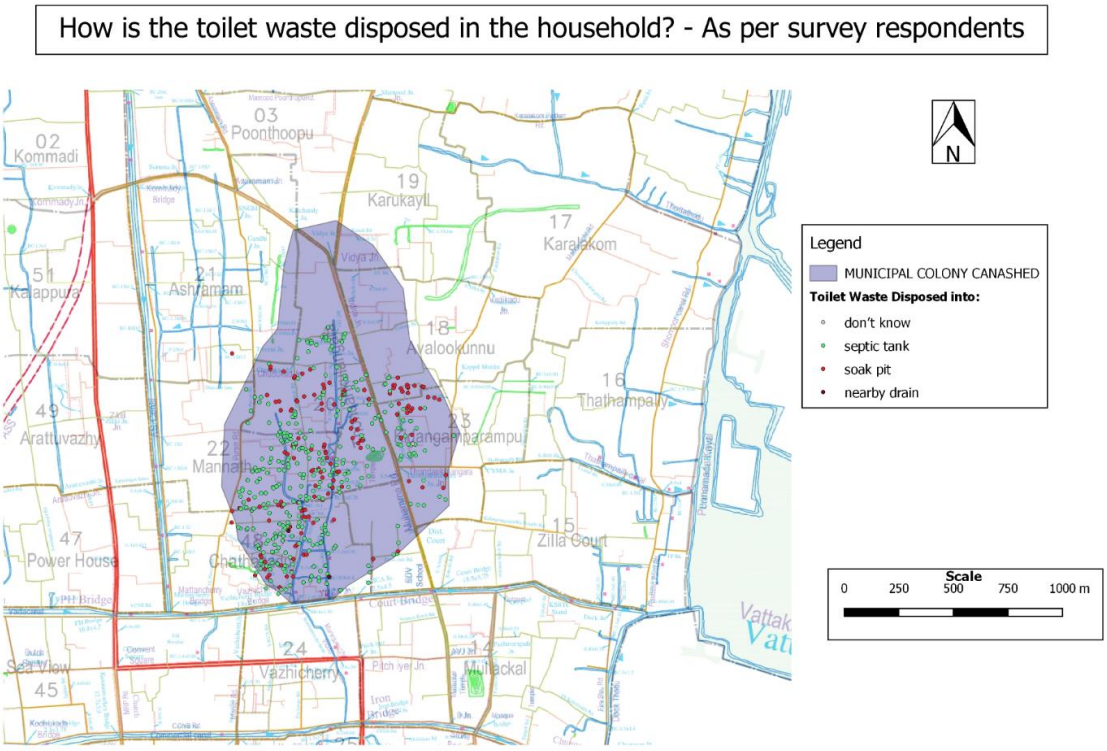


Figure 6.11 Toilet Waste Disposal According to Respondents

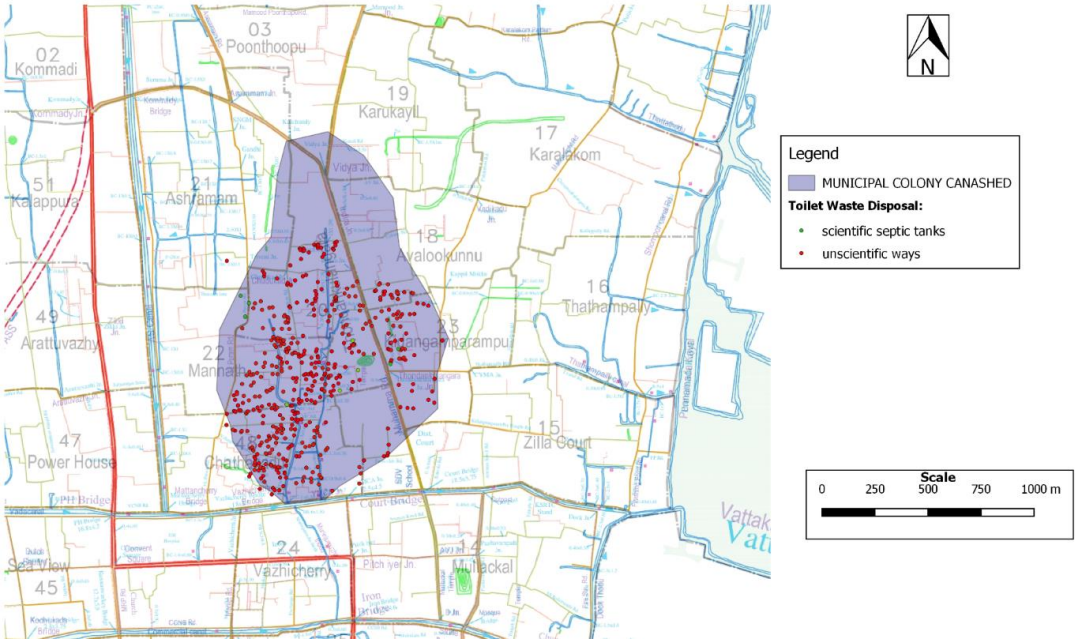


Figure 6.12 Toilet Waste Disposal After Analysis

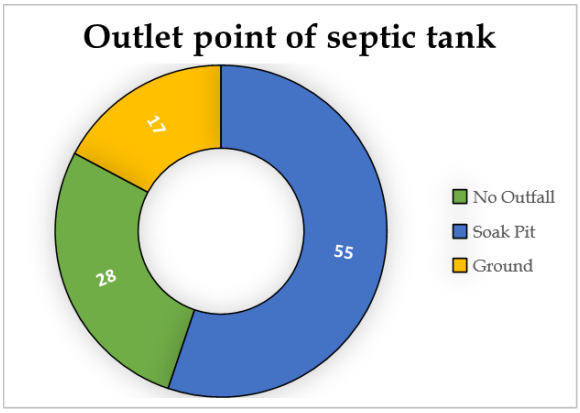


Figure 6.13 Outlet Point of Septic Tank

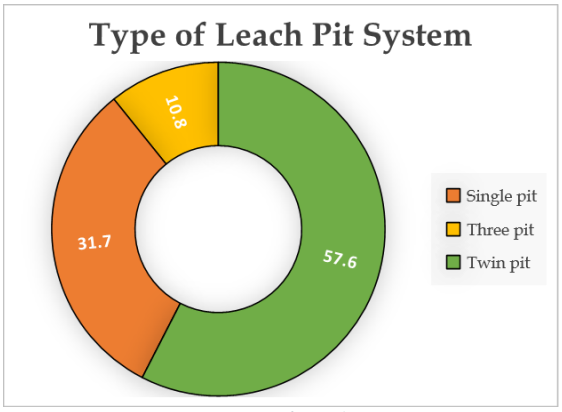


Figure 6.14 Type of Leach Pit System

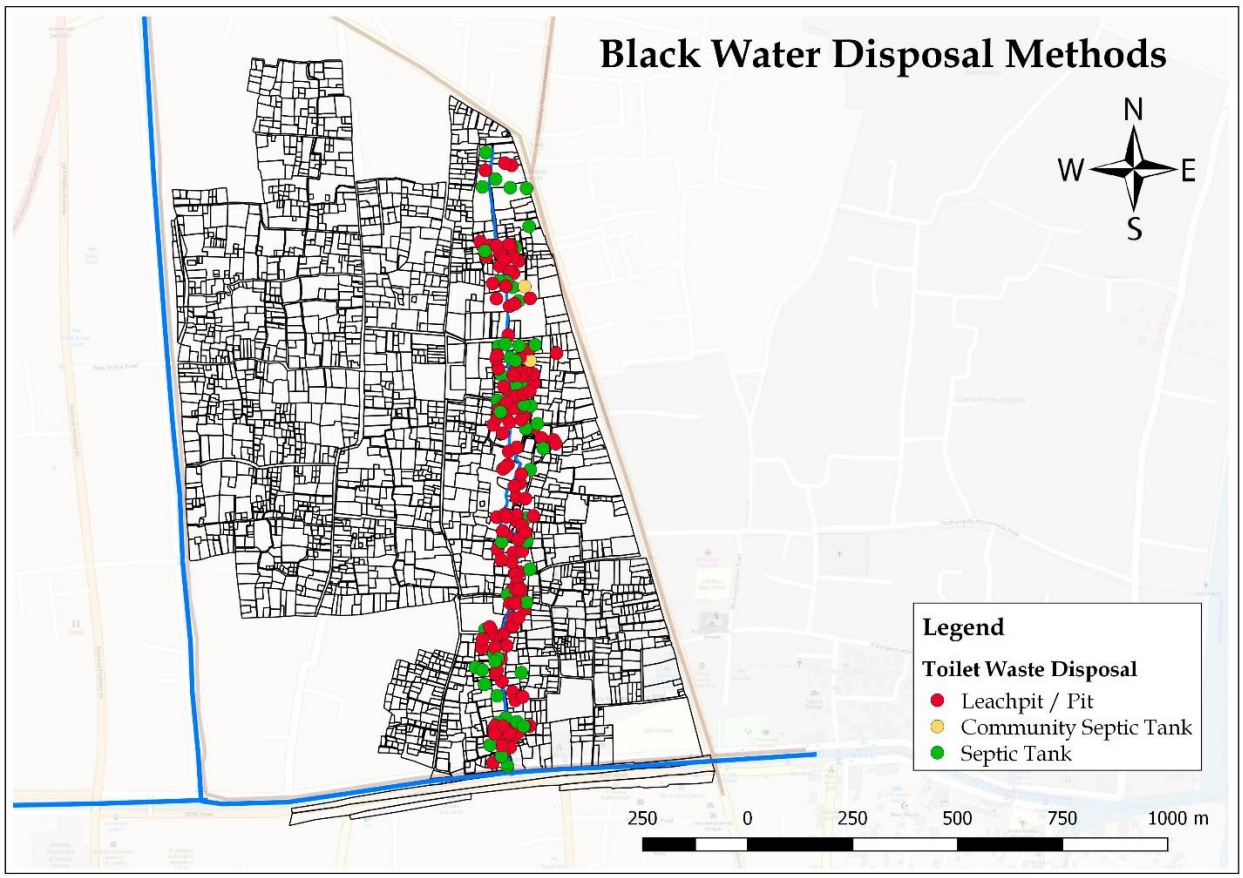


Figure 6.15 Map Showing Black Water Disposal Methods Adopted in The Pilot Area

From the analysis, all septic tanks which are found to be unscientific (side wall is not impervious, has no bottom or has no outfall) is considered a leach pit. Thus, as is evident from Figure 6.10, only 30% of the households have a septic tank. However, out of the 58

only 55% of these have an outfall. Presence of an outfall ensures operational efficiency of septic tank and maintains its structural integrity. Thus, it has been established that out of 198 households only 32 households have a proper system in place for management of black water. The spatial representation of the black water treatment system is given in Figure 6.15. From the figure, it is clear that most of the households have a leach pit for managing their black water.

