The Bill & Melinda Gates Foundation

# Final Report

## Landscape Analysis and Business Model Assessment in Fecal Sludge Management, Extraction and Transportation in three Cities of Ethiopia (Addis Ababa, Dire Dawa and Hosaena)

**By: Ethiopian Team**

*Hywas Engineering Consultants & Partners*

**(Water supply & Sewerage Consulting Firm in Category III)**

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# Executive Summary

*Ethiopia is an East African country with a population of over 80 million. Based on the 2007 Census, about 55% of the population has access to potable water while only 33% have toilet facility. Considering the urban population, the water supply coverage was 92% and the sanitation coverage was about 72%. In Ethiopia, the sanitation issues are dealt with under different government organs such as the Ministry of Water and Energy, Ministry of Health, Environmental Protection Authority, city municipalities etc. because of its trans-sectoral nature.*

*Recognizing this overlap of service delivery and the gap in accountability in the sanitation sector, the Bill & Melinda Gates Foundation under its Water, Sanitation & Hygiene sector formulated a program entitled "Landscape Analysis and Business Model Assessment in Faecal Sludge Management: Extraction and Transportation Models in Africa and Asia" to address the emptying and proper disposal of faecal sludge from low income population of urban areas. In Africa, the project covers five countries, namely, Senegal, Nigeria, Burkina Faso, Kenya and Ethiopia.*

*The main objective of the research study is to analyze the extraction and transportation operation of fecal sludge in the country and identify business opportunities in this sector. Accordingly, the following tasks are accomplished by the consultant:-*

- *i) Lead the in-country research in 3 cities i.e. Addis Ababa with a population of 2,738,248, Dire Dawa with a population of 341,834 and Hosaena with a population of 69,995 based on the census of 2007 of the country,*
- *ii) Conducted desk reviews and house hold surveys,*
- *iii) Developed an analytical research framework,*
- *iv) Developed case studies for the country including comparative analysis of emptying/transportation in the three cities, with identification of opportunities for product and business model innovation and*
- *v) Collected data and key outputs through direct field surveys and interviews with relevant stakeholders in the cities,*

*The consultant team developed a comprehensive approach to capture all relevant information and data related to FSM available in the three cities. This involved literature review, household sample surveys of each of the three cities, and interviews and discussions with service providers, government regulators, beneficiaries and all other relevant stakeholders in the management of fecal sludge extraction, transportation and disposal services. The actors in this field included government authorities and institutions, private operators and non-government organizations (NGO).*

*The result of the study indicated that the policy and regulatory framework of the country is conducive to the proper disposal of sludge. However, few gaps and overlaps are observed here and there in the different cities in the implementation of the regulations.*

*Among the interviewed households in Addis Ababa, 85.8% have private water supply connections, while 2% get water from kiosk, 12% buy from vendor and while other 0.2% belong to others. Similarly, 90.8% have a sanitation facility in their respective compounds while 9.2 % of the respondents do not have a sanitation facility, and they use either public toilets or open spaces as their basic sanitation facilities.*

*In Dire Dawa, 71.3% of the households interviewed responded that they have private water supply connection, while 3.2% get water from kiosk, 24.5% buy from vendor. 95% have a sanitation facility in their respective compounds while 5 % of the respondents do not have any kind of sanitation facility and they use either public toilets or open spaces as their basic sanitation facility.*

*Similarly in Hosaena, 64.6% have private water supply connection, while 4.6% get water from kiosk, 24.5% obtain from vendor, and the remaining belong to borehole 0.7%, well 1.7, surface*

*water 3.3% and other 0.7%. 91.7% have a sanitation facility in their respective compounds while 8.3 % of the respondents do not have a sanitation facility, and use either public toilets or open spaces as their basic sanitation facilities.*

*According to the 2007 Population and Housing Census of Ethiopia, the sanitation coverage of these three cities is summarized by the table below:-*

| City | | Total No. of HH* | Flush toilet Private | Flush toilet Shared | VIP Latrine private | VIP Latrine Shared | Pit Latrine private | Pit Latrine shared | No Toilet facilities |
|---|---|---|---|---|---|---|---|---|---|
| **Addis Ababa** | No. of HH* | 628,985 | 58,123 | 32,423 | 28,904 | 95,521 | 62,008 | 258,192 | 90,206 |
| | **%** | **100** | **9** | **5** | **5** | **15** | **10** | **41** | **15** |
| **Dire Dawa** | No. of HH* | 72,936 | 2,597 | 2,906 | 2,207 | 5,402 | 8,712 | 20,298 | 30,814 |
| | **%** | **100** | **3.6** | **4.0** | **3.0** | **7.4** | **11.9** | **27.8** | **42.3** |
| **Hosaena** | No. of HH* | 16081 | 189 | 216 | 335 | 561 | 4727 | 8224 | 1829 |
| | **%** | **100** | **1** | **1** | **2** | **3** | **29** | **51** | **11** |

*HH*= households*

*Addis Ababa is the only city in the country where conventional sewerage system is available. Even here its present coverage is only 11%. Therefore, on-site sanitation system combined with fecal sludge extraction, transportation and disposal service is the only option to improve the sanitation condition of the country in the near future. Not so long ago, vacuum truck services were wholly provided by government offices as municipal services. In recent years, however, private operators are allowed to give the service as business undertakings. This made the charge for disludging by vacuum truck per trip variable ranging from as low as USD 4.0 in Addis Ababa by a government authority to over USD 35.0 by private operators serving in Hosaena by traveling from nearby city such as Addis Ababa. The general conditions of the sanitation facilities available for the three cities under as study are as follow:*

| No. | DESCRIPTION | CITIES | | |
|---|---|---|---|---|
| | | **Addis Ababa** | **Dire Dawa** | **Hosaena** |
| 1 | Water borne sanitation facilities inside houses (% of total housing units (HU))- 2007 Census | 14 | 7.6 | 2.5 |
| 2 | On-site disposal facilities (pits of all sorts) in% HU - 2007 census | 71 | 50.1 | 86.1 |
| 3 | Housing units with no toilet facilities - 2007 census in %age of HU | 15 | 42.3 | 11.4 |
| 4 | Availability of sewer system | yes | no | no |
| 5 | Availability of waste water treatment facilities | yes | no | no |
| 6 | Availability of fecal sludge treatment facilities | yes | yes | Only official dumping place |
| 7 | Number of trucks available in the city -2011 | 107 | 5 | none |
| 8 | Number of people served per truck (No.1/No.8) | 25,603* | 68,367 | N.A. |
| 9 | Use of manual emptying | Uncommon | Widely practiced | Uncommon |
| 10 | Average distance vacuum trucks to disposal sites (Km.) | 15 | 6 | 5 |
| 11 | Amount of sludge collected per year | 528,395m3 (recorded) | 32,500 m3 ( estimated) | Not recorded |

*The study has also analyzed the demand and supply for FS emptying and transportation business. Based the emptying frequency and size of collection facilities the total volume of sludge to be emptied per year for 2011 is as follows:*

***Addis Ababa 793,235 m³ , Dire Dawa 49,333 m³** and for **Hosaena 10,972 m³***

*Based on the above analysis and estimated sludge production the present sludge transportation capacities with existing performance levels are not matching the demand for service. In the case of Addis Ababa the major problem for mismatched demand/supply is the low performance of the vacuum trucks (average trip per truck per day being around 3 if all vacuum trucks are considered). In the case of Dire Dawa the vacuum capacities are sufficient but due to management problems (two trucks from the public company are not used because drivers are not hired) and technology related problems the supply cannot match the supply. In the case of Hosaena there is no vacuum truck so the demand is not matched with a supply.*

*Financial analysis of FSM businesses has been carried out. The anlsysis was carried out the profitability of existing companies and the financial viability of a FS emptying and transporting company.*

*The financial analysis of existing companies showed that all private companies are making net profits (after servicing depreciation allowance and income taxes), however both public utilities were making operating deficits.*

*The reasons for making operating deficits for public companies was that in Addis Ababa the price is too low (4.81USD) while in Dire Dawa a problem of management.*

*Further a break even analysis was carried out to show the level at which costs and revenue are in equilibrium. Accordingly, a breakeven analysis for a one truck company was carried out and in order the company to become break even it has to make **1500** trips and charge 32.6 USD.*

*In addition, financial analysis is carried out to determine the financial viability of a new FS emptying and transportation project. It assess whether the revenues of the project will be sufficient to amortize the project loan, pay operation and maintenance costs and meets interest and other financial obligations.*

*The result of financial analysis shows that the project is financially viable for both scenarios, which are carried out in two scenarios (investment through loan and investment without debt).*

*The results of the financial analysis are adequate to justify the financial viability of the FS transportation business with one truck if the tariff rate is 40 USD and an annual 1500 trips is achieved. The sludge emptying and transportation business is exposed to a number of potential risks like any other business. Sensitivity analysis has been carried in order to test the business vulnerability to possible changes. Accordingly, sensitivity analysis will be conducted with the following variables:*

- *Reduction of tariff to 25USD,*
- *Decrease in trips to 1000*

*The result shows under both changes the profitability of the company will be significantly affected.*

*The study also analyzed the factors that would make FS sustainable business in all three cities. The main recommendations to make sustainable business for Addis Ababa are pricing and tariff structure, Cost and revenue optimization, access to finance and capacity building. A*

*recommendation has also been made to expand fleets of private companies and reducing the fleet of AAWSA.*

***Similarly proposals for sustainable FS businesses are made for Dire Dawa and Hosaena**. Further with regard to size of businesses the following has been recommended:*

- *In Addis Ababa middle sized companies are preferred because they would be managed as standalone business with higher efficiency and profitability.*
- *For Dire Dawa both small and medium sized (2 trucks) would be profitable but if the company gets bigger it would have monopoly position.*
- *For Hosaeane one truck is even too big, therefore, it has to share vacuum truck with other Cities.*

*Recommended actions to improve the general condition of the service in the country can be classified as legal and institutional, operational, technical, business and financial and aspects of capacity building.*
*Institutionally this includes establishing clearly delineated institutional framework with clear mandates and city specificity considered in its implementation, demarcating area of operation and limiting the scope of service of the public utility is one of the requests posed by the private operators. In this way the two can go hand in hand and become efficient and the provision of emptying and transportation of FS shall be provided by private companies, while the role of public utilities shall be limited to regulation, licensing, oversight and provision of service to urban poor.*
*On operational aspects, the provisional of maintenance workshops, reduction of the travel time for dumping, awareness creation to all stakeholders on all aspects of fecal sludge management, provide incentives specially for the staffs working in this field to avoid health risks. Furthermore, it is proposed to have vacuum trucks of size with 8m3 to 12 m3 that are believed to be an ideal size for efficient utilization of the resources.*
*On technical issues, the following major recommendations and suggested interventions should be given high priority in order to improve the existing conditions .*

- *The standardization and control in the design and construction of all sanitation facilities at the household level.*
- *Standardization on the purchase of feasible and sustanable type and size of vacuum trucks and major accessories based on good knoweledge of the sludge cahacterstics.*
- *Construction of well desigined addtional transfer station on the selected areas inorder to reduce transportation cost.*
- *Expansion of the existing fecal sludge treatment plants with due consideration of having an improved way of managing the facilites.*
- *Introduction of the use of raw fecal sludge for forestery development around the prephery of the cities and proper handling of reuse in the agricultural sector.*
- *Introduction of high performance vacuum trucks to be used for dry pit latrine emptiyng service as the existing pumper trucks are not suitable to take all the sludge from the pit.*

*To improve the business and financial condition of the operators, special fund should be established to help both private and public companies with loan that have lower interest rates and longer repayment periods under a convenient conditions, encourage the provision of maintenance workshops and spare parts to reduce down time vacuum trucks, devise appropriate mechanism for subsidizing low income group of the community and at the same time avoiding subsidy to high income group to cover to cover the full cost and support private operators to improve their services.*

Landscape and Business Model Analysis of FSM in Ethiopia

# 1. COUNTRY FSM BACKGROUND

## A) Background of the Study

Sanitation is generally considered as a trivial issue in the formulation of policies and political agenda of most governments as its evolutionary after effect is not so visible to propagate immediate public concern or resentment. This trend is more pronounced in developing countries such as in Ethiopia where pressing issues which cause instantaneous havoc are given high priority. Based on the 2007 Census, about 55% of the population of the country has access to potable water while only 33% have toilet facility. Considering the urban population, the water supply coverage was 92% and the sanitation coverage was about 72%. This shows the bias in favour of water supply to provision of sanitation service. Sanitation service includes site disposal facilities, extraction or collection of the excreta, transportation of the waste and safe disposal or reuse of both the liquid waste and the sludge involving many actors in the process. In Ethiopia, the sanitation issues are dealt with under different government organs such as the Ministry of Water and Energy, Ministry of Health, Environmental Protection Authority, etc. because of its trans-sectoral nature. The Ministry of Water and Energy under its Ethiopian Water Resources Management Policy of 1999 allocated a section on Water Supply and Sanitation Policy; the Ministry of Health in its Health Policy considers as part of the Environmental Health issue and the Federal Environmental Authority deals it as the major issue of Pollution Control.