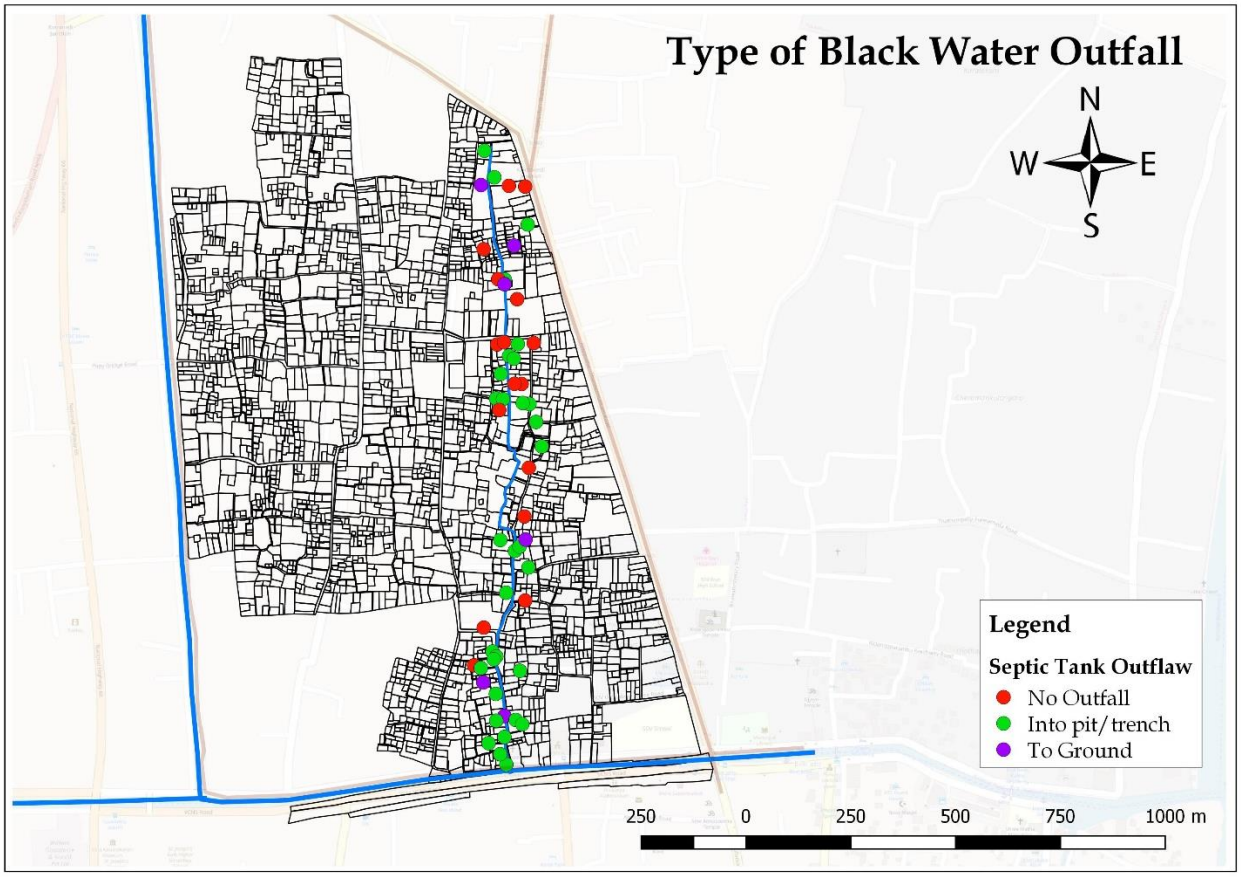


Figure 6.16 Map Showing Septic Tank Outfall in The Pilot Area

Figure 6.16 is the map which shows the outflow conditions of the identified septic tanks. The red color represents septic tanks without an outflow and the green color represents the septic tank with proper soak pit system. Thus from the map it can be concluded that there exist septic tanks without an outflow which is the clear indication that the same cannot be considered as scientific.

6.4.2 Grey Water Management

Grey water is the major contributor of waste water in the Alappuzha canal systems. Almost every HH has an individual black water treatment system within their premise – either a septic tank or a leach pit. But the grey water management is considered to be of lower priority as compared to the black water.

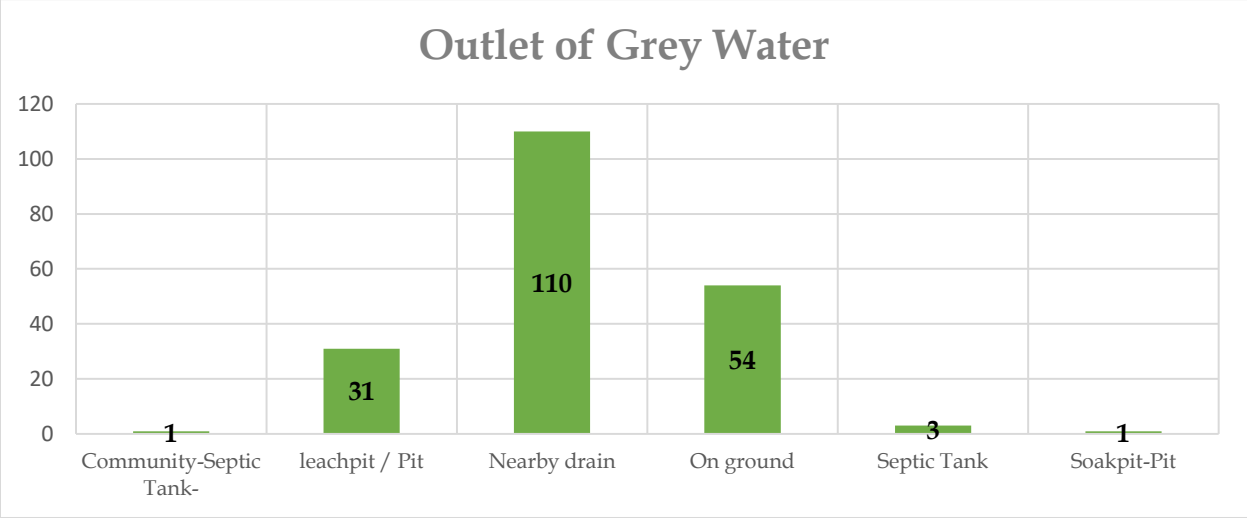


Figure 6.17 Outlet of Grey Water (Number of HHs)

Figure 6.17 shows the characteristics of grey water treatment systems adopted in the HH level. Out of 200 HHs surveyed, 110 HHs are directly discharging grey water to drains, which is about 55% of total HHs. And 54 HHs discharge grey water to ground without any treatment.

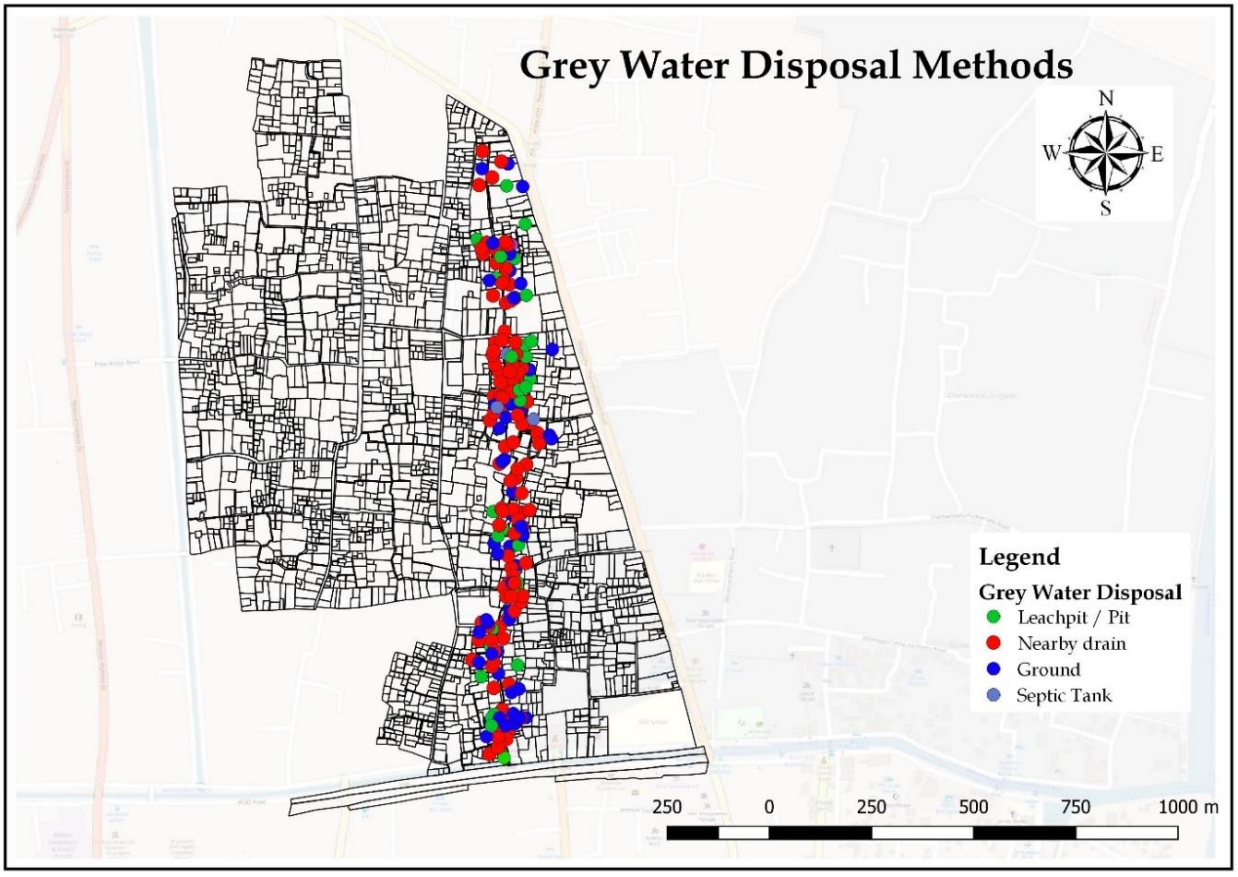


Figure 6.18 Map Showing the Grey Water Disposal Methods in The Pilot Area

The map (Figure 6.18) illustrates the distribution of grey water treatment methods along the canal. Analyzing the distribution pattern, HHs at the middle portion of the canal has a higher concentration rate which are discharging grey water directly to canals. And its concentration reduces towards the downstream side of the canal.

6.4.3 Combined Grey and Black Water Management

As per various standards like BIS, CPHEEO the black and grey water should be managed separately (BIS, 1995) and (CPHEEO & JICA, 2012). All the households in the pilot area have an individual household latrine and an onsite treatment system for black water, however there are no systems adopted for grey water management (refer previous section). Figure 6.19 shows the distribution of HHs with combined grey and water management. Only 23 HHs manage waste water combined and the rest have separate systems for management of both the streams.

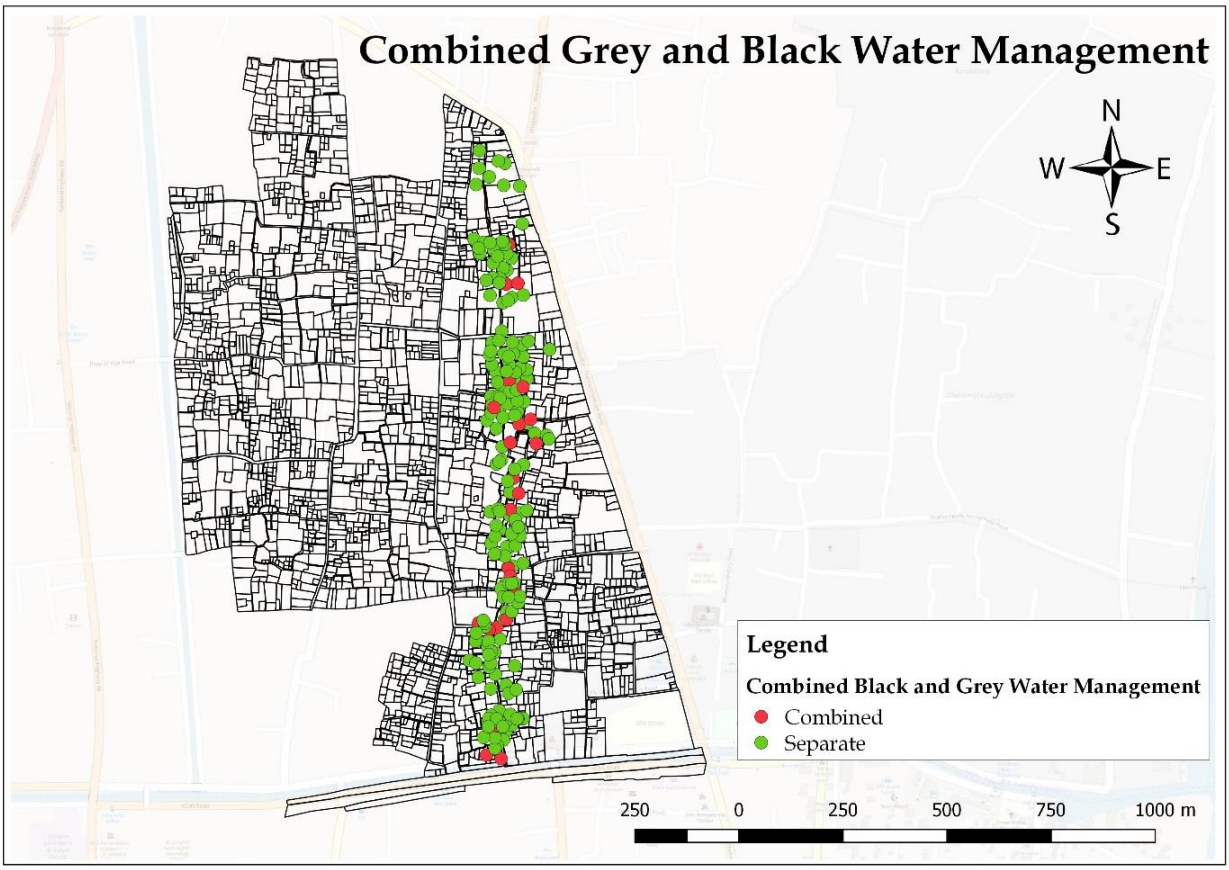


Figure 6.19 Map Showing HHS with Combined Grey & Black Water Disposal in The Pilot Area

The survey data was further analyzed to determine the problems associated with the septic tanks and soak pits and how these might affect the performance and efficiency of the same. In case of septic tanks which are performing sub-optimally, there is a need to replace the current system. The parameters against which the septic tanks and Soak Pits were assessed is presented in the Table 6.2.

Table 6.2 Onsite Sanitation Systems: Relevance of results and insights

Parameters	Relevance	Results
Septic tanks with ventilation pipes	If not maintained, can affect the efficiency. Important for safety.	Out of 58 HHs with septic tank only 21 HHs has ventilation pipe.
Though it may not affect the structural integrity of a septic tank, it is always advisable to have a ventilation pipe while constructing a septic tank-soak pit system.		

Presence of separate system for grey & black water	If not separated, can affect the efficiency of tank	23 HHs are managing the black and grey water together.
There is a need to identify these 23 households and divert grey water from the black water stream to be treated separately		
Size appropriateness of septic tanks for 4-5 family size household	If not maintained, can affect the efficiency of tank	Pilot area has an average HH size of 4.03
As per our analysis the pilot area has septic tank of standard size and is size appropriate		
Presence of mosquito proofing	It's a measure of epidemic diseases	Out of 21 HHs with vent pipe, only 10 HHs have mosquito proof.
Awareness should be provided about the health implications of not mosquito proofing the system		
frequency of using toilet cleaners	Over usage may affect the proper biological process of septic tank	Almost 75% of the HHs cleans the toilet every week
Instead of using the chemical cleaners, natural cleaners should be promoted		
Odour from ST/Leach pit	It's a measure of improper working mechanism of the system	Only 9 HHs having odour problems
Though most of the households do not have odour issues, the reason for odour emanation from septic systems in these 9 houses must be investigated		

6.5 INDIVIDUAL HOUSEHOLD PLOT SIZE

The plot area can be used to demarcate the available space for installing a new system if necessary. This along with the AutoCAD drawings created as part of the civil survey can give an idea of the possible locations where the new system can be installed if necessary. Understanding the plot size distribution also will help us in identifying plots with smaller size as they are the ones which require immediate intervention. This plot size distribution has been represented spatially in Figure 6.21.