Recognizing this overlap of service delivery and the gap in accountability in the sanitation sector, the Bill & Melinda Gates Foundation under its Water, Sanitation & Hygiene sector formulated a program entitled “Landscape Analysis and Business Model Assessment in Faecal Sludge Management: Extraction and Transportation Models in Africa and Asia” to address the emptying and proper disposal of faecal sludge from low income population of urban areas. In Africa, the project covers five countries, namely, Senegal, Nigeria, Burkina Faso, Kenya and Ethiopia.

For Ethiopia, Bill and Melinda Gates Foundation (BMGF) assigned Hywas Engineering Consultants and its partners as per contract agreement signed on 18 April 2011.

As described in the scope of work, ‘the purpose of this research is to inform the sanitation sector, for the purpose of informing more in-depth empirical research and/or investments by governments, donors and other development partners. A synthesis report from each region will provide analysis of wider patterns across countries in which the research will be conducted. In the countries and cities where the study will be carried out, results will be structured to feed into discussion and debate at the local level among urban sanitation policy makers and practitioners, in order to develop a better understanding of this area of sanitation service delivery.’

## B) Objective of the Study

The main objective of the research study is to analyze the extraction and transportation operation of fecal sludge in the country and identify business opportunities in this sector. To achieve this main objective, the following tasks are expected to be accomplished by the consultant:-

vi) Lead the in-country research in 3 cities i.e. Addis Ababa, Dire Dawa and Hosaena,
vii) Conduct desk reviews,
viii) Develop an analytical research framework for locations to be studied,
ix) Develop rigorous case studies for the country including comparative analysis of emptying/transportation in the three cities, with clear identification of opportunities for product and business model innovation,
x) Collect data and key outputs as described below through direct field surveys and interviews with relevant stakeholders in the cities,
xi) Publish findings in peer reviewed literature and

xii) Present at national workshops to policymakers and other local stakeholders.

In line with the requirement of the Scope of Work (SOW) by BMGF, the three cities selected for the study are 1) the capital city - Addis Ababa which is located at the center of the country and the highest populated urban area in the country, 2) a city administration – Dire Dawa which is located on the eastern side of the country with the second highest urban population in the country and 3) a zonal town – Hosaena which is located south western part of the country with population of less than one hundred thousand.

### C) City Specific Information

## Addis Ababa

### Location

Addis Ababa is the Capital City of the Federal Democratic Republic of Ethiopia (FDRE) and was founded by the late Emperor Menelik in 1887. It is the largest urban centre and also the political, economic and social nerve centre in the country. It plays host to the African Union and many other international organizations and diplomatic missions.

The City of Addis Ababa stretches some 25 km. from East to West and some 20 km. from North to South. It lies between latitudes 8° 56' and 9° 05' North and between longitudes 38° 43' and 38° 50' East. Presently the city covers an area of 540 km2. Its elevation ranges from 2700 masl in the North to about 2200 masl in the South. The Entoto mountains range, which rises to over 3000 masl, limits the city expansion in the North.

### Temperature

The mean minimum annual temperature in Addis Ababa occurs in the month of December, with a value of 9.8°C. The mean maximum annual temperature occurs in the month of May and rises to a value of 23.4°C.

### Wind

From September to May, the wind blows from the east and the south-eastern at average velocity of 7.5 knots. Between June and August, which is a rainy season, the wind blows from the southwest at average velocity of 11 knots.

### Evaporation

The maximum monthly-recorded pan evaporation values at Bole Airport meteorological gauging station range 150 mm to 190 mm during the months of October to January whereas the minimum monthly pan values occur in the period June to September, with a mean value of 83 mm.

### Rainfall

The rainfall patterns around Addis Ababa are influenced by the Inter-Tropical Convergence Zone (ITCZ) .The ITCZ passes over Ethiopia twice a year and this migration alternately causes the on-set and withdrawal of winds from the North and South. This causes Addis Ababa to have a bimodal type of rainfall. The main rain season called Kiremt occurs between June and September while the short rains season known locally as Belg occurs from March to April.

The mean annual rainfall for Central, Eastern and Southern Addis Ababa are 1257 mm, 1067 mm and 1163 mm respectively. The mean maximum monthly rainfall occurs in July and August with values of 274 mm and 294 mm respectively. It is estimated that about 60% of the rainfall occurs during the long rain season (Kiremt).

### Administration

The City has a decentralized structure of governance with ten (10) sub-cities and one hundred and one (101) Kebele administrative units in 2010. It is led by a Mayor, who controls his own cabinet. There is also a Judicial and Chief Auditor. The city administration focuses mainly on minimizing the rate of unemployment, housing, infrastructure development, environment; disease spread control, promoting investment and industrial growth

## Dire Dawa

### Location

Dire Dawa is the capital city of Dire Dawa Administrative Council, which is situated in Eastern part of Ethiopia at about a road distance of 521km East of Addis Ababa and 306 Km. from Djibouti to south-east directions by road.

The geographical location of the Dire Dawa town is between 9° 4' N latitude and longitude E 41° 52' E and the mean altitude is 1160 m a. s. l. The proximity to Djibouti made Dire Dawa an outlet for export and import carried out between the hinterlands and the outside world. Neighboring regions of Dire Dawa are the Somali Regional State in the North and West, and Oromiyia Regional State in the East and South directions.

As per the CSA 2007 census base population, the city population is projected to be 267,311 in 2010 with nine Kebele Administrative structures. Since the implementation of the first phase of the water supply system, the settlement and the size of the city have increased dramatically. The size of the city under AESL (… year) study was 83.2 Square Kilometer ($Km^2$), while under WWDSE (… year), the area has increased to 192.45 Square Kilometer ($Km^2$) in 2004. Furthermore, the size of the city has been expanded to encompass about 379.28 Square Kilometer (Km2) in 2006 Spatial Development Framework study of the IDP of Dire Dawa.

### Land escape

The city of Dire Dawa is situated just at the foots of the hills stretching from south-east to west direction by making a border line between the highlands of the previous Hararghe region and the vast lowlands extending up to the red sea.

The most northern and western parts of the administration is flat land and the rest of the areas are naturally rugged terrain in topography. The landscape of the south-eastern and southern parts of the administration is dominated by sharp edged hills (escarpments) with a slope exceeding 45 %. The slope is gentle in other parts of the administration that goes down up to 0 % in the flat areas. In the entire administration, the altitude ranges between 950 - 2450 meters above sea level. The topography of the city is generally flat and the city center is found at an altitude of 1050 meters above sea level.

### Climate

The climate of the administration is generally semi-arid nature with an average annual rainfall of 604 millimeters and a mean daily temperature of 25.4°C. It is characterized by low amount of precipitation, high temperature and a considerable amount o evaporation that affects the moisture level of the soil to undertake rain fed agricultural production as conventionally exercised in the most highland parts of the country.

## Hosaena

### Location

Hosaena Town, capital of Hadya Zone is found in Southern Nations, Nationalities and Peoples Regional State (SNNPS) of Ethiopia. Hosaena town is located between 833000N and 835000N

latitudes and 373000E and 374000E longitudes in UTM coordinates. The town is located at an elevation ranging between 2250 m. and 2380 m. above sea level and 230 km south west of the Country's Capital city Addis Ababa in direction of Alemgena and Butajira Road.
Hosaena town comprises of three Kifle Ketemas (Sub-cities) and fifteen Kebeles. It is one of economically and socio-politically dynamic towns in the region and has relatively adequate infrastructures including safe water supply.

## Landscape

Hosaena town is located mostly on the wind side of a hill and has undulation topography. Generally the town slopes down from the western and southern side towards the east and north direction with an elevation difference of up to about 130 meters. The south and south western part of the town is over 2300 m. above sea level while the eastern side goes down up to 2250 m.

## Climate

Hosaena is characterized with highland or 'Dega' climatic conditions. It has annual average temperature ranging from 16°C to 17°C and a mean annual rainfall of 1179.3 mm/year. Therefore the town has moderate temperature most of the year.

The location of these three cities/towns is shown in Fig. 1-1 below:


**Table 3-1 1-1 Location Map of Cities under the Case Study**

This is a final report, as required by the contract, to compile and present the findings of the consultant for the three cities i.e. Addis Ababa, Dire Dawa and Hosaena and synthesize the results to come to a country wide solution on best practice for fecal sludge extraction and transportations mechanism.

The report describes the objective of the research, the general description and locations of the cities selected for the study, the methodology employed in the study, presentation of the results of the research and discussions, financial and economic viability of extraction and transportation of fecal sludge in **Addis Ababa, Dire Dawa, Hosaena** and in the country as a whole. Finally conclusions and recommendations are presented.

# 2. METHODOLOGY

## General

The consultant team developed a comprehensive approach to capture all relevant information and data related to FSM available in the three cities. It started by gathering relevant documents of all the three cities to the study and review them.

## Criteria for site selection

Based on the requirement of the SOW prepared and sent to the consultants, the selected three cities are composed of "the capital city, a secondary large city and a mid-sized city". These cities are selected because of their population size and their commercial and industrial developments in order to make them viable for private operators of fecal sludge extraction and transportation to establish business.
Another important criteria used in the selection of the cities is the existence of different kinds of sludge management practices and technologies for handling fecal sludge. The possiblity of getting data is also other criteria that is considered.
The geographical distribution of the cities in the country is also taken into account. Since the capital city – Addis Ababa is located at the center of the country, the second city – Dire Dawa is chosen because it is found on the eastern side of the country, while Hosaena is on the south western side.

## 2.1 Literature review

All relevant documents pertinent to fecal sludge extraction and transportation from the three cities and other federal legal, regulatory and policy documents and reports are explored during the study. These reports and documents can be classified in two major types such as general documents relevant to the whole country and specific studies of each of the three cities. These documents are quoted below as to their importance to fecal sludge extraction and transportation.

- Constitution, General Policies, Proclamations and Regulations
- Regional State and/or City Administration Level Regulations
- 2007 National Population and Housing Census of Ethiopia
- Wastewater Masterplan of Addis Ababa, NEDECO/DHV 2002
- Draft Business Plan for Addis Ababa Water and Sewerage Authority, 2011 (Not Published)
- Dire Dawa Water Supply and Sanitation Study, MS Consult, 2010
- Dire Dawa City Public latrine baseline Survey Analysis, City Administartion, 2010
- Hosaena Water Supply and Sanitation Detail Design Study, HYWAS, 2010 and
- Other relevant documents on the production, extraction and trasportation of fecal sludge which are quoted at their appropriate places in the report.

## 2.2 Situational analysis methodology

### 2.2.1 Household survey design

The basis for framing the sampling is administrative rosters, in the Ethiopian Context called Kebeles (smallest administration Area). Cities are divided into either Woredas (Districts) or Kifle Ketemas (Sub Cities). Kifle Ketemas or Woredas are further divided in to Kebeles. Since some cities do not have Kifle Ketemas we used Kebeles as the basis for framing the sample area.

Once the areas are identified, we use multi-stage sampling techniques to arrive at good sampling. The sampling units will be selected with systematic random sampling to increase representativeness.

The sampling is designed to address the following representations:

- High income households
- Medium income households
- Low income households
- Households with accessibility problem (either very narrow or steep slope pathway to acces by vehicle for disludging, etc.)
- Multipurpose used compounds (compounds such as having houses for dwelling, handicraft, shop etc.)

In selecting the areas we have also made an effort to capture distance and proximity to the city sanitation facilities including sewer network, transfer station and treatment plant.

### Size of the Sample

In determining the sample size we have considered ensuring that the size will ascertain representativeness in the city. Considering the time limitation and ensuring representativeness we have decided to size the sample as follows:

### Survey Area

Determining the survey area is essential to ensure representativeness and the quality of sampling. Therefore, it is decided to cover the whole Kifle Ketemas (Sub Cities) where Sub Cities are part of the administrative structure in the City in all three Cities. Where there is no Sub City, the whole Kebeles (the smallest administration unit) are covered.

In Dire Dawa and Hosaena we covered the all Kebeles while in Addis Ababa we covered all districts and 6 Kebeles in each district to address the representativeness.

The size of survey areas in the cities is presented in Table 2-1 below

**Table 2-1 Selected Districts and Kebeles of the Three Cities**

| City | Total Adm. Areas | | Sampling Areas | | Total Sampling Sizes |
|---|---|---|---|---|---|
| | Sub Cities | 'Kebeles' | Sub Cities | 'Kebeles' | |
| **Addis Ababa** | 10 | 116 | 10 | 60 | 600 |
| **Dire Dawa** | 0 | 9 | 0 | 9 | 400 |
| **Hosaena** | 3 | 8 | 3 | 8 | 300 |

The details of selected areas of Addis Ababa are shown in Figure.1 below while for the two cities all the Kebeles (Lower level of administration area) will be covered.