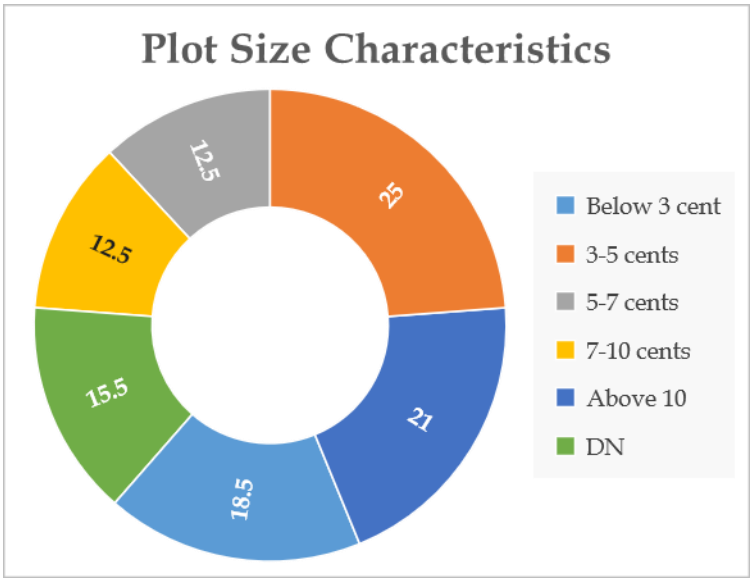


Figure 6.20 Plot Size Characteristics

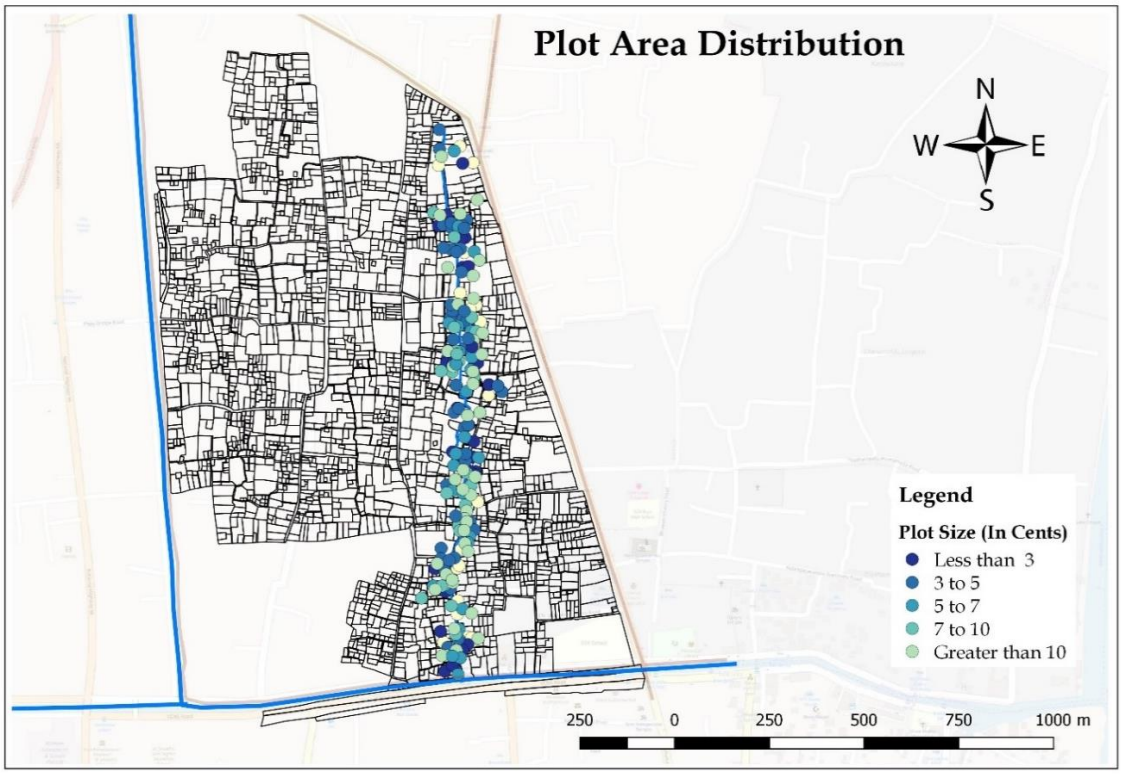


Figure 6.21 Map Showing the Distribution of Plot Size in the Pilot Area

Chapter 7. Water Quality Analysis

7.1 INTRODUCTION

Alappuzha is a water stressed low land in Kerala and many studies have found that the groundwater in coastal district of Alappuzha is vulnerable to bacteriological contamination due to shallow water levels and the existing sanitary practices. Faecal contamination is present in 90% of drinking water in wells and in canals. High population density with unscientific black and grey water disposal are considered to be the major reasons for the widespread bacteriological contamination of the groundwater aquifers.

Water quality is a complex subject, which involves physical, chemical, hydrological and biological characteristics of water and their complex and delicate relations. From the user's point of view, the term "water quality" is defined as "those physical, chemical or biological characteristics of water by which the user evaluates the acceptability of water" (CPCB, 2007).

7.2 METHODOLOGY

The first and foremost step in water quality analysis is to identify the hotspots in the Marthoma Church Canal. With the help of field visit, six hotspots were identified and geotagged. The water samples were collected by composite sampling. The parameters selected for the analysis are pH, Total Suspended Solids, Biochemical Oxygen Demand, Chemical Oxygen Demand, Ammoniacal Nitrogen, Phosphate, Total Kjeldahl Nitrogen and Oil & Grease. The collected samples were preserved in an ice box and transported to the laboratory that day itself. Laboratory analysis were done and the results were obtained.

7.3 SAMPLING

In most cases, composite samples refer to a mixture of spot samples collected at the same sampling site at different times. This method of collection reduces the analytical effort, because variations are middled out in one analysis. It is a useful technique when daily

variations occur and seasonal variations are the objective of the programme. The sampling times selected are 8a.m, 10a.m, 1p.m, 4p.m and 8p.m. (CPCB, 2007)

7.3.1 General Guidelines for Sampling

- Rinse the sample container three times with the sample before it is filled.
- Leave a small air space in the bottle to allow mixing of sample at the time of analysis.
- Label the sample container properly, preferably by attaching an appropriately inscribed tag or label. The sample code and the sampling date should be clearly marked on the sample container or the tag. (CPCB, 2007)

7.3.2 Sample Preservation and Transport

Samples for BOD and bacteriological analyses should be stored at a temperature below 4^{o} C and in the dark as soon as possible after sampling. In the field this usually means placing them in an insulated cool box together with ice or cold packs. Once in the laboratory, samples should be transferred as soon as possible to a refrigerator. If samples collected for chemical oxygen demand (COD) analysis cannot be analysed on the day of collection they should be preserved below pH 2 by addition of concentrated sulphuric acid. This procedure should also be followed for samples for ammoniacal nitrogen, total oxidised nitrogen and phenol analysis. After labelling and preservation, the samples should be placed in an insulated ice box for transportation. Samples should be transported to concerned laboratory as soon as possible, preferably within 48 hours. (CPCB, 2007)

The sampling points are:

CAP1 – Upstream end, near fish market, Kaichoondi mukku (Hot spot)

CAP2 – Immediately before MC colony, near Boby garments, opposite to transformer

CAP3 – Intermediate point, near Thekkumuri house (Hot spot)

CAP4 – Immediately after MC colony, near Kavitha ITI

CAP5 – Intermediate point, Kalungu near Kaipallil house (Joining point of another stream)

CAP6 - Mouth of Marthoma Church Canal

The collected samples are taken to Environmental Services Laboratory, Ernakulam – an NABL accredited laboratory.

Figure 7.1 Map showing sampling points

Figure 7.2 Sample collection

Figure 7.3 Collected sample

7.4 CANAL WATER CHARACTERISTICS

The parameters selected for the analysis are described below:

7.4.1 pH

The acidity or the alkalinity of any solution can be indicated by the term of pH which stands for the power of the hydrogen ions H+ .pH is related to the concentration or more strictly the activity of hydrogen ions. (Alwan, 2008) As per surface water quality standards pH varies from 6.5-8.5. (CPCB, 2007)

7.4.2 Total Suspended Solids (TSS)

Total suspended solids (TSS) refers to the mass or concentration organic or inorganic matter consisting of fine particulate matters. The cohesive solids moves frequently resulting in the formation of larger aggregated flocs. (Brazier, 2008)

7.4.3 Biochemical Oxygen Demand

Biochemical Oxygen Demand (BOD_5) is a measure of how much dissolved oxygen is consumed by aerobic bacteria in 5 days at 20^o C. It is the broad measure of the strength

of the organic matter in a waste stream. The typical range of BOD_5 in domestic wastewater ranges from 100 to 300 mg/L. (Hammam, 2014) As per surface water quality standards, there should not be any BOD.

7.4.4 Chemical Oxygen Demand (COD)

COD is chemical oxygen demand and is measured chemically by digestion with acid. There exists a definite correlation between the COD and BOD under certain conditions and by determining the COD, the information about the BOD of the wastewater can be derived, but it is highly waste dependent. (Hammam, 2014)

7.4.5 Ammoniacal nitrogen

Wastewater derived from black water and greywater potentially contains nitrogen, which contributes to the decline in the quality of water. Nitrogen contamination in water can create problems, such as deterioration of water quality, eutrophication of dam, and potential hazard to animal and human health. The nitrogen compound is a nutrient that can cause algal bloom, which reduces the amount of oxygen in the water, while the ammonia-nitrogen (NH3-N) is toxic to aquatic life. (Media, 2017)

7.4.6 Phosphate

The presence of trace concentrations of dissolved phosphate is often responsible for causing eutrophication problems in lakes, reservoirs, other confined water bodies and coastal waters. In this regard, both biological and physico–chemical treatment processes have been studied extensively to remove phosphate from contaminated water/wastewater. (DongyeZhaoArup, 1998)

7.4.7 Total Kjeldahl Nitrogen (TKN)

The nitrogenous compounds, were in the form of organic nitrogen and inorganic total ammonia nitrogen (NH3+NH4- N), represented together by the TKN, and the oxidized nitrogen compounds, such as nitrate (NO3-N) and nitrite (NO2-N) nitrogen. The nitrogen cycle is the means by which atmospheric nitrogen is made available in various forms to living organisms. In order for the cycle to operate smoothly it is vital to know the amount

of nitrogen contained in the various phases of the cycle. TKN analysis provides the opportunity to quantify the amount of nitrogen contained in organic form (Ragaa El Sheikh, 2016).