The following Kebeles in Addis Ababa are selected within each Sub City as shown in Table 2-2 and Figure-2 below.

**Table 2-2 Selected Kebeles within the Sub- cities of Addis Ababa**

| No. | Kifle Ketema /Sub-city | Selected Kebeles |
|---|---|---|
| **1** | Akaki Kaliti | 02,04,05,06,10,11 |
| 2 | Nefas Silk- Lafto | 05,06,07,12,13,15 |
| 3 | Kolfe Keranyo | 02,03,06,08,09,12 |
| 4 | Gulele | 03,04,05,07,09,15, |
| 5 | Lideta | 04,06,09,10,15,16 |
| 6 | Kirkos | 01,13,14,15,16,19 |
| 7 | Arada | 07,08,11,12,15,16 |
| 8 | Addis Ketema | 10,14,16,17,18,21 |
| 9 | Yeka | 01,02,08,15,18,19 |
| 10 | Bole | 02,03,05,12,13,16 |
| **Total** | | **60 Kebeles** |

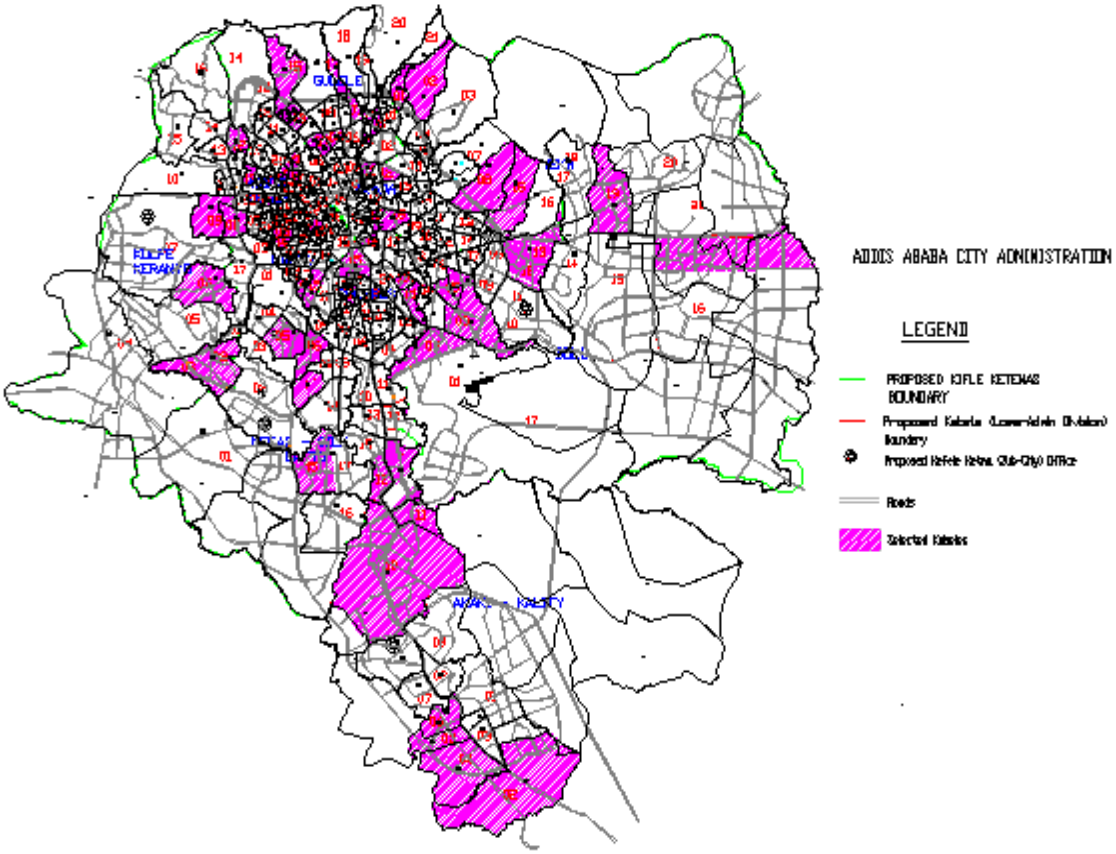



Table 3-1 2-2 Selected Kebeles in Addis Ababa

**Expected outputs from the household survey**

The household survey on Fecal Sludge Management study was designed to provide adequate information on the modes and practices of fecal sludge management among the households, and on the availability and quality of the fecal sludge emptying service.

The scope and coverage of the household survey include:-

- Water and Sanitation Coverage in the city
- Types and distribution of Sanitation facilities
- Faecal sludge extraction and transportation system
- Faecal sludge extraction frequency
- Faecal sludge extraction cost
- Challenges faced by households
- Willingness to improve FS Management in the city

**Sampling Procedure**

The study team employed a clustered stratified random sampling technique, where the all sub-cities (in Addis Ababa and Hosaena) and all Kebeles in Dire Dawa were used as clusters. From each cluster areas were randomly selected, and yet, from each selected area households were randomly identified and interviewed based on the sampling frame.

In order to make the sample more representative the sampling frame was designed based on the following criteria:-

- Higher income ---------- 20%
- Middle Income---------- 30%
- Lower Income---------- 30%
- Inaccessible households---------- 10%
- Multipurpose Compound households-------- 10%

The income level of the family was determined by the type of the housing. This was made in order make sampling as easy and consistent for the enumerators to select the interviewee randomly and decide before entering the house. Accordingly, a private single Villa (a villa used by one family) inside a plot larger than 300 m2 is considered high income. A private house inside a plot smaller than 300m2 is considered middle income. Houses in shared compounds and single house made of mud are considered low income. Inaccessible households are families living in areas with no access road (or narrow) to their compounds. Multipurpose compounds are concessions used not only for living but also used as shops, kiosks, workshops, bars etc.. Inaccessible houses are usually inhabited by lower income families. Multipurpose compounds do not reflect income level but it was selected to show the complexity or difficulty of handling fecal sludge in concession used by different families and people only working in the compounds but not living there. The sampling does not reflect 100%the habitat and income level of households but this is the best probability of accessing all types of families and fecal collection typologies in the City.

**Survey Process**

Enumerators were selected, and were provided with a half day training to undertake the assignment to its highest quality and standard. One enumerator was assigned to each Sub-city/Kebele, and each enumerator has managed to conduct 60 questionnaires in the respective area.

The household survey was concluded within 30 days (May 2011). In order to ensure quality output, the performance of each enumerator was monitored on a daily basis, and the necessary corrective measures were taken for observed enumeration errors.

**Data Entry, Cleaning and Analysis**

The data entry task was conducted by two secretarial staff of the consultant. The overall entry process was finalized in 14 days, (June 2011). Appropriate training was provided as a general guideline to the entry software. As discussed during the training and Kick-off Workshop at the Addis Ababa Hilton, the consultant has used SPSS version 15.0 to compute the data, which has been submitted to the client in a Microsoft Excel format.

The next step on the data computing process is data cleaning, which was conducted by the survey supervisor. This assignment was completed within two and half days. Prior to the data entry process, a code was given to each questionnaire. This code corresponds to the relevant Sub-City, and served as an indication to the questionnaires during the data cleaning task.

The final step in working with the surveyed data is the data analysis processes. While conducting the analysis the consultant has employed two basic terminologies, “Not Applicable” and “Not Specified”. The “Not Applicable” terminology describes that any value cannot apply to a certain variable due to its preceding value. For example, if the answer for the question “Do you have a sanitation facility?” is “No”, then the next question, “What kind of Sanitation Facility do you have?” or “Are you satisfied with the type of facility you have?”, does not apply to the respondent due to its preceding response.

The “Not Specified” terminology, as the name shows, indicates questions that could not get any response from the respondents.

Basically, the consultant has used descriptive frequency analysis methodology to compute the data.

**Limitation of the Household Survey**

Despite the thorough preparation and detailed explanation and discussion with respondents the following limitations were observed:

- Most of the respondents were not willing to specify their incomes (over 50% in three cities)
- The households were unable to estimate the quantity of fecal sludge produced in their households.
- Most of the respondents could not give the quantity of sludge evacuated
- Some of the respondents were unable to exactly identify the frequency of emptying

### 2.2.2 FSM practices and data collection

The FSM practices in the three cities are collected from Statistical Tables for the 2007 Population and Housing Census of Ethiopia. Where available, this is also supplemented by other studies done for the respective cities. The house hold surveys done by the consultant are also used in having in-depth understanding of the fecal sludge management practices of the cities under study and the condition in the country in general.

### 2.2.3 Methods to validate financial data

Validating data has been a very serious challenge during the study. The study team has recognized the seriousness of the issue and has used alternative sources of information to validate the data. These are:-

**Household Survey**

- Information from Public Utilities
- Population and Housing Census data
- Waste water Master Plans for waste water in the three Cities

**Companies Operation Data**

- Information from Dumping and treatment plant
- Maintenance Workshop

**Companies' Financial data**

- Household data
- Operators response
- Planned activity of companies (Intention to procure additional trucks)
- Information from the Public Utility

Based on the alternate sources assumptions were made and an attempt was made to verify the assumptions with company owners, operators and former staffs.

### 2.2.4 Treatment Plant/Dumping Sites Model

## 2.3 Determination of financial flows and key stakeholders

The source for the identification and determination of financial flows of FSM has been the following:

- Interview of key stakeholders
- Secondary sources like wastewater master plans of the Cities
- Household survey
- Vaccum Truck Owners and Operators interview

Key stakeholders of FSM have been identified initially by discussing with the public organizations responsible for providing FSM service. The public utilities have provided the team with the list of key stakeholders of FSM from their perspective. This list has been used as a road map but was complemented with secondary sources /literature and questioning Experts of FSM in the Country.

This information was a good starting point but they were strongly enhanced through the interviews of vacuum truck owners, operators, re-users and others. Further it was enhanced through the result of the household survey.

## 2.4 Market size calculation method

### 2.4.1 FS production and collection computation

The market size of FSM was calculated by using a combination of methods and sources:

- Population size was taken from National Census and projected to 2011
- To determine the proportion of sludge collection types the Census of 2007 was used as a primary source and was projected to 2011 considering various factors.
- To determine sludge production, the frequency of emptying was taken from the household survey and the per capita generation was computed using the table that was provided by the Foundation (with minor adjustments)
- The result were verified by comparing with theoretical per capita production rates
- Determination of collection rates vary from City to City, while for Addis Ababa the annual sluge amount dumped was taken from the Public utility, for Dire Dawa it was computed based on the number of trips obtained fom the both the public utility and private company.

## 2.5 Financial Analysis methodology

The methodology to be applied for financial analysis will depend on the purpose of the analysis. For the FMS study the purpose of the financial analysis was the following:

- To analyze the profitability of existing companies (Income Statement)
- To analyze the financial viability of a new emptier company for investment decision (IRR, NPV, CF)
- To analyze variables that affect profitability of companies (Breakeven analysis)
- To test sustainability of FS business models from financial point of view

The first step in any financial analysis is to organize and pull together required parameters and assumptions that will be used as inputs for the financial analysis. Accordingly, based on the findings of the survey, other secondary sources and expert judgment assumptions and parameters were made.

Assumptions made for the following items:

- Service life — 10 years
- Vacuum Truck fuel consumption — 3.5Km/liter
- Maintenance expense — 5% of truck price[1]
- Insurance expense — 1% of truck price

[1] The majority of the companies are either not willing to give or do not know (because they do not have proper financial records) their expenses!! In this case the team made estimates based on actual or close to actual costs. Example insurance cost is close to 1% of truck price.

The next step is to put the input data and compute to get the income statement. Excel based simple sheets were used to compute the expense and revenue comparisons and generate income statements. This was done for small, medium and large companies based on actual financial figures of existing companies.

To analyze the financial viability of a new emptier company two scenarios were done with loan based finance and equity based finance. The computation was conducted in a model provided by the Foundation and IRR, NPV and Cash Flow were tested. This was done for a company of one truck.

Some companies might not be profitable or does not generate sufficient surplus, therefore, it is essential to analyze what will make them profitable. For the FS business the following two variables were selected:

- Tariff
- Number of trips

Based on these variables breakeven analysis was carried out and the tariff rate and number of trips were determined that will make the company breakeven.

In addition to this analysis the key variables were identified and sensitivity analysis was carried out. The key variables that would affect the business are numerous like fuel cost, age of truck, tariff and number of trips. For this study sensitivity analysis was carried out for tariff and number of trips.

# 3. Results and ANALYSIS OF URBAN FSM PRACTICE

## 3.1 Situational analysis of extraction/transportation

### 3.1.1 Demographics of the three cities

According to the 2007 census the population of Addis Ababa city is 2, 738,248 with the annual growth rate estimated of 2.1 % based on this estimate the population of Addis Ababa will be doubled in 33.3 years.

Dire Dawa has the second highest urban population in the country next to Addis Ababa. According to the population census of 2007 the city has a total population of 233,224. The population of the rural part of the administration is 108,610 totaling 341,834.
According to the 2007 census, the total number of Hosaena town population has also been found 69,995.

**Table 3-1 population size and distribution of sex group within the tree cities**

| City/Town Name | Population | | | Remark |
|---|---|---|---|---|
| | Male | Female | Both Sex | |
| **Addis Ababa** | | | | |
| 2007 | 1,304,766 | 1,433,482 | 2, 738,248 | census |
| 2011 | | | 3,000,000 | Estimate |
| **Dire Dawa** | | | | |
| 2007 | 171,461 | 170,373 | 341,834 | census |
| 2011 | | | 350,000 | Estimate |
| **Hosaena** | | | | |
| 2007 | 34,472 | 35,523 | 69,995 | census |
| 2011 | | | 75,000 | Estimate |
| | | | | |

The average numbers of persons per housing unit for Addis Ababa obtained from the last censuses (1994 & 2007) have shown also a declining rate.

- Census 1994 5.1 inhabitants per housing unit
- Census 2007 4.27 inhabitants per housing unit

It has been further assumed that the number of inhabitants per housing unit will decline gradually from 4.27 people per HU by 2007 down to 4.0 people per HU by 2020.

The number of conventional housing units in Addis Ababa, Dire Dawa and Hosaena during the 2007 census was 629,984, 72,937 and 16,082 respectively.

It has been observed that in all these three cities, the housing and infrastructural development is rapidly expanding and developing for the last recent years and still continues at present that creates more job opportunity which attracts high immigrant population from the semi urban and rural surroundings.

### 3.1.2 Drinking water supply coverage

#### 3.1.2.1 Addis Ababa

The water sources of Addis Ababa are mainly from surface water (Legedadi & Gefersa) and ground water (Akaki well field, city wells & springs & deep wells). The total production by the end of 2009 was 270,157m3/day). The historical production and source are presented in Table 3-2below.

**Table 3-2 Water Source and Production for Addis Ababa**

| Year | Unit | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|
| Legedadi | $m^3$ /day | 156,389 | 163,053 | 164,489 | 164,966 | 165,264 |
| | $10^3$ $m^3$ /year | 57,082 | 59,514 | 60,038 | 60,213 | 60,321 |
| Gefersa | $m^3$ /day | 22,782 | 22,297 | 23,197 | 20,596 | 28,959 |
| | $10^3$ $m^3$ /year | 8,316 | 8,138 | 8,467 | 7,518 | 10,570 |
| Akaki wells | $m^3$ /day | 35,452 | 36,612 | 41,035 | 46,088 | 46,088 |
| | $10^3$ $m^3$ /year | 12,940 | 13,364 | 14,978 | 16,822 | 16,822 |
| City springs & wells | $m^3$ /day | 4,757 | 5,052 | 7,658 | 10,433 | 28,249 |
| | $10^3$ $m^3$ /year | 1,736 | 1,844 | 2,795 | 3,808 | 10,311 |
| Deep wells | $m^3$ /day | 0 | 0 | 0 | 0 | 1,597 |
| | $10^3$ $m^3$ /year | | | | | 583 |
| **Total production** | $m^3$ /day | **219,380** | **227,014** | **236,380** | **242,083** | **270,157** |
| | $10^3$ $m^3$ /year | **80,074** | **82,860** | **86,279** | **88,360** | **98,607** |

AAWSA has a total of *327,996* active connections as of december 2010. The proportions per type of customers are: *284,664,* Domestic connections (86.8%), *1,510* Public fountains (0.5%) and *41,822* Non-domestic connections (12.7%).

Statistical report regarding source of drinking water for Addis Ababa has been adopted with minor modification as it is reported in 2007 CSA document, refer Table 3-3 below.

**Table 3-3 Water Supply Coverage in Addis Ababa**

| Water source | Connection, Type | Housing Units | %age of HU | Person per HU | Persons | Coverage % | No of Conns. | HU / Conn. |
|---|---|---|---|---|---|---|---|---|
| Tap inside the house private | House Connection Private , HC | 21,998 | 3.5% | 4.27 | 93,995 | 3.4% | 21,998 | 1.0 |
| Tap inside the house shared | House Connection Shared, HCS | 29,330 | 4.7% | 4.27 | 125,327 | 4.6% | 14,665 | 2.0 |
| Tap in compound private | Yard Connection, YC | 162,861 | 25.9% | 4.27 | 695,891 | 25.4% | 162,861 | 1.0 |
| Tap in compound Shared | Yard Connection Shared, YCS | 221,558 | 35.2% | 4.27 | 946,697 | 34.6% | 34,033 | 6.5 |
| Tap outside compound | Public Fountain (PF) (1506x30) | 45,180 | 7.2% | 4.27 | 193,051 | 7.0% | | |
| Tap outside compound | Vendors | 133,460 | 21.2% | 4.27 | 570,263 | 20.8% | | |
| River, well & spring | | 14,598 | 2.3% | 4.27 | 62,376 | 2.3% | | |
| Total | | 628,985 | 100.00% | | | | 233,557 | |

#### 3.1.2.2 Dire Dawa

Ground water is the main source of water supply in Dire Dawa City. The provision of water supply service is managed by Dire Dawa Water Supply and Sewerage Authority (DDWSSA) of Dire Dawa city. Currently there are 10 deep wells and one spring.

The wells defer in service period and production capacity. Of the existing wells, seven are old wells that have been serving for more than 15 years while the other three wells are new that were drilled between 2005 and 2007.

The (which) wells design yield was 280 liters per second while their actual discharge rate is about 200 liters per second at present. In addition to the wells, the Lega Hare spring also discharges water into the city's water supply system. The spring produces an actual yield of 25 liters per second.

With this level of discharge rate from the wells the daily distribution of water to all pressure zones from Sabian pumping station is on the average 9,000-9,500 $m^3$[2]. Distribution of water to all forms of connections is managed from six reservoirs having a total capacity of 6,050 $m^3$. Privately connected customers up to the end of April 2008 were 10,050. Besides, there are 250 public water points established in areas where people living in congested compounds (slums) and marginal parts of the city (informal settlement areas). The average daily water consumption of privately connected customers is estimated to be 2,450 $m^3$ and that of the public water points is 590 $m^3$ per day. Besides, the unaccounted for water (UfW) is 29% at present.

**Table 3- 4 Housing Units in Dire Dawa by Source of Drinking Water: 2007 Census**

| Urban-Rural | All Housing units | Tap inside the house | Tap in compound Private | Tap in compound Shared | Tap outside compound | Protected well or spring | Unprotected well or spring | River/ lake/pond |
|---|---|---|---|---|---|---|---|---|
| Urban+ Rural | 72,939 | 2,879 | 7,175 | 10,892 | 38,979 | 4,018 | 4,875 | 4,121 |
| Urban | 51,596 | 2,617 | 7,148 | 10,358 | 31,182 | 234 | 40 | 17 |
| Rural | 21,343 | 262 | 27 | 534 | 7,797 | 3,784 | 4,835 | 4,104 |
| % of Urban HU | 100 | 5.1 | 13.9 | 20.1 | 60.4 | 0.4 | 0.1 | 0.0 |

As can be observed from Table 3.7, residents of over 60% of the housing units had to fetch water outside their compounds. Even though this condition might have changed after 2007, the number of people who use tap water inside the house could not change significantly in the near future because of the slow change of the economic condition of the city.

### 3.1.2.3 Hosaena

The Construction of existing water supply was completed at the end of 1974 GC. It had two phases. Phase one was designed for 10 years from 1975 –1985 GC and phase two for 10 years from 1985 – 1995 G. C. However the second phase was not implemented. The existing water supply system comprised of 6 bore holes, a dam with the capacity of 460,000m3 and reservoir with two 150m3 capacity each.

The dam was designed to yield 627 l/s (541.73 $m^3$ /day). However as a result of encroaching settlement and erosion, the catchments area of the dam and run off to the dam is decreasing thereby decreasing the capacity of the dam.

The water meters installed at BH-2, BH-4 and the combined measurement for BH-5 and the treatment plant are working properly. During the site visit the yield of BH-4 was 11.4l/s, BH-2 was 10l/s and BH-5 and the dam was 15.3 l/s (data obtained from the last 24 days daily records). BH-1 is estimated to have a yield of 5l/s. BH-3 is abandoned because of the decrease in yield which has dropped to about 3l/s. BH-6 is not working as no pump is sunk. The service has a plan to put it in to operation very soon.

The following table shows summary of existing water sources of the Town.

Hosaena water service has a total of 4142 connected customers and 15 public taps. As per 2007 Census, the source of drinking water is given in Table 3.5 below.

Table3- 5 HOSAENA/TOWN/- WEREDA Housing Units by Source of Drinking Water: 2007

| Urban-Rural Residence | All Housing Units | Tap inside house | Tap in Compound Private | Tap in compound Shared | Tap outside compound | Protected well or spring | Unprotected well or spring | River/ lake/ pond |
|---|---|---|---|---|---|---|---|---|
| Urban + Rural | 16,081 | 572 | 2,331 | 4,587 | 6,487 | 1,133 | 831 | 140 |
| Urban | 16,081 | 572 | 2,331 | 4,587 | 6,487 | 1,133 | 831 | 140 |
| % of Urban HU | **100** | **3.6** | **14.5** | **28.5** | **40.3** | **7.0** | **5.2** | **0.9** |

## 3.1.3 Sanitation coverage

### 3.1.3.1 Addis Ababa

Excreta Disposal services in the city are classified as: - On-site and Off-site disposal system,

- Among the three catchment areas (Kaliti, Eastern and Akaki) that covers the whole administrative boundaries of Addis Ababa only part of Kaliti catchment is covered by the existing sewer network which is a small portion of the city.
- At present only a*bout 11% of the total population of Addis Ababa is connected to sewer system and t*he total number of connections amounts to 48, 441 out of which approximately 96% are domestic .
  Some apartment blocks having a number of household within the floor connected to the sewer system considered as one connection.
- 19% of total population is served by septic tanks and cesspools.
- 61% of the population has access to pit latrines, and
- 9% of the total population has no access to sanitary facilities and uses all forms of open defecations.
- The city has two existing faecal sludge treatment plants known as Kaliti and Kotebe.
- As per the information collected from AAWSA at present the two faecal sludge treatments plant receives about 528,395m3 of sludge annually from septic tanks and pit latrines by tankers owned by AAWSA, NGOs and private operators.
- AAWSA has a total of 67 trucks (with different capacities ranging 3 to 16 m3).
- Profit making companies (estimated 10 companies, totalling 21 trucks with different capacities ranging 6 to 8 m3).
- Non-profit organizations currently working (estimated 3 organizations, totaling 3 trucks with different capacities (ranging 10 to 8 $m^3$).
- Private prices for FS emptying service usually range between (USD 29.4) 500 Birr/trip and (USD 19.4) 330 Birr/trip, while AAWSA's tariff is (USD 4) 69 Birr/trip for domestic customers and (USD 11.5) 196 Birr/trip for non- domestic customers.
- Sewage transported by sewers is treated by stabilization ponds at Kaliti treatment.
- Sludge for pit latrine, cesspools and septic tanks transported by vacuum trucks are treated by sludge lagoons and drying beds both at Kaliti and Kotebie treatment sites.

The environmental sanitation case study for Addis Ababa, conducted in 1997 and 2007, indicated that about 210,000 & 383,355 people were using septic tanks and 1,460,000 & 1,944,156 people used individual or shared dry pit latrines respectively.

Still at present the majority of the population of Addis Ababa uses either septic tanks or dry pit latrines. This causes problems in the densely populated areas of Addis Ababa, as the access to the tanks or pits is difficult. Following the recommendations of the 1993 Master plan, six 3 $m^3$ vacuum trucks and twelve small portable pumps and tankers were purchased to empty dry pit latrines in difficult areas.

Due to the poor condition of most of the access tracks, steep gradients and poor pumping characteristics of the dry pit latrine contents, the operation of the portable pumps has been discontinued. The transfer stations are however still used by the 3 $m^3$ vacuum trucks. The sludge of these small trucks is taken to one of the four transfer stations and transferred into a large truck.

The existing practice to empty a pit latrine is to add water to the pit and liquefy the contents to allow them to be pumped. This only liquefies part of the contents leaving most solids in the pit.

The sludge from the dry pit latrines and the septic tanks is treated in Kaliti and Kotebe. The sludge drying beds and lagoons in Kaliti are able to treat approximately 505 $m^3$/day of sludge and consist of 8 drying beds and one sludge storage lagoon. The sludge disposal facility at Kotebe has the capacity to treat approximately 475 $m^3$/day of sludge and consists of 20 drying beds and 10 lagoons.

As the two fecal sludge treatment plant of Kaliti and Kotebe have no adequate capacity to treat the present volume of fecal sludge collected, the lagoons designed to hold only the rainy season sludge volume is used also to store part of the dry season collected sludge, when it fills there is a practice to pump the decanting water to the Kaliti stabilization pond located up stream. In few cases when it fills it overflow to the river course located downstream.