7.4.8 Oil & Grease

Organic toxic waste (oil & grease (O&G)) causes environmental damages and adversely affects aquatic organisms, plant and animals. They discharge from different sources to form a layer on water surface that decreases dissolved oxygen. O&G layer reduces biological activity of treatment process where oil film formation around microbes in suspended matter and water. (El-Gawad, 2014)

7.5 RESULTS AND DISCUSSIONS

The results obtained from the laboratory analysis is shown in the table below.

Table 7.1 Sample results

Sl. No.	Parameters	Unit	CAP1	CAP2	CAP3	CAP4	CAP5	CAP6
1	pH	pH units	6.5	7.5	7.5	7.2	7.4.	7.3
2	TSS	mg/L	85	32.6	38	31.6	29.7	34.5
3	BOD	mg/L	420	184	216	239	198	209
4	COD	mg/L	985	576	628	674	482	517
5	Phosphate	mg/L	120	39	46	47	32	42
6	Ammoniacal Nitrogen	mg/L	80	19	24	21	14	18
7	TKN	mg/L	90	24	29	18	19	26
8	Oil & Grease	mg/L	3.8	1.6	1.9	1.2	1.4	2.1

As per Surface Water Quality Criteria for Different Uses (specified by CPCB, 1979 and the Bureau of Indian Standards, 1982), the canal water comes under the class D, which includes the use of water for propagation of wild life and fisheries. From that, it is inferred that Class D water should not contain BOD and other forms of Nitrogen. But from the data analysis, it is observed that the value of BOD, COD and forms of Nitrogen are relatively high. And thus the canal water is highly polluted.

The first point, CAP1 is the upstream end of the Marthoma Church canal a fish market is located in adjacent to the canal and that is why the point has been chosen. The water quality analysis shows that the water in that point acidic and the BOD and COD values are relatively high. Also the values of TSS, Phosphate, Ammoniacal Nitrogen, TKN, oil & grease are high compared to other points and the presence of high organic and inorganic contents maybe due to the presence of the fish market.

The second point CAP2 is a little far away point and it is immediately before the Municipal Colony. The analysis result shows that the water is neither acidic nor alkaline and the other values are reduced. This may be due to the flow of water as it got diluted.

The third point CAP3 is a hot spot and thus the values got increased from the second point. Also the fourth point, CAP4 is immediately after the Municipal Colony and here also, the values got increased from the third point. These increments may be due to the presence of organic waste and also due to presence of grey and black water.

The fifth point, CAP5 is an intermediate point, which is a joining point of another stream and thus the values got reduced and that may be due to the dilution of water. And the last point, CAP6 is the mouth of the canal and the values got increased and that may be due to the accumulation of organic and inorganic matters and also due to the presence of grey water.

7.5.1 Biodegradability index

As BOD is predominantly a biochemical parameter, it generally reflects biodegradability of organic matter in water thus making BOD: COD ratio a good indicator of the proportion of biochemically degradable organic matter to total organic matter. Thus BOD: COD ratio is typically a measurement used to describe the organic composition in the water and it appears to be a good representation of waste stabilization. (Nikraz, 2014)

Typical values for the ratio of BOD/COD for untreated municipal wastewater are in the range from 0.3 to 0.8. If the BOD/COD ratio for untreated wastewater is 0.5 or greater, the waste is considered to be easily treatable by biological means. If the ratio is below

about 0.3, either the waste may have some toxic components or acclimated micro-organisms may be required in its stabilization. (Montaser Y.Ghaly, 2011)

Table 7.2 Bio-degradability index

Sl. No.	Sampling Points	Biodegradability Index
1	CAP1	0.43
2	CAP2	0.32
3	CAP3	0.34
4	CAP4	0.35
5	CAP5	0.41
6	CAP6	0.40

It is inferred that the biodegradability index for all the points are between the range and it can be treated by biological means.

7.6 WILLINGNESS TO INSTALL

In order to providing a new system for liquid waste management people's behavior towards willingness to install the system is to be addressed. As part of pilot phase survey, 153 households out of 200 are willing to install the new system in their houses.

Chapter 8. Recommendations

8.1 INTRODUCTION

This section presents output of the analysis presented above. The key ones include a discussion on appropriateness of the selected technical alternative, criteria used for identification of an initial set of beneficiaries, and the list of beneficiaries in the pilot area.

Surveys carried out during the earlier summer and winter schools found that the canals were polluted due to inadequate liquid waste management especially by households along the canals. Even visually, it is apparent that the canal water has high suspended solids. Surveys of households along the Marthoma Church sub-canal found that 88 percent households discharge black and grey water separately while the remaining disperse them together. More than 83 percent have their toilets connected to leach pits while only less than 17 percent have septic tanks. 55 percent households discharge their grey water directly into the canal, 27 percent on open grounds and remaining disperse them through soak pits.

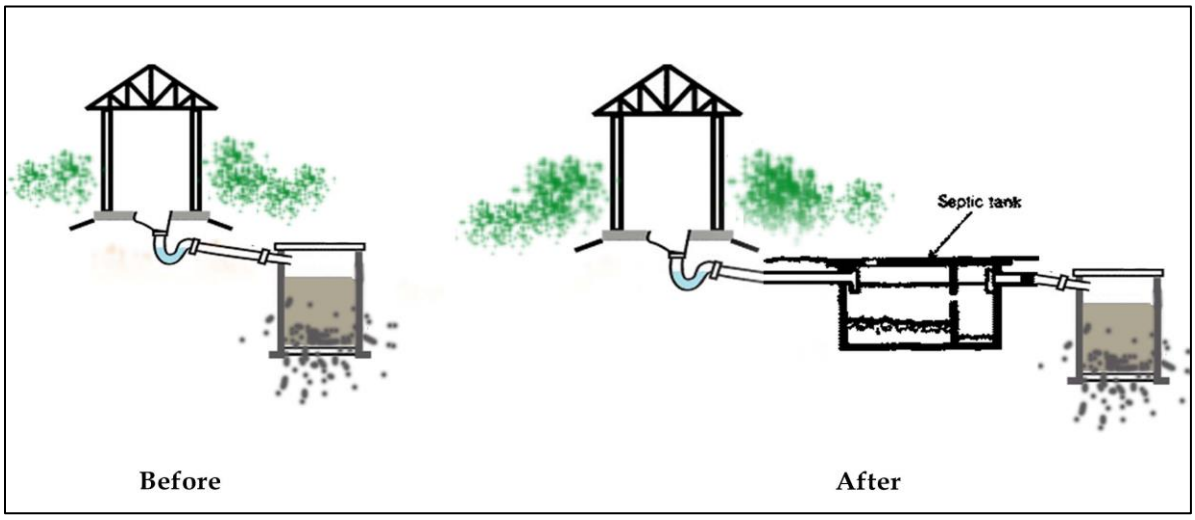


Figure 8.1 Current System and Proposed Intervention

As discussed above, two interventions are necessary in pilot area. Use of soak pits for managing liquid waste in a dense settlement like municipal colony (average plot size is 80 cents) is inappropriate. At the same time there is no space for plot level intervention

nor is retrofitting of existing systems feasible. Thus, a community level treatment system is proposed to manage liquid waste of the entire municipal colony.

After due consideration, the municipality decided to implement a DEWATS[4] treatment system to manage liquid waste in Municipal colony (See Annexure VI for detailed design). The technology can treat both grey and black together and is found to be more efficient than septic tanks. It is adaptable to areas with high water table and easy to customize. It has been successfully implemented at community and institutional scales at multiple locations across the country. Additionally, since the treatment efficiency is high, the outfall can be directly discharged into the canal.

Figure 8.2 Under construction community DEWATS system in Municipal colony

Out of the remaining 200 HHs surveyed, 151 were willing to install a new system for treating their black water. 32 of these HHs were found to have scientific septic tanks while the rest of the 119 dispose off black water into a soak pit. Thus, these HHs have to be targeted and immediate action should be taken to replace/retrofit. To this end, 40 beneficiaries have been identified from the site plans and service plans of the HHs surveyed.

The initial list of 40 households is based on heat map of the pilot area and willingness of the households, type of onsite system currently in use, household income category and

4 *DEWATS stands for Decentralized Waste Water Treatment System. It is developed by CDD society.*

size of the plot. 153 out of 200 households expressed willingness to install a new system during the survey. Of these 115 have pits. These 115 households were sorted based on their income category and size of the plot. The initial list of beneficiaries includes households belonging to both APL and BPL income categories and with plot size varying from 1.5 cents to 25 cents. This is to enable testing of the system for varying topographical, economic and social contexts.

For the remaining households in the pilot area the existing systems will be retrofitted. If not available, a new septic tank will be constructed to collect fecal sludge and provide partial treatment to black water. The existing leach pits will be emptied and used as soak pit to treat and disperse grey water and effluent from septic tanks.

The design and details of DEWATS system is described in the previous Volume.

Chapter 9. Action Plan

The action plan is detailed in the table below. The different elements of the action plan have been detailed in Annexure VIII.

Action	Responsible Authority	Status
Construction of the Community level DEWATs system.	CDD	In progress
Monitoring and evaluation of the installed community level DEWATS for 1 year.	CDD	Yet to commence
Finalization of the beneficiary list for installing individual DEWATS system.	CANALPY Team	Completed
Installation of individual new system black water to the beneficiaries.	CDD	To be completed by end of January
Installation of individual new system grey water to the beneficiaries.	Municipality	To be completed by end of January
Monitoring and evaluation of the installed individual DEWATS for 1 year.	CDD/ CANALPY	Yet to commence
Identifying HHs specific intervention in the case of remaining HHs (Either retrofitting existing system or construction of new system)	CANALPY	Yet to commence
Grouping of HHs in terms of the interventions and technology selected and the availability of resources and space constraints.	CANALPY	Yet to commence
Implementation of HH specific interventions in a phased manner.	ULB	Yet to commence

Operation and maintenance.	Owners	To be completed
Campaigning by Canal Kara committee for smooth operation and maintenance of the system installed as well as systems retrofitted.	CANALPY	Completed
Replication of the pilot area methodology for assessing liquid waste management practices in Shadamani Canal.	CANALPY	In progress

ANNEXURE

Annexure I. Questionnaire Used for Socio-Economic and Solid Waste Management

GENERAL QUESTIONS:

- Name of house owner:
- House number:
- Ward number:
- Geo location:
- Total plot area:
- Area of house:
- Survey number of plots:
- House ownership:

  a) Own b) Rent
- Number of family members: ☐

  Male ☐ **Female** ☐ **Children (0-3yrs)** ☐
- Age group

  a) 10-15 ☐ **b) 15-25** ☐
- Are there any bed patients?

  a) Yes b) No
- Ration card

  a) APL b) BPL
- Primary source of HH Income

  a) private job b) govt job c) Abroad d) business

e) Agriculture f) house boat g) fishing h) House renting i) daily labour j) others

- Number of storey's
  - **a) Only ground floor b) Ground floor + one storey c) Ground floor + two storeys d) Ground floor + more than two storeys**
- Floor Type
  - **a) Mosaic/Floor tiles b) Burnt Brick c)cement d) marble e) Mud f) other**
- Roof type
  - **a) asbestos/metal sheet/galvanized iron b) burnt brick c) concrete d) handmade tiles e) machine made tiles f) stone/slate roof g) wooden/bamboo/mud h) other**
- Household appliances:
  - **a) TV b) Refrigerator c) AC d) Washing machine e) Micro wave ovenf) Water heater g) Other**
- No. of Vehicles
  - **a) Two wheeler ☐ b) car ☐ c) Auto rickshaw/Ape ☐ d) Heavy vehicles ☐**
- Phone number:
- Gender of the respondent:
  - **a) Male b) female**

SOLID WASTE DETAILS:

1. Do you segregate solid waste?
   - **a) Yes b) No**
2. What all types of waste are segregated and stored separately?

a) kitchen waste b) plastic waste c) paper wastes d) hazardous wastes e) E-waste f) Others

3. How do you manage wet waste/kitchen waste?

a) Pipe compost b) Portable bio-gas plant c) Fixed bio-gas plant d) Ring composte) Kitchen bin f) Disposing in Aerobic bins g) Dumping in your own compound h) Dumping in canal i) Dumping in other places h) others

4. If biogas is installed, no of hours cooking gas is available

a) Less than half an hour b) half an hour to one hour c) 1- 2 hours d) More than 2 hours e) Gas not available f) Nil

5. Number of years since installed?

a) 0-2 years b) 2-5 years c) 5-7 years d) 7-10 years e) More than 10 years

6. Reason for opting it?

a) Upon personal interest b) Government mandatory c) Less land availability

7. Functional status of on-site system?

a) Good b) Average c) Poor

8. Can you explain the working method of this system? { Note down if issues any }
9. What is the reason for the poor condition of the existing system?

a) **Flooding b) lack of knowledge c) poor maintenance d) faulty system e) Unable to get a person to repair e) others**

10. Any issues faced in using this system?

a) **Bad smell b) fly nuisance c) Leaching d) Worms in the pipes e) Issue with rats f) Non-availability of gas g) Others**

11. Did you try to repair?

a) **Yes b) No**

12. Whom do you contact if there is any issue with the system?

a) **No one b) Know a local person c) Call the maintenance team**

13. Whether you are ready for repair/reinstallation?

a) Yes b) No

14. What do you do with the manure?

a) **Use in own garden b) give it to others c) sell it**

15. Any training undergone about the working method?

a) **Yes b) No**

16. Are you interested in installing on-site waste management system?

a) **Yes b) No**

17. Would you like to use community level treatment system (Aerobic compost units)?

a) **Yes b) No**

18. If yes, at what distance do you prefer?

a) 150 m b) 250 m c) 500m d) More than 500m e) less than 150m f) others

19. Suggest any suitable location for installing community level system?

20. How do you manage dry leaves?

a) Burning b) Dumping in your own compound c) Dumping in canal d) Dumping in other places e) used in compost unit f) Giving to aerobic unit g) others

21. Willingness to provide it for aerobic composting units for free?

- **Yes b) No**

22. How do you manage plastic waste?

a) Littering b) Giving to plastic collection facility c) Burning d) Dispose into canals e) others

23. Frequency of grocery shopping?

a) Daily b) weekly c) twice a week d) two weeks e) once in a month f) Others

24. Frequency of buying parcel foods?

a) Daily b) weekly c) twice a week d) two weeks e) once in a Month f) Others

25. How do you manage E-waste?

a) Dumping b) scrap dealer c) swap shop d) others

26. Do you know about the swap shop operating in the municipal area?

a) Yes b) No

27. Willingness to use swap shop?

a) Interested b) Not interested

28. Usage of sanitary napkins/ Baby diapers?

a) Sanitary pads b) Cloth napkins c) Diaper d) Nil

29. How do you manage sanitary napkins/ Baby diapers?

a) Burn (outside/inside plot premises) b) Bury (inside/outside plot premises) c) Dump into nearby place d) others

30. Opinion about installing incinerator at community level to manage sanitary waste?

a) Interested b) Not interested

31. Willingness for disposing sanitary napkins at community level by own if paper carry bags are given for disposing?

a) Interested b) Not interested

32. Are there any small scale enterprises attached to house?

a) Yes b) No

33. If yes, what kind of small scale enterprise?

a) Catering b) Stitching c) Pickling unit d) Others

34. If yes, how do you manage the waste generated?

a) Littering **b) Giving to plastic collection facility** **c) Burning**

d) Disposing into canals **e) composting** **f) others**

35. Do you feel pipe compost/biogas plant as beneficial?

a) Yes **b) No** **c) Not aware of**

36. How do you manage hazardous waste?

a) Littering **b) Burning** **d) Disposing into canals** **f) others**

37. Caste:

a) SC/ST **b) General** **c) OBC**

Annexure II. List of households having on-site waste management systems

Sl. No.	House no	Ward no	House owner name	Telephone number	Existing on-site system
1	663	48	Sunny.P.M	9495440649	Kitchen bin
2	690	48	Prembhas	7356693044	Kitchen bin
3	585	16	Udayamma Chakrapani	9556961687	Kitchen bin
4	713	48	K T Jacob	9495346088	Kitchen bin
5	713	48	K T Jacob	9495346088	Kitchen bin
6	692	48	Deep George	9633102796	Kitchen bin
7	970	48	Deepa Rani	9495758419	Pipe compost
8	552	20	M.N. Ramachandran Nair	9446526390	Ring compost
9	580/B	20	Shameer	9061667666	Kitchen bin
10	311	20	R Gopinath	9846144822	Pipe compost
11	184	20	Noushad	9895607450	Kitchen bin
12	270	20	A P Muhammad Basheer	9947033332	Bio-gas plant
13	Nil	48	Santhosh	8281281128	Pipe compost
14	569	22	Sumangala	9495917066	Kitchen bin
15	645	22	Sina Snehagan	9400421139	Kitchen bin
16	614	48	Shivanandhan	9447804620	Biogas Plant
17	616	48	Suthan	9947360474	Biogas Plant
18	1012	48	Rajesh	9048538399	Biogas Plant
19	806	48	Chandran	9446454920	Biogas Plant
20	620	48	Babu M K	9495736415	Biogas Plant
21	850	48	Prasad	9446726538	Ring compost
22	792	48	Ratheesh	9287591423	Kitchen bin
23	798	48	Saiju	7736302810	Kitchen bin
24	14	20	Sasi	0	Pipe compost
25	22	48	Aju	0	Kitchen bin
26	656	48	Subash Babu	9495605361	Biogas Plant
27	570	22	Venugopal	9287939909	Biogas Plant
28	676	22	D Balagopal	9388052109	Pipe compost
29	617	22	Nayana	9744955758	Kitchen bin
30	686	22	Salim	9846669990	Kitchen bin
31	674A	20	Somannair	9446143746	Ring compost

32	dn	20	Abubekar	9947216424	bio_bin
33	DN	48	Mehaboob	8157883488	Kitchen bin
34	799A	48	David	9747418604	Kitchen bin
35	475	20	Alex	9947777093	Pipe compost
36	475 b	20	Jose K S	9846201797	Biogas Plant
37		48			Biogas Plant
38	100	22	Sasi		Pipe compost
39	471	22	Harhara Subhramanyan	9633360261	Kitchen bin
40	470	22	G. K Narayan	9446234471	Biogas Plant
41	1279	22	Narayana Pilla	9496110413	Kitchen bin
42	879	20	Shinu Joseph	0	Kitchen bin
43	705	20	Parameshwaran	9633179439	Kitchen bin
44	22	20	Sasidharan Nair	9739262372	Pipe compost
45	416	22	Sonichan	95467570408	Pipe compost
46	406	22	Rajagopal	9847918368	Pipe compost
47	402	22	Biju S Pillai	9847755655	Pipe compost
48	892	22	Sathosh Kumar	9061425252	Pipe compost
49	655	22	Shaji	9656892053	Kitchen bin
50	571A	48	Filomina Vargese	9847040708	Bio-gas plant
51	571	48	Ashif Besheer	9847040708	Bio-gas plant
52	308	20	Velayudhan	9446920211	Pipe compost
53	514	22	Sudheesh	9400534151	Biogas Plant
54	863	22	P Raju	9745897223	Bio-gas plant
55	691	20	Mohana Kumar	9495439310	Pipe compost
56	792	20	Johnkutty	9846249214	Bio-gas plant
57	720	20	Jasmine Basheer	9446416563	Bio-gas plant
58	570	20	C Venugopal	9387916183	Bio-gas plant
59	613	20	Ajmal	9544334555	Pipe compost
60	617b	20	Deepu R	974495575	Pipe compost
61	145	20	Ravidran Pillai	9447896848	Bio-gas plant
62	143	20	Haridasan	9746995174	Bio-gas plant