Vacuum trucks operated by both AAWSA, NGO'S, government departments and private operators are used to collect sludge from the dry pits & septic tanks.

Based on the present survey data obtained from the two FSTP, the amount of sludge collected is about 528,395m3/year out of which 73%( 386,720 m3) is covered by AAWSA and 27% (141,675) by the private operators.
The present estimate of total sludge production made through this study in Addis Ababa based on survey data is 793, 235m3/year that makes the service coverage of households to about 66%. The remaining amount of sludge produced is believed to be disposed in the following ways:-

- diverted to the river course or natural gullies
- left in the pit as it is solidified
- Connected to the storm drainage system illegally.

In this regard the computation obtained from the theoretical value assigned for sludge generation per capita per year, i.e. for septic tank 0.7 up to 1 .0 lit/capita/year and for pit latrine 0.3 up to 0.60 lit/capita /year using the lower value gives a total amount 446, 470 m3/year which is smaller (less than 60%) compared to the amount obtained from the survey data.
The reason for this could be one of the following

- The addition of water to liquidity the pit latrine sludge
- The fabric food ( teff) that the city dwellers traditionally consumes each day produce more sludge
- Some use their sanitary facilities to dump their solid waste related items that makes difficult even for emptying

**Table 3-6 Quantity of Sludge collected in Addis Ababa**

| Sludge Production | Sludge Amount collected by Private | Sludge Amount collected by AAWSA | Total |
|---|---|---|---|
| Sludge amount collected and dumped at the FSTP of AAWSA as has been reported for the last physical year. | 141,675 | 386,720 | 528,395 |
| Coverage based on sludge collected per year | **27%** | **73%** | **100%** |

In order to determine the l average no. of trips the following data has been abstracted from the truck profile sheet**.**

- Small size( private) companies are four in no. and have three trucks
- Medium size( private) companies are six in no. and have 17 trucks
- Large size (public) company is one that is AAWSA and has 42 operational trucks.

The small companies have very old trucks and also have no adequate customers as they are not well known and organized to win the customer confidence.
The medium sized private companies have relatively new trucks and are well known to have customers.
Even though the normal working hours is eight hours/ day, some of the medium sized companies are working more than twelve hours when they have long waiting list of private customers and big demand from the institutions.
Accordingly it has been assumed to have long idle time for small sized companies and for the public as the procedure to procure the spare parts and maintain the trucks takes very long time.

**Table 3-7 Addis Ababa vacuum truck operations per size of companies**

| Company Classification | Trips /day/truck | Down time | Actual average trip / day/truck | |
|---|---|---|---|---|
| Private (small size) | 4 trips/day | 40% | 2.4 | Combined average for private is about 4.6 |
| Private (Medium size) | 8 trips/day | 20% | 6.4 | |
| AAWSA( Public ) | 6 trips/day | 40% | 3.6 | |

Note:- In Addis Ababa the main reason for having low trip per day is contributed from the distance to dumping site and the bad condition of vehicles leading to high down times, as a result when the actual number of trips is divided by the total number of trucks the number of trips per day will go down substantially.

**Table 3-8 Type of Toilets in Addis Ababa as per 2007 count by CSA**

| Sub City | Total No. of HH As of 2007 CSA | Flush toilet Private | Flush toilet Shared | VIP Latrine private | VIP Latrine Shared | Pit Latrine private | Pit Latrine shared | No Toilet facilities |
|---|---|---|---|---|---|---|---|---|
| Total no of HH | 628,985 | 58,123 | 32,423 | 28,904 | 95,521 | 62,008 | 258,192 | 90,206 |
| Coverage by type of Toilet facility % | | 9% | 5% | 5% | 15% | 10% | 41% | 15% |

### 3.1.3.2 Dire Dawa

Human excreta and gray water are major constituents of the generated liquid wastes in Dire Dawa. There are also industrial chemicals and garage wastes released into the environment. According to SANBEA, out of the gray water produced by households 77 % is just released on surface. The most frequent type of gray water released by households is water discharged after washing clothes and cleaning household utensils.

On the other hand, households accessed to latrine account 79 %. Of the available latrines 88 % are dry pit latrines. The rest 21% of households do not have latrine and hence use the open fields for defecation. Areas like Detchatu River and other small drainages are main places where open defecation is usually practiced. In fact, there are 13 public latrines in the city, but the service the latrines provide is inadequate to curb the problem of open defecation because of deficient management and less number of the latrines as compared to the large number of population in need of the service.

**Table 3-9 Housing Units of Dire Dawa by Type of Toilet Facility: 2007 Census**

| Urban - Rural | All Housing Units | No Toilet Facility | Flush Toilet | | VIP Latrine | | Pit Latrine | |
|---|---|---|---|---|---|---|---|---|
| | | | Private | Shared | Private | Shared | Private | Shared |
| Urban Rural | 72,936 | 30,814 | 2,597 | 2,906 | 2,207 | 5,402 | 8,712 | 20,298 |
| Urban | 51,594 | 10,272 | 2,565 | 2,879 | 2,138 | 5,210 | 8,499 | 20,031 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Rural** | 21,342 | 20,542 | 32 | 27 | 69 | 192 | 213 | 267 |
| **% of all HU by type of facility** | **100** | **42.3** | **3.6** | **4.0** | **3.0** | **7.4** | **11.9** | **27.8** |

Latrine emptying service is provided by Dire Dawa Water and Sewerage Authority (DDWSSA), which is a public enterprise, carries out the disludging service of the city by three vacuum trucks and covers 60% of the service request while a private operator known as JAVA who has two trucks have a share of 40% of the service. The private operator, though he has got new trucks, has started the service recently, and one of the trucks just begun during the visit by the consultant team. So the number of customers received by the private operator has not yet grown to full capacity. Otherwise, it could have better out puts in terms of trips per day. Overall, customers using the service are small in number as compared with the total number of existing dry pit latrines in the city.

The lower usage of the service is mainly attributed with the self drying nature of dry pit latrines and secondly the relatively higher price of the service (private 41 and public 35 USD/trip), which is beyond the affordable limit of most households in the city. Hence, whenever there is a desire to empty pits, people in some localities use human labor (manual emptier) for excavating of wastes that will be buried or dumped at nearby. This practice is common in densely populated parts of the city where space is a constraint to dig new pit latrine. The profile of manual emptiers in Dire Dawa is indicated in Annex.6

The reasons why the customers opt for manual emptying services are due to one or another of the following factors;

- Pit is inaccessible for mechanical operation
- Complete emptying of pit by vacuum truck(suction trucks) is difficult due to Consolidated sludge and or solids deposit
- Unable to pay full service fee for trucks at a time
- Too long waiting time for trucks, as pit is already overflowing the compound.

**Table 3-10 Dire Dawa Vacuum Truck Operations**

| **Dire Dawa City** | **Java** | **DDWSSA** | **Total** |
|---|---|---|---|
| **No. of trucks** | 2 | 3 | 5 |
| **Trips per day** | 10 | 15 | 25 |
| **Coverage based on trip per day** | 40% | 60% | |

In general there are efforts to improve latrine services in the city, Local Development Agency of the administration, few NGOs and in some place the beneficiary community through construction of public and community latrines; organized education programs and trainings on environmental sanitation and hygiene related issues.

### 3.1.3.3 Hosaena

Sanitation in Hosaena town at the moment is the responsibility of both the Municipality and the Worde health office, even though neither has sufficient means to adequately execute their roles.

There are no trucks for refuse collection, no sewerage system but the municipality registers those who needs a vacuum truck service for disludging pit latrines and septic tanks and arranges such services from Addis Ababa. There is no safe disposal system for wastewater generated in the town even though the expected wastewater volume is low. Each household is responsible for the

disposal of its own waste. It is clear that the existing facilities do not meet the needs of the town in terms of sanitary provisions.

Sanitation facilities currently in use are as follows:

- Flush / pour-flush toilets,
- Private lined and unlined pit latrines,
- shared pit latrines,
- Few public latrines not properly managed at present.

Table 3-7 Housing Units of Hosaena by Type of Toilet Facility: 2007 Census

| Hosaena CSA 2007 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | All Housing Units | No Toilet Facility | Flush Toilet | | VIP Latrine | | Pit Latrine | |
| | | | Private | Shared | Private | Shared | Private | Shared |
| Urban | 16081 | 1829 | 189 | 216 | 335 | 561 | 4727 | 8224 |
| | | **11%** | **1%** | **1%** | **2%** | **3%** | **29%** | **51%** |

Latrine emptying service is provided on scheduled call basis from neighboring cities of either Addis Ababa and/or Hawassa. Most of the on call disludging service benefits the non domestic users who have proper septic tanks in the city and can afford the high cost of the service (i.e., over USD 35/trip). Besides the high cost, the lower usage of the service by the domestic users is mainly attributed with the construction of the pit latrines which are relatively deep and self drying nature that takes long years to fill and the difficulty of getting the vacuum truck service.

Hence, whenever there is a desire to empty pits, people in some localities resort to dig other pits besides their existing ones or where there is not enough space close to their pits they will be forced to use the open field.

### 3.1.4 on site sanitation facilities

The present survey made on the different type of latrines facilities indicate the common size and extractable volume of sludge as shown in the table 3.12 below

Table 3-8 Estimated size Vs extractable volume of latrines

| Assumptions | | |
|---|---|---|
| Type of facility | Typical capacity in m3 | Extractable in m3 |
| Pit latrine | ( 2X2X3m) | 60% of the total volume ( 7m3 per cycle) |
| Cesspool | (2.5X2.5X3m) | 60% of the total volume(12 m3 per cycle) |
| Septic tank | ( 2.5X2.5 X3) | 60% of the total volume ( 12 m3 per cycle) |

#### a) Septic tanks and Cesspools

Under Ethiopian condition, septic tank is an underground masonry wall /reinforced concrete tank having a compartment and its effluent is discharged to a soak away pit while cesspools are considered as a septic tank without any compartment and soak away pit.

Generally septic tanks and cesspools have the following major constraints and problems:

- Insufficient land for soak away drains or the soil has a lower permeability than required.
- Insufficient soak away provision for the effluent from septic tanks.
- Lack of proper regulation, restrictions and verification during construction
- Limited access for emptying
- Under-capacity of existing facilities
- Use of septic tanks to dispose of domestic waste.

**b) Dry pit latrines**

There are two types of pit latrines; dry pit latrines and wet pit latrines.

- The dry pit latrines are generally not lined and all the liquids in the pit will infiltrate in the surrounding soil.
- The wet latrines are in general lined and only a small portion of the liquids coming into the pit will infiltrate into the surrounding soil. A wet pit latrine needs de-sludging.

Generally it was observed that dry pit latrines have the same problems as septic tanks i.e.

- Lack of access for emptying pit latrine
- Lack of maintenance of the superstructure
- Use of the pit latrine by too many users
- Lack of lining to pits
- Lack of adequate equipment for emptying the pits.
- Use of pits to dispose of domestic waste

Significant problems are still being experienced in emptying the pits. The common practice is to add water to the pit to try and liquefy the contents to allow them to be pumped. This only liquefies part of the contents leaving most of the solids in the pit. A vast number of people in the low-income areas of the city cannot afford a private sanitation facility. But they could afford to share a sanitation facility with household in the neighborhood. These facilities are called communal toilet facilities.

The communal sanitation facilities are owned, cleaned and maintained by the community itself. The big difference with a public toilet facility is that not everybody has access to the communal facilities.

### 3.1.5 Comparative Analysis of Access to Sanitation in the three Cities

Addis Ababa being the largest city in the country, it has all types of sanitation facilities that are available in the country while have the other two cities have less complexity in their sanitation facilities. From results of 2007 Census of the country and our sample survey, the following table (Table 3-13) highlights few points of access to sanitation facilities in these cities:-

**Table 3-9 Access to Sanitation of the Cities Surveyed**

| No. | DESCRIPTION | Cities | | |
|---|---|---|---|---|
| | | Addis Ababa | Dire Dawa | Hosaena |
| 1 | Population (2007 Population Census) | 2,739,551 | 341,834 | 69,995 |
| 2 | Water borne sanitation facilities inside houses (% of total housing units (HU))- 2007 Census | 14 | 7.6 | 2.5 |
| 3 | On-site disposal facilities (pits of all sorts) in% HU - 2007 census | 71 | 50.1 | 86.1 |
| 4 | Housing units with no toilet facilities - 2007 census in %age of HU | 15 | 42.3 | 11.4 |
| 5 | Availability of sewer system | yes | no | no |
| 6 | Availability of waste water treatment facilities | yes | no | no |
| 7 | Availability of fecal sludge treatment facilities | yes | yes | Only official dumping place |
| 8 | Number of trucks available in the city -2011 | 107 | 5 | none |
| 9 | Number of people served per truck (No.1/No.8) | 25,603* | 68,367 | N.A. |
| 10 | Use of manual emptying | Uncommon | Widely practiced | Uncommon |
| 11 | Average distance vacuum trucks to disposal sites (Km.) | 15 | 6 | 5 |

* Out of this 11% of the Addis Ababa population is served by sewer connections. N.A. = Not applicable

As can be observed from the above table, the service level in these cities could not easily compared because of technological, geological and cultural factors are not collected. From the field observations during the survey, the type of pit construction, the geological formation, climatic condition and the practices of using the facilities differ in all the three cities.

For example the hot climatic condition and sandy soil formation of Dire Dawa accelerates the compaction of the sludge which makes disludging with vacuum trucks very difficult and unpractical. Therefore, most people resort to the use of manual emptying. Similarly in Hosaena, the high depth (up to 10m.) of a hole requires many years to fill which in return demands practically less frequency of disludging by vacuum trucks. As shown in Table 3-12, Hosaena with 86.1% on-site sanitation facilities seldom requires as frequent disludging as in Addis Ababa.

Since the waiting time for the vacuum truck service in Addis Ababa and Dire Dawa cities is similar, the same can be said about the high difference in the number of people per truck between Addis Ababa and Dire Dawa.

### 3.1.6 Institutional and legal framework

**Federal Environmental Policies and relevant Legislation**

The Federal Democratic Republic of Ethiopia (FDRE) was formally established by proclamation No.1 on August 21, 1995. The FDRE comprises of the Federal States and nine Regional State members. The relative roles of government at the different levels (Federal, Regional and Local) in terms of power and duties, including fiscal matters, have been defined by the Constitution, Proclamations Nos. 33 of 1992, 41 of 1993, and 4 of 1995. Under these proclamations, duties and responsibilities of Regional States include: planning, directing and developing social and economic programs, as well as the administration, and development and protection of natural resources (of their respective regions).

**The Constitution**

The Constitution provides important provisions related to the country's Environmental Policy. The right of the people to enjoy to a clean and healthy environment is clearly stipulated in Article 44 of the Constitution of the Federal Democratic Republic of Ethiopia.

It also states under Article 92 that:

- The Government shall endeavor to ensure that all Ethiopians live in a clean and healthy environment.
- The design and implementation of programs and projects of development shall not damage or destroy the environment.
- People have the right to full consultation and to the expression of views in the planning and implementation of environmental policies and projects that affect them directly.
- The Government and citizens shall have the duty to protect the environment.

**Environmental Policy of Ethiopia**

The Environmental Policy of Ethiopia was approved by the Council of Ministers in April 1997 (EPA and MEDaC, 1997). It is based on the Conservation Strategy of Ethiopia

The policy is fully integrated and compatible with the overall long-term economic development strategy of the Agricultural Development-Led Industrialization (ADLI) program and other key policies, such as the National Population Policy and the National Policy on Women. The policy has the broad aim of rectifying previous policy failures and deficiencies, which in the past have led to serious environmental degradation.

The EPE's overall policy goal may be summarized in terms of the improvement and enhancement of the health and quality of life of all Ethiopians, and the promotion of sustainable social and economic development, through the adoption of sound environmental management principles.

### Conservation Strategy of Ethiopia

The CSE provides a comprehensive and rational approach to environmental management in a very broad sense, covering national and regional strategies, sectoral and cross-sectoral policies, action plans and programs. It recognizes the importance of incorporating environmental factors into development activities from the outset, so that planners may take into account environmental protection as an essential component of economic, social and cultural development.

### Federal Water Resource Policy

The Ministry of Water Resources has formulated the Federal Water Resource Policy for a comprehensive and integrated Water Resource Management. The overall goal of the water resources policy is to enhance and promote all national efforts towards efficient and optimum utilization of the available water resources for socio-economic development on sustainable basis. The policy is meant to establish and institutionalize environment conservation and protection requirements as integral parts of water resources planning and project development. The policy is also to ensure that all water resources schemes and projects shall have "Environmental Impact Assessment and Evaluation."

### Legislation related to Environmental Impact Assessment

At present there is no legislation in Ethiopia that mandates Environmental Impact Assessments for policies, programs or projects. However, an Environmental Impact Assessment Proclamation has been developed and is currently being reviewed by the Environmental Council and will soon be presented to the Council of Ministers for their approval.

The following regulations and guidelines have also been prepared:

- Environmental Impact Assessment Guideline, Volume I, Procedural Guideline, Environmental Protection Authority, Addis Ababa, June, 1997.
- EIA – Sectoral Guideline, Volume II, EIA – Guideline for Agricultural Sector Development Projects, Environmental Protection Authority, Addis Ababa, June, 1997.
- EIA – Sectoral Guideline, Volume III, EIA – Guideline for Industrial Sector Development Projects, Environmental Protection Authority, Addis Ababa, June 1997.
- EIA – Sectoral Guideline, Volume IV, EIA – Guideline for Transport Sector Development Projects, Environmental Protection Authority, Addis Ababa, June 1997.

### Environmental Protection Authority

The Environmental Protection Authority (EPA) at the Federal level was established under Proclamation No. 9 of 1995 which placed the responsibility of Environmental Management, as well as Environmental protection within the EPA. The objective of the Authority is to ensure, that the country's social and economic development activities are carried out in a manner that will protect the welfare of human beings, and that the resources - on which they depend for survival - will be sustainably protected, developed and utilized. EPA is an autonomous government body, reporting directly to the Council of Ministers.

The key functions of EPA are defined in Proclamation 9/1995 and are summarized as follows:

- Prepare environmental protection policies and laws and ensure that these are implemented.

- Prepare directives and implement systems necessary for the evaluation of the impacts of projects on the environment.
- Prepare environmental protection standards and directives concerning soil, water and air.
- Conduct studies on desertification and co-ordinate efforts to combat it.
- Prepare recommendations regarding measures needed to protect the environment.
- Enhance environmental awareness programs.
- Review of Environmental Impact Assessment reports;
- Implement international treaties concerning the environment to which Ethiopia is a signatory.
- Provide advice and technical support to the regions on environmental matters.

**Addis Ababa City Administration**

The Addis Ababa City Administration (formerly Region 14), which is one of the Regional States established by the Federal Government, has its own environmental agency: the Environmental Protection Bureau (EPB).

**Environmental Protection Bureau (EPB)**

The Environmental Protection Bureau has been established within the Addis Ababa City Administration. The key functions of EPB are summarized as follows:

- Follow-up the implementation of Federal Environmental Protection policy and laws.
- Prepare regional environmental protection regulation and directives and, upon approval, follow up and supervise their implementations.
- Prepare directives for evaluating the impact of social and economic development projects on the environment and follow up and supervise their implementation.
- Prepare appropriate standards, which can help protect soil, water and air, as well as the biological system in the region.
- Review of Environmental Impact Assessment reports;
- Supervise the disposal of solid, liquid and industrial waste and agricultural by-products.

**Specific Tasks and Mandates Assigned to Public utility Services Providers**

Public utilities both in Addis Ababa and Dire Dawa have similar mandates to the provision of waste water/sludge collection and disposal within their respective jurisdictions and areas. The service in Hosaena, however, is directly run by the town municipality.

### 3.1.7 Flow of money chart for FSM transactions

There are different sources of finance that are being accesses by the fecal sludge emptying and transportation companies and builders and operators of the dumping sites. The following financing sources are available:

- Treasury budget
- Grant from Donors
- Loan from International Financiers
- Loan from Commercial banks

The first three financing sources are only available for the public utility for procurement of vacuum trucks and building of fecal sludge dumping sites. Private operator companies can only make use of loans from commercial banks.

### 3.1.8 FS emptying business owners' profile

Vacuum tanks are operated by AAWSA, NGO'S, government departments and private companies as shown below.

Table 3-10 Types and ownership of vacuum trucks in Addis Ababa

| Ownership | Capacity in Cubic meters | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 3 | 6 | 7.5 | 8 | 10 | 14 | 16 | Total |
| AAWSA (Public utility) | 12 | 3 | 10 | 39 | - | - | 3 | 67 |
| Non Profit | - | 3 | - | 5 | - | - | - | 8 |
| NGO | - | 1 | - | 3 | - | - | - | 4 |
| Private Operators | - | 1 | 4 | 20 | 2 | 1 | - | 28 |
| Totals | 12 | 8 | 14 | 67 | 2 | 1 | 3 | 107 |

Note: - The number of trucks includes all owned trucks which are not operational.

Table 3- 11 Conditions of Vacuum Trucks in the Surveyed Cities (Profile of private operators)

| Name of organization | Status of Vacuum Trucks | | |
|---|---|---|---|
| | No. | Size (m3) | Age (Yrs) |
| Dadimos | 2 | 10 & 14 | >30 |
| Efoyta | 1 | 7 | >30 |
| Ziquala | 1 | 7 | 28 |
| Tirign | 3 | 8,8,10 | >25 |
| Nana | 1 | 8 | >20 |
| Ethio-Sewerage | 4 | 8 | >10 |
| NACID NGO | 1 | >10 | NR |
| CBISD NGO | 1 | NR | 14 |
| OXFAM UK | 1 | 8 | 16 |
| Kara Alo | 1 | 10 | >25 |
| Zihon | 2 | 8 | 10 |
| Selam | 2 | NR | NR |
| NAHA | 4 | 8 | 10 |
| AAWSA Megenagna BR | 2 | 8 | 4 & 26 |
| AAWSA Nifas Silk | 6 | 8 | >20 |
| AAWSA Gulele BR | 10* | 3,8,14,16 | 3,8,3,1, 0,8 |
| AAWSA Arada BR | 9 | 3,7,8,16 | NR |
| AAWSA Addis Ketema BR | 6 | 3,7,8,14,16 | 25,35, 25,15 |
| AAWSA Mekanisa Br | 6 | 8 | 15,>15, >25 |
| AAWSA Akaki | 4 | 8 | 10, >20 |
| AAWSA Gurd Shola | 3 | 8 | 4 to >20 |
| **Dire Dawa** | | | |
| JAVA | 2 | 8 & 12 | 1.5 |
| DDWSA | 3 | 6,6,8 | >25, >2,2 |

### 3.1.9 Household survey results and analysis

As mentioned above, the housing units covered in the survey are of two types, residential and multipurpose. In addition, the surveyed housing units are comprised from the higher, middle, and lower living standards.

#### A) Addis Ababa

**Profile of respondents**

Among the interviewed 64.2% of the respondents are household heads. 75.2 % have attended formal education, and 17.3 % have obtained non formal school, while the rest 7.5% have not attended any type of schooling. While 54% are owners, tenant account 44.5% and others constitute 1.5%. The average number of persons living in the concession is 6.52. The average monthly income is 140.5 the maximum being 2958.6 and minimum 7.1.

**Water and Sanitation**

Among the interviewed households 85.8% have private water supply connection, while 2% get water from kiosk, 12% buy from vendor and while other 0.2% belong to others.

Among the interviewed, 90.8% have a sanitation facility in their respective compounds while 9.2 % of the respondents do not have a sanitation facility, and they use either public toilets or open spaces as their basic sanitation facilities.

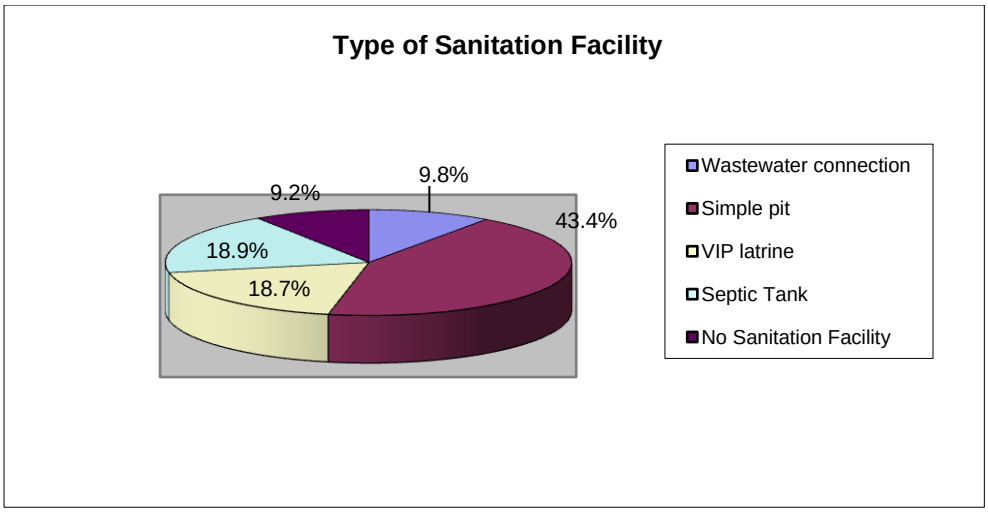



Figure 3-1 Type of Sanitation Facilities for Addis Ababa

In addition, 65.8% of the respondents believe that their sanitation facility is pleasing. However, around 25% of the respondents are not satisfied with their sanitation facilities.