Annexure III. Comparison of Technological Options

Beneficiary Type	Sl No	Technology Options	Factors for selection						
			Space/Land Requirement	Utility			Challenges during operation and maintanance	Cost	Remarks, Issues faced
				Waste to compost	Waste to energy	Others			
Organic waste management									
Household	1	Biogas plant (portable)	x	x	✓	Slurry obtained can be used as manure	Requires continous maintenance and care	Rs. 3375	Mosquito breeding
	2	Kitchen bin	x	✓	x	x	Less maintenance	Rs. 410	Need to maintain low moisture content
	3	Bio bin	x	✓	x	x	Less maintenance	Rs. 900	Need to maintain low moisture content
	4	Pipe compost	x	✓	x	x	Less maintenance	Rs. 890	Issues due to worms
	5	Vermi composting	x	✓	x	Leachate can be used as manure	Requires continous	Rs. 950	Degradation takes time and noticeable odour

							maintenance and care		
	6	Ring composting	✓	✓	x	x	Less Maintenance	Rs. 2500	Fly nuisance and odour problems
Community	7	Aerobic composting unit	✓	✓	x	x	Requires continous maintenanace and care	Rs. 1.4 Lakhs	Fly and rodents nuisance
	8	Windrow composting	✓	✓	x	x	Requires continous maintenance and care		Fly nuisance and odour problems
Inorganic waste management									
Community	9	Incinerator	✓	x	✓	Can be used to manage sanitary napkins	Requires maintenance	Rs. 20,000 to 2.5 Lakhs	Fluegas produced must be cleaned before dispersed
	10	Material Recovery Facility	✓	x	x	Used for seperating and diverting recyclable waste	Requires maintenance	For 500 sqft MRF – Rs. 7.4 Lakhs	-

	11	Plastic shredding unit	✓	x	x	Used to Shred plastic waste	Requires maintenance	5.25 Lakhs	-
	12	Swap shop	✓	x	x	Used for exchanging reusable goods	Requires maintenance		-

Annexure IV. Liquid Waste Management Questionnaire

1. General Details
2. No. of permanent residents in house; no. of adults and no. of children.
3. Any home-based job such as pickle making or grinding units at home.?
4. Primary Source of water

    a. KWA **b. Public taps**

    c. Well **d. Others**

    e. Tankers

5. If tanker, specify capacity of water taken per day (in liters)
6. If KWA, specify bill amount every 2 months:
7. If well, specify capacity of tank and number of times filled per day:
8. If public taps specify quantity
9. Toilet Present at home or not
10. Disposal method of black water

    a. Septic tank **b. To drains**

    c. Leach pit **d. Others, specify**

11. Disposal of grey water

    a. Septic tank **b. To drains**

    c. Leach pit **d. Others, specify**

12. How do you dispose toilet waste? (select any one)

    a. **Septic Tank** **b. Community /shared septic tank/facility**

    c. **Leach pit/ Pit** **d. Other**

e. Nearby drain **f. Community /shared septic tank/facility**

8. How old is your Septic Tank/Pit (Year)? (select one)

a. Less than 1 yr. **b. 7-9yr**

c. 1- 3 Yr **d. 10-12yr**

e. 4-6 Yr **f. 13-15yr**

9. Where septic tank /leach pit is located? (select one)

a. Just under the toilet **b. Not under the toilet**

10. Shape of Septic Tank / Leach pit (Select any one)

a. Round / Cylindrical **b. Round / Cylindrical** **c. Round / Cylindrical**

11. Wall material of Septic Tank / Leach pit (Select any one)

a. Rings **b. Rings**
c. Perforated rings **d. Perforated rings**
e. Bricks/stone masonry **f. Bricks/stone masonry**
g. Perforated bricks **h. Perforated bricks**

12. Bottom material of Septic Tank / Pit (Select any one)

a. No bottom **b. No bottom**
c. Concrete **d. Concrete**

13. Does the Septic Tank / Pit has opening at top? (Select any one)

a. Yes **b. Yes**

14. What kind of opening does the septic tank / pit have? (select one)

a. Manhole with iron lid **b. Manhole with iron lid**

c. Manhole with cement lid **d. Manhole with cement lid**

e. Removable round cement lid **f. Removable round cement lid**

15. Number of chambers in Septic Tank/Soak pit? (select one)

a. 1 **b. 1**

c. 2 **d. 2**

e. 3 **f. 3**

16. Does the septic tank/leach pit have a ventilation pipe? (select one)

g. Yes **h. Yes**

17. Does the ventilation pipe have a mosquito proof wire mesh? (select one)

i. Yes **j. Yes**

18. Wastewater from septic tank/soak pits is released into? (Select any one)

a. It does not have outfall **b. It does not have outfall**

c. Outfalls into a nearby drain **d. Outfalls into a nearby drain**

e. Outfalls into pit/trench specifically made for this purpose **f. Outfalls into pit/trench specifically made for this purpose**