**Fecal Sludge Management**

Around 70% of the respondents use mechanical emptier, while 1.2% use manual emptier, where manual emptying is done both by family members (0.2%), and by daily laborers (1%).

Moreover, the cost for manual emptying service ranges from 2 USD – 6 USD. According to the respondents, manual emptying alternative is usually adopted when the facility is inaccessible, or when mechanical emptying is unaffordable.

The survey findings show different emptying frequency. Accordingly, 22.5% empty their facilities once a year, 17.7% empty every couple of years, 17.2% empty twice a year, and 7.5% empty 3-12 times a year.

In this section, 3% of the respondents could not specify the emptying frequency, and they have claimed that they are not the responsible unit in the household for the task. The rest 32.8% fall under the category 'Not Applicable' mainly because:-

- 9.2% do not have a sanitation facility
- 13.8% the facility is not yet full
- 9.8% are connected to the city's sewer line

Around 10.2% of the respondents are not happy with the payment methods basically because: It is not affordable, the private service providers are expensive, the service is unavailable even after it is paid for and it would have been good if the payment is in trench mode.

Furthermore, 13.7% do not appreciate the quality of service. Grounds for dejection include: The service is unavailable when it is required, the service lacks time concept, i.e., usually it takes 3 months to get the service once it is paid for, few mechanical emptying machineries and operators do not clean it properly and completely.

According to the survey findings, there is average familiarity with FS management, i.e., 47.1% have the concept that sludge from their facilities is treated and marketed. On the contrary, the reverse is true for 48.1% of the respondents. However, awareness regarding sludge reuse appears to be low in the city. Only 6.8% claim that they reuse the sludge from their facilities as a fertilizer and for biogas production.

In addition, the majority (56.3%), lack the knowhow that their way of managing fecal sludge has an impact on water quality, health and on the environment.

**Willingness to pay**

When it comes to willingness to pay for improved emptying service 15.3% indicated that they are willing to pay whatever is required, without setting a certain price interval. 5.3% have claimed that they cannot afford to make any kind of payment for emptying services, and the other 9.8%could not specify their willingness in monetary terms.

**Hosaena**

**Profile of respondents**

Among the interviewed 55% of the respondents are household heads. 80.8 % have attended formal education, and 6 % have obtained non formal school, while the rest 13.2% have not attended any type of schooling. While 74% are owners, tenant account 22.2% and others constitute 3.6%.The average number of persons living in the concession is 6.88. The average monthly income is 297, the maximum being 12130 and minimum 3.4.

**Water and Sanitation**

Among the interviewed households 64.6% have private water supply connection, while 4.6% get water from kiosk, 24.5% obtain from vendor, and the remaining belong to borehole 0.7%, well 1.7, surface water 3.3% and other 0.7%.

Among the interviewed 91.7% have a sanitation facility in their respective compounds while 8.3 % of the respondents do not have a sanitation facility, and use either public toilets or open spaces as their

basic sanitation facilities. The difference between the survey results and the Government figures is too small. According to Census in 2007 89 % had latrine facility compared to 91.7% found in the survey result. The people using latrine according to Census in 2007 was 86% while the survey result indicated 81%. The difference in terms of statistical accuracy is insignificant considering the time difference. The main difference in results is observed regarding septic tanks which is 8% (survey) which amounted 3% before 4 years. This could be due to the City's regulation to have only septic tanks in core areas for new houses or selection of houses favoring un-proportionally using septic tank. [2]

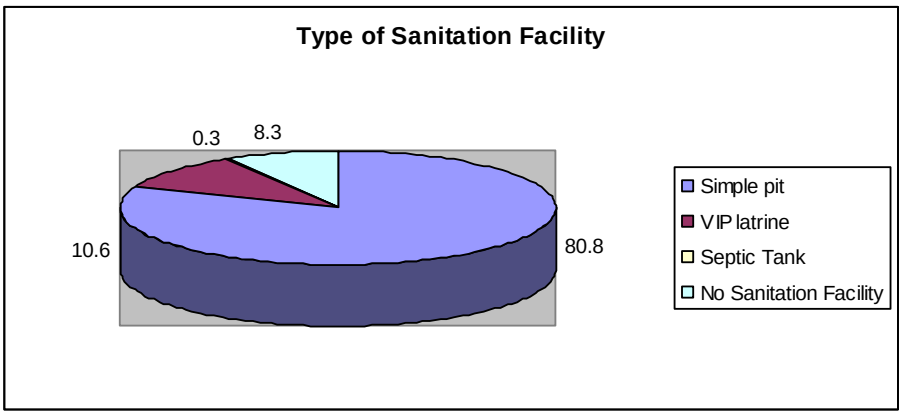



Figure 3 1 Type of Sanitation Facilities for Hosaena

In addition, around 23.8% of the respondents are not satisfied with their sanitation facilities mainly because mainly it is below the standard, it is not clean, it is smelly and it is not well constructed.

## Fecal Sludge Management

Around 14.2% of the respondents use mechanical emptier, where payment for the service ranges from 5.9 USD – 35.5 USD. On the other hand 1.2% empties their facilities manually. The survey findings have indicated that there are no specific professionals as "manual emptier". This service is usually conducted either by daily laborers or family members, and the average price is 19 USD.

Most importantly, 27.5 % of the respondents have suggested that mechanical emptying service suffers availability and cost related factors, i.e., there are no mechanical emptying service providers in Hosaena, thus, service providers have to drive a long way, usually from Addis Ababa, whenever the service is required. In addition, because such mode of practice has made the service very expensive and unaffordable, the majority has chosen to close the pit and to dig another hole rather than emptying it mechanically.

The survey findings show different emptying frequency characteristics, which corresponds to the ground water and the soil proximity of the city. Accordingly, 0.3% empties their facilities once a year, 13.2% empty every couple of years, and 0.7% empty twice a year, and 51% have indicated that the pit has not yet been full.

Around 3 % of the respondents are not happy with the payment methods while 4% do not appreciate the quality of service, and the service's unavailability and timeliness are the basic grounds for dejection.

[2] Pls note that the figures shown in page 21 are census results from 2007. As a result of the time difference of four years some variance in result can be expected.

According to the survey findings, only a few minorities (16.9%) believe that sludge from their facilities is treated and marketed. Consequently, awareness regarding sludge reuse appears to be low in the city. Only 2.3% claim that they reuse the sludge as a fertilizer and for biogas production.

### Willingness to pay

When it comes to willingness to pay for improved emptying service 43.4% indicated that they are willing to pay whatever is required, without setting a certain price interval, and the other 26.5% could not specify their willingness in monetary terms. The average that households are willing to pay is 15.4 USD while the maximum is 89 USD.

## B) Dire Dawa

### Profile of respondents

85.9% of the respondents are household heads. 66.6 % have attended formal education, and 11.6 % have obtained non formal school, while the rest 21.8% have not attended any type of schooling. While 77% are owners, tenant account 22% and others constitute 1%. The average number of persons living in the concession is 8.33. The average monthly income is 160 USD, the maximum being USD 1775 and minimum USD 21.

### Water and Sanitation

Among the interviewed households 71.3% have private water supply connection, while 3.2% get water from kiosk, 24.5% buy from vendor.

Among the interviewed, 95% have a sanitation facility in their respective compounds while 5 % of the respondents do not have a sanitation facility and use either public toilets or open spaces as their basic sanitation facility. The national Census in 2007 found that only 80% of residents of the City had latrine facilities while the survey found 95%. The difference is substantial. Either there has been significant development in the City to have made this change of improved latrine coverage or the structure or purpose of the survey has affected the results. In national Census latrine facilities are not the major issue and replies could be not so accurate. Another reason could be the sampling size could have affected the result. It could be that most of randomly selected house could have over proportionally latrine facilities.

With regard to the type of facilities there are no significant variations. Flush toilets increased from 11% (Census) to 12.9% (survey), while latrine facilities increased from 55% to 57.9% respectively. The difference in proportion of VIP is however significant from 14% to 24.5%, which could have been affected as earlier noted.

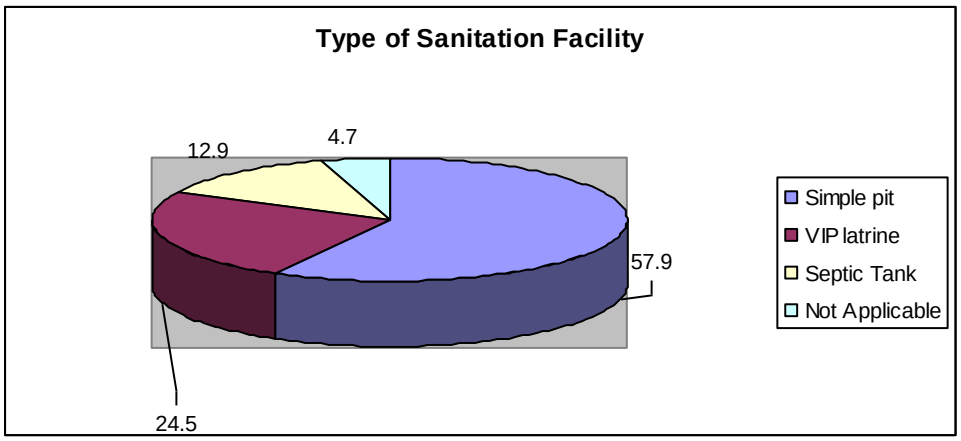


Figure 3 2 Sanitation Facilities for Dire Dawa

Among the interviewed 61.4% of the respondents believe that their sanitation facility is pleasing. However, around 32.7% of the respondents are not satisfied with their sanitation facilities mainly because, it is not suitable, it is below the standard, it is cramped and it gets full frequently.

## Fecal Sludge Management

Around 40.1% of the respondents use mechanical emptier, while 26.2% use manual emptier.[3]. Moreover, the cost for manual emptying service ranges from 4.14USD – 47.3 USD. The difference on service fee arises due to the range of activity done by manual emptier. Sometimes it requires only emptying, for some it includes digging new well to bury the extracted, and sometimes it includes the breaking and fixing of superstructure. The amount paid is also related to the volume of FS removed; either total emptying (transferring) of pit or partial removal (siphoning) ) of sludge. For total emptying the fee is USD 47.3 including burying, while the charge for siphoning/partial removal goes as low as USD 4.14USD depending on the quantity removed.

According to the respondents, manual emptying has become the best suitable alternative. Even higher income households who have been using mechanical emptying services are diverting to the manual alternative claiming that the mechanical emptier do not clean the toilet properly.

The survey findings show different emptying frequency, which corresponds to the ground water and the soil proximity of the city. Accordingly, 15.1% empty their facilities once a year, 43.6% empty every couple of years, 4% empty twice a year, 0.5% empty 4 times a year, 0.5% three times a month, and 0.4% have indicated that they empty their facilities every 15-16 years.

Around 14.4 % of the respondents are not happy with the payment methods while 25.2 % do not appreciate the quality of service.

According to the survey findings, there is average familiarity with FS management, i.e., 30 % have the concept that sludge from their facilities is treated and marketed. However, awareness regarding sludge reuse appears to be low in the city. Only 1.2 % claims that they reuse the sludge as a fertilizer. In addition, the majority (48.5%), lack the knowhow that their way of managing fecal sludge has an impact on water quality, health and on the environment.

## Willingness to pay

When it comes to willingness to pay for improved[4] emptying service 21.8% indicated that they are willing to pay whatever is required[5], without setting a certain price interval, for improved service. 5.2 % have claimed that they cannot afford to make any kind of payment for emptying services, and the other 20 %could not specify their willingness in monetary terms. The following table shows the frequency distribution of willed amounts to be paid for improved emptying services.

[3] From the remaining 34% respondents 27% replied that their latrine was never full, 5% have no facilities and 2% did not reply.
[4] Improved service mean speedy response, less bad smell, one trip service and emptying fully.
[5] The 21.8% want mechanical service with improved service regardless of the price because the pits are so dry that they cannot be emptied using the existing pumps.

### 3.1.10 FSM emptying practices and technologies used: Manual and Mechanical

The extraction and emptying of FS from pit latrines and septic tanks is done mainly by mechanical emptying equipment (Vacuum tanker truck) and to a lesser extent by manual emptiers.