19. Have you cleaned septic tank/pit till date? (select one)

a. Yes **b. Yes**

20. Frequency of cleaning leach pit/septic tank (Select any one)

a. Once in 3 months **b. Once in 3 months** **c. Once in 3 months**

d. Once in 6 months **e. Once in 6 months** **f. Once in 6 months**

g. Once in 12 months **h. Once in 12 months** **i. Once in 12 months**

21. Specify the agency employed to clean the septic tank/pit most of the times (select one)

22. Material used for construction

a. Concrete **b. Concrete** **c. Concrete**

23. Bottom sealed or not:

a. Yes **b. Yes**

24. Cleaning Period:

a. Once in 3 years **b. Once in 3 years** **c. Once in 3 years**

25. Agencies involved for cleaning:

a. Private Agency **b. Private Agency** **c. Private Agency**

26. Usage of toilet cleaners:

27. Frequency of using toilet cleaners:

a. Weekly once **b. Weekly once**

c. Once in two weeks **d. Once in two weeks**

28. Is there be any odour from septic tank?

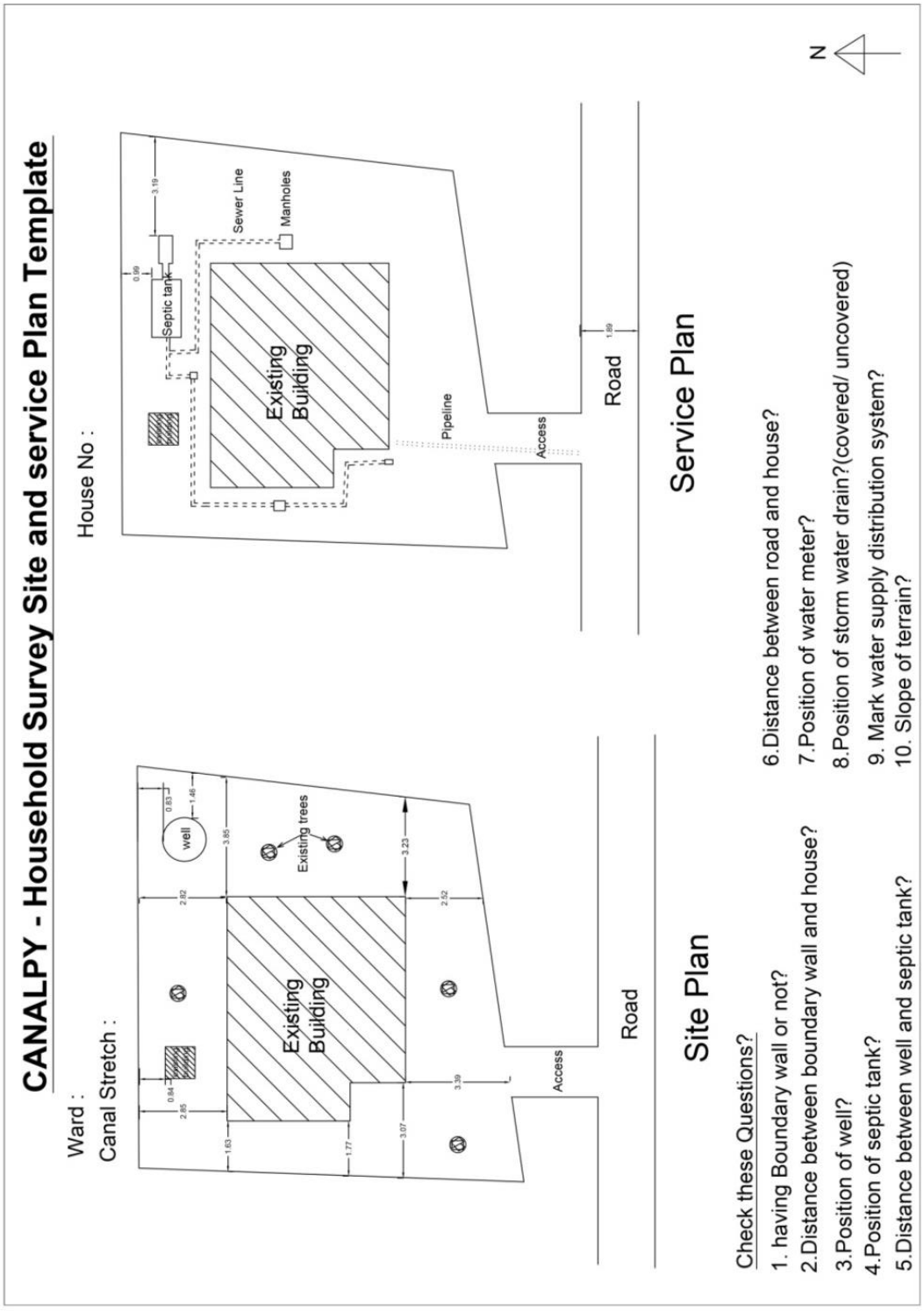
a. Yes **b. Yes**

29. Willingness to install a new system:

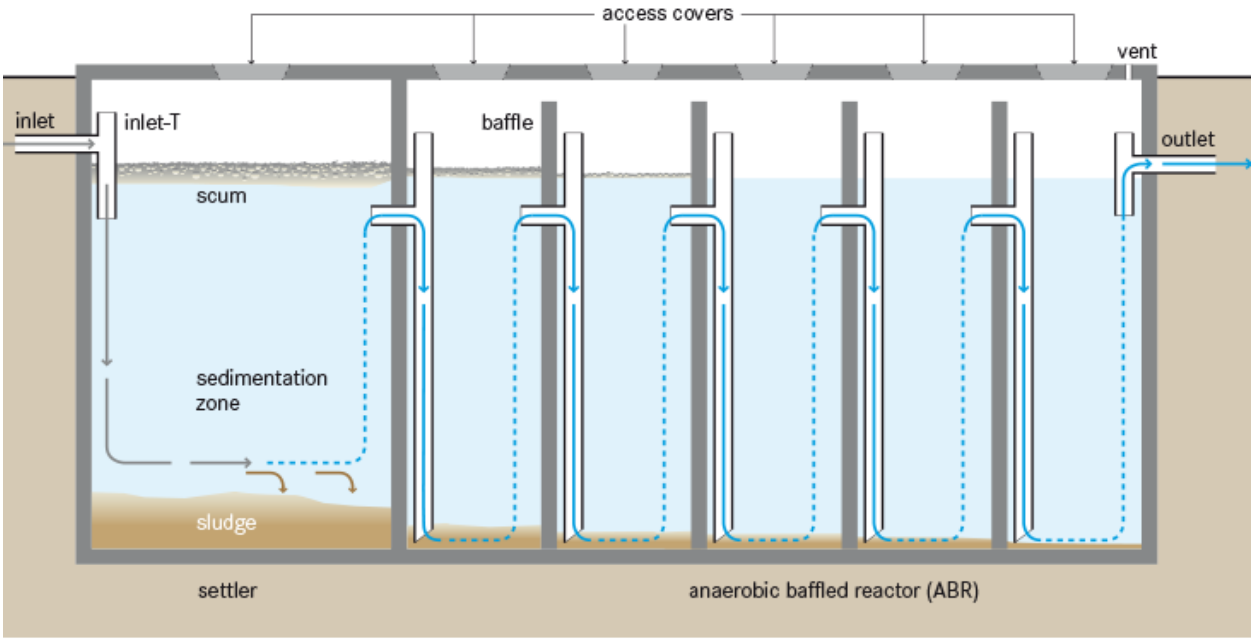
a. Yes **b. Yes**

30. Photos covering all sides

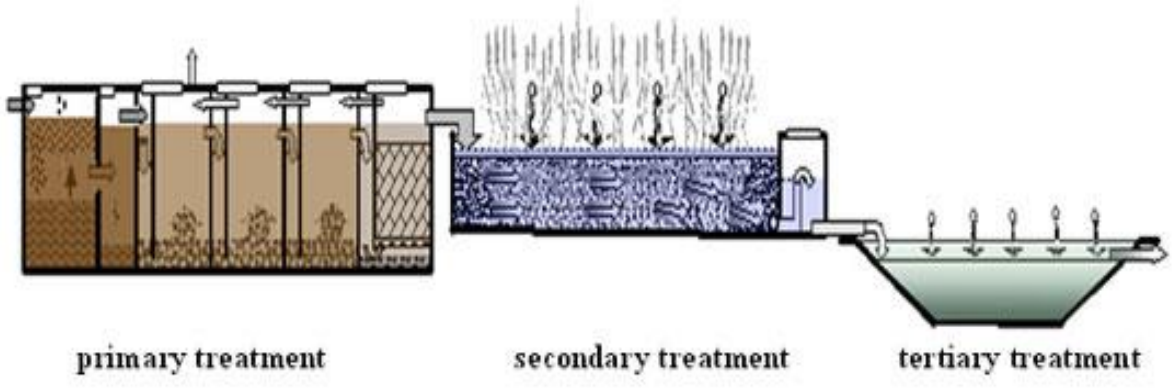
Annexure V. The template of field drawing which is needed to adopt for survey



Annexure VI. DEWATS Design Community Level

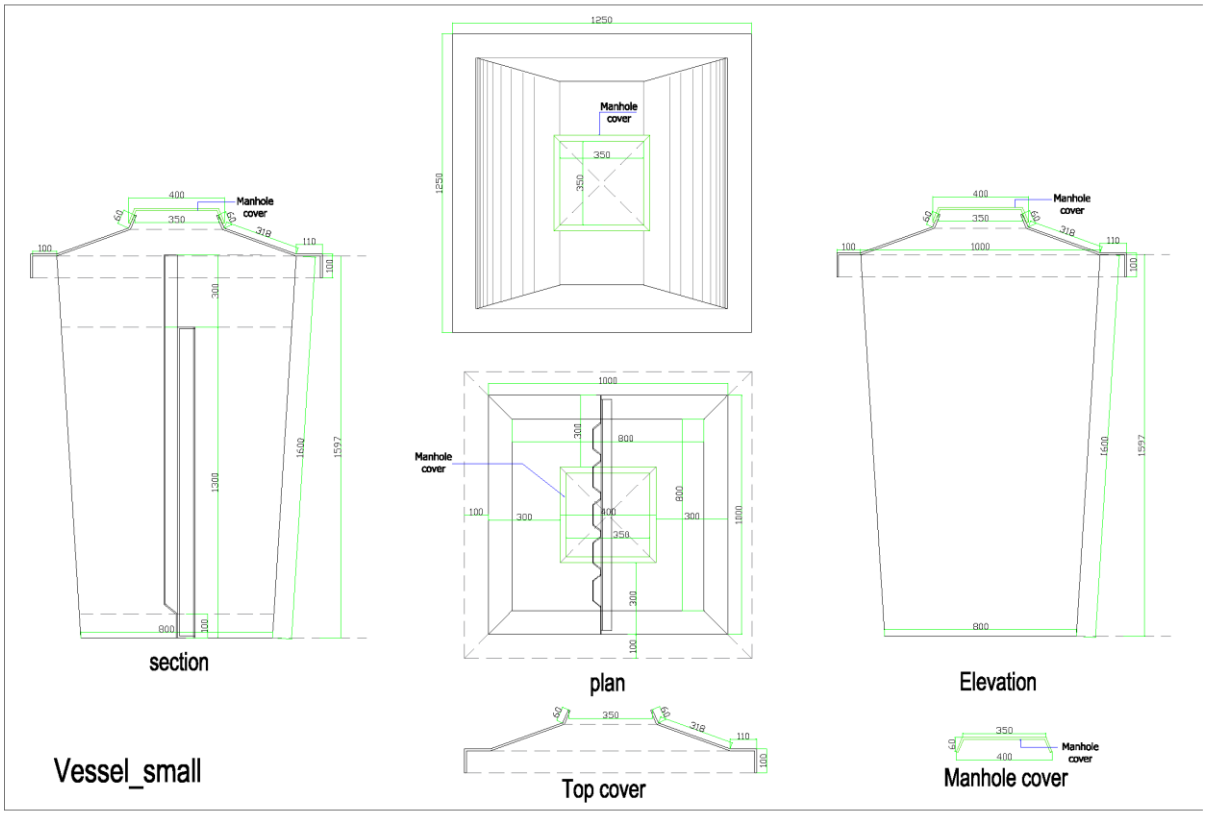


Section of anaerobic baffle reactor



Baffle reactor

Annexure VII. DEWATS Design Individual System



Annexure VIII. The different elements of the action plan

An action plan is a document that lists what steps must be taken in order to achieve a specific goal. The purpose of an action plan is to clarify what resources are required to reach the goal, formulate a timeline for when specific tasks need to be completed and determine what resources are required. Before begin an action planning process, the strategic framework for the work of project should be in place.

Action plan is based on time frame. Three type of action plan are adopted and they are:

Short term actions: The actions which needs to be done immediately can be listed as short-term actions. Ideally these are the actions which are targeted to be completed within 3 months.

Medium term actions: Typically, actions which require fair amount of pre planning or the ones for which funding options and legal provision are required are listed in medium term actions. They have to be targeted to be completed within 6 months.

Long term actions: Actions which require short-term and medium-term actions to be completed before initiating implementations can be listed here. They have to be targeted to be completed within 1 year.