Mechanical Operators are either of public utility services, none profit institutions, NGOs or private entrepreneurs. There are also few informal operators who empty pit latrines manually, but the number is insignificant in Addis Ababa, while manual emptier provide significant services in Dire Dawa city.
The service provision for mechanical operators is based on prior request of the customer through advance payment of the service fee; registering and appointment until service is rendered, preparation of the pit for disludging including arrangements for access to the pits (in some constrained areas), extraction of the sludge; transportation to dumping site; dumping at designated and allowed dump sites and letting it to dry for about 45 to 60days drying period. The dried sludge cake is then manually removed and stock piled on adjacent fields.
The dumping sites are owned and administered under the respective municipal council. However, all operators, government, none government, private service provider fecal sludge emptiers use the dumping sites centrally. The dumpsite owners like AAWSA, DDWSA use the dump site for free as they also administer it. Others are required to pay marginal amount to use the dump sites. The charge is 200ET Birr /year/truck (USD 11.5) for Addis Ababa, while it is 15Birr/truck/trip (USD 0.86) for Dire Dawa City. All operators have the privilege of using the dump site facilities like water for washing their trucks.
As open dumping is legally prohibited, the truck operators are obliged to use the dumping sites, though they have to pay for it. If found discharging in open air, both the truck operator owner and the emptier (truck driver) will be penalized. So it is expected and is being done (to the best of our knowledge) that all truck operators in the cities are dumping the FS at the recognized dumping sites.
The operators should register, get permission and technical supports from the public service provider (AAWSA) and some also use the garages of AAWSA for maintenances up on payment of service fee. In principle there is policy direction that private operators should be encouraged through incentives and supports from the municipalities.
The private operators are, however, severely complaining for lack of supports from the government, interference by public utility providers (by reducing the service fee and competing for market). Almost all of the operators responded that there is no incentive given to them by the government, while some responded that they are allowed duty free importation of machinery (trucks and accessories).
However, the incentives given either in the form of free importation or in other forms, apply for all operators uniformly.

#### Manual and mechanical operators

Mechanical fecal sludge emptiers are the dominant operators for the fecal sludge in the cities. However, in cases where the suction equipment(vacuum track) fails to serve, then the city dwellers are forced to look for other options; manual operators ( emptier) for Dire Dawa case and also in Addis at few places.

Major constraints causing mechanical empting operation to fail include;

- Lack of access road to reach the pit latrines
- Consolidated soil and sludge mix creating difficulty for suction
- Inadequate volume of the pit to fill a truck at a time
- The fee per truck being fixed irrespective of the pit size

These factors and the lengthy waiting time for mechanical emptier service, force the households to opt for manual operators' services as well.

Manual emptying is done late in the night; usually from 10 PM up to 3AM. According to interviewed manual operators, this time is chosen, not to disturb the neighbors with the odor nuisance. First they excavate a burial pit for the extracted fecal sludge adjacent to the existing pit.

The manual operators go into the pit after they break the superstructure to get access and using ladders, hoes, rope, and jerrican; as tools for the operation. Neither protective clothing nor protective device is used, while in operation. This group of people are willing and in need of being organized and supported to carry out the service in an improved manner. Even though this area is not legally recognized it can be considered as one of the possible focus area of study and intervention. About 26% households in Dire Dawa and 1.2% in Addis Ababa depend on manual emptiers for FSM.

Manual fecal sludge emptying has become a normal practice in Dire Dawa, and those providing the service are well known among the beneficiaries. They have a commonly known location where they are available and receive requests for the service. Anybody who seeks for the service can go and meet those groups and negotiate. The price is fixed through negotiation.

Table 3-13 : Manually emptied FS buried in front of compound.

Representatives of two manual operator groups (having 4 members each) were interview in Dire Dawa during the field assessment of this study.

The manual operators are known both by the community as well as the local administration, though they are not officially recognized as operators.

The major limitation and problems manifested in this operation is the difficulty in reinstating of the superstructure and the health hazard to the manual operators, fecal contamination of skin and inhaled gaseous products of anaerobic digestion (including H2S, CO2 and CH4 gases) can pose adverse health impacts to the manual operators on duty

### 3.1.11 Overview of all WWTP, FSTP or Dumping Sites

#### 3.1.11.1 Addis Ababa

The sewage effluent is treated in a waste water treatment works at Kaliti, which consist of two parallel stabilization ponds each with two facultative and two maturation ponds in series. (See Fig. 4 below). The existing recirculation system of the treatment works is currently not in use because of the low BOD load. The capacity of the treatment works as quoted in the original design document is 7,600 $m^3$/day of flow and a Biochemical Oxygen Demand (BOD5) load of 3,500 kg/day.

Even though, the flow design capacity of the works is about 7600$m^3$/d, recent records show that the average daily dry season flow is 4,500$m^3$/d. Based on a total sewer length of 120Km and an average

infiltration rate of 0.25litres/second/Km it can expect that infiltration is approximately 3,000 $m^3$ /day. Thus the sewage flow rate is thus 1,500$m^3$/day.

Figure 3 3 Kaliti Treatment Plant & Sludge Disposal Site

Figure 3 4Kotebe Sludge Disposal Site

## Wastewater and Sludge Treatment Facilities

### a) Kaliti Wastewater Treatment Plant

Construction of Kaliti wastewater treatment plant commenced in 1977 and was completed in 1981. The design capacity of the works for the first or current phase is about 7,600$m^3$ /day with a biochemical oxygen demand load of 3,500kg /day. Major components of the treatment plant are the following:

- The inlets works consists of screening and de-gritting chambers, two sets of fixed screens and grit channels installed in parallel with a capacity of 30,000 $m^3$/day of sewage flow.
- Biological treatment works: consists of an effluent distribution chamber and two parallel multi-stage pond systems each made up of one facultative pond, one maturation pond and two polishing ponds.
- Four trapezoidal shaped tanks of reinforced concrete each with a capacity of 1000$m^3$ were provided for sludge thickening. These tanks have been abandoned as the sludge from the dry pit latrines and septic tanks could not be thickened. The drying beds associated with the settlement tanks are no longer operational.

### b) Kaliti sludge disposal facilities

The sludge drying beds and sludge lagoons were constructed in 1999 to alleviate the immediate problems of dumping raw sludge in the Akaki River. These sludge drying beds and lagoons are constructed below the last series of ponds, in the area which was reserved for the future expansion of the sewage treatment ponds. It is reported that the sludge drying beds and lagoons have been sized to treat 505 $m^3$/day of sludge.

### c) Kotebe sludge disposal facilities

Kotebe sludge treatment plant is located approximately 3-4 km to the south east of Bole International Airport. The sanitation facilities were constructed at a cost of Birr 49 million. (Fig. 5 above)

It is reported that the sludge drying beds and lagoons have been sized to treat 475 $m^3$/day of sludge.

As the two fecal sludge treatment plant mentioned above have no adequate capacity to treat the present volume of fecal sludge collected, the lagoons designed to hold only the rainy season sludge

volume is used also to store part of the dry season collected sludge when it fills there is a practice to pump the decanting water to the Kaliti stabilization pond located up stream but in both cases when it fills it overflow to the river course located downstream.
The planned expansion of sludge treatment plant at Kotebe site has been hampered due to the fast expansion of housing development project all around the site which endangers to use the originally allocated land for raw sludge application on forestry.

### d) Mikililand and Gelan WWTP

The Mikililand and Gelan sewerage systems have been constructed in 2009 and 2010 with the intensions to be used for condominium housing projects for a population equivalent of 25,000 and 50,000 respectively constructed by Addis Ababa housing development project. (Fig. 6a & 6b below)

The design capacity of both treatment plants is estimated to be about 4,650m$^3$ /day

The Mikililand sewerage system is located at the north western part of Addis Ababa while the Gelan sewerage system is located at the southern part of the city about three km downstream side of the existing Kaliti WWTP.

Major components of the treatment plant are the following:

- The inlets works consists of screening and de-gritting chambers, two sets of fixed screens and grit channels installed in parallel.
- Biological treatment works: consists of an effluent distribution chamber and two parallel multi-stage pond systems each made up of one facultative pond, one maturation pond and polishing ponds.

Figure 3 5 Mikililand WWTP -Lagoon system


Figure 3 6 Gelan WWTP -Stabilization ponds

### e) Transfer stations

There are four FS transfer stations for the city of Addis Ababa, built by the public utility service provider (AAWSA). These transfer stations are meant to reduce the travel distances of the smaller trucks to the final dumping sites (treatment plants) that are located at outskirts of the city. The transfer stations could reduce the travel distance by about 12- Km. for a single round trip. The stations are serving only AAWSA owned trucks, while others are not allowed to use it, due to capacity limitations. The stations are also limited to serving only some of the AAWSA branch offices that are found at relatively furthest locations as compared to the dumping sites. Those close to the dumping sites directly go to the plants for discharging. It is estimated that about 35% of AAWSA

owned trucks that use the transfer stations, while all non- AAWSA trucks are not using transfer stations. This is mainly due to the capacity limitation of the currently available transfer stations.

**Table 3-12 Existing sludge transfer stations in Addis Ababa**

| Description | GPS Location | | Location | | Remark |
|---|---|---|---|---|---|
| | X | Y | Branch office | Woreda | |
| Kechene | 0473080 | 1000988 | NE, NW | 11,8 | Compound Area coverage 1000m2 |
| Arat Kilo/Silassie | 0474481 | 0997851 | NE, central | 2,11 | Compound Area Coverage 1000m2 |
| Kolfe | 0469440 | 0998516 | NW | 8 | Compound Area coverage 1500m2 |
| Geja | na | na | Central, South | 2,20 | Out of function due to redevelopment program of the area |

The three transfer stations that are currently in use have been visited and the following observations have been made: -

The transfer stations are not operating as per the design, and some mal practices are observed.

- Of the four transfer stations, Geja located around the center of the city has been demolished and out of service as the area located is under redevelopment program for high rise condominium buildings.
- In all of the transfer stations the upper elevated pass way (discharge area) is not being used for transferring sludge from the small vacuum suction trucks by gravity to the larger trucks Instead the receiving area is used to transfer the sludge using the pumps in the tankers and holding tanks.
- In some of the transfer stations trailers are kept on the site and not transported to the treatment plants due to maneuvering problem.
- Due to Improper usage of the facilities during transfer, sludge spills to surrounding area have created Odor problem and un-hygienic condition for the whole environment.
- Workers have protective cloths but protective devices are lacking.

All of those discrepancies are related to lack of proper site management and operational skills, though constraints are also observed in accommodating all arrivals adequately and on timely bases. The current unhygienic way of the site operation is working against the objectives of the sanitation service being provided and has to be improved.
Among those currently working Transfer stations some important operation data have been collected and presented as follows:-

**Table3- 13 Transfer stations**

| Descriptions | Kechene | Arat Kilo/ Silassie | Kolfe |
|---|---|---|---|
| Average Daily flow | 200m3 | 80m3 | 384m3 |
| Holding tank capacity | 36m3 | 62m3 | 72m3 |
| Distance from nearby houses | 20m | 30m | 50m |
| Distance from the nearby FSTP | 18km | 12km | 20km |
| No. of Employee per site | 2-Operators<br>1. Clerk<br>2. cleaners | 2-Operators<br>1. Clerk<br>2. cleaners | 1. Clerk<br>1. Clerk<br>2. cleaners |
| Nearby FS Treatment plant | Kotebe | Kotebe | Kaliti |

Figure 3.7 Transfer Station at Kechene

#### 3.1.11.2 Dire Dawa

The Dire Dawa FST plant known as Mude Anano Sludge treatment plant has been constructed in 2009/2010 and now it is under operation, the consultant team has also visited and has the following observation.

The newly built fecal treatment plant is located around six (6) km out of the city center the plant has about eight units of sand drying bed having masonry wall all around and sludge dumping entry facility for each unit.

All the sand drying bed has a percolation pipe under the sand and a long collector pipes that receives the liquid part of the sludge that transfer to the two leachate ponds.

Except the two last sand drying beds all are filled with a fecal sludge creating a dried cake on top of the sand which requires immediate clearing of the cake and preparation for the next dumping but this task are not yet started.

The two leachate ponds have also partially filled with liquid part of the sludge and require minor maintenance work.

Even though, it is newly built treatment plant, there is no organizational unit or assigned expert except the guard and lacks proper operation and maintenance procedure.

The site has been located on a gentle slope where there is no settlement in all the three sides. Some newly settled pastoralists are located at one side of the treatment plant beside the office block and a lime factory to about 500m away. The solid waste disposal site is also located beside this treatment plant. The capacity of the plant is designed to treat sludge of 130 $m^3$ /day which will satisfy the needs for the coming five (5) years if proper operation and maintenance procedure is followed.

The following are some pictures of the FS treatment plant of Dire Dawa.

Figure 3 8a. New sand drying bed

Figure 3-8 b. Sludge dumping entry & Dried sludge

Figure 3-8 c. Filled drying bed

Figure 3-8 d. Dried sludge under collection

Figure 3-8 e. Leachate pond-1

Figure 3-8 f. Leachate pond-2

### 3.1.11.3 Hosaena

Fecal sludge treatment plant and disposal site for Hosaena town is under construction by the municipality using its own fund located at about 5 km outside the city center . There is no study conducted regarding the capacity of the existing official dumping site as well as for recently constructed holding tank.

The following pictures show the existing condition of the official dumping site of the fecal sludge:-

Figure 3 9 a. Existing official dumping site-1

Figure 3-9b. Existing official dumping site-2

Figure 3-9 c. Improved official dumping site under construction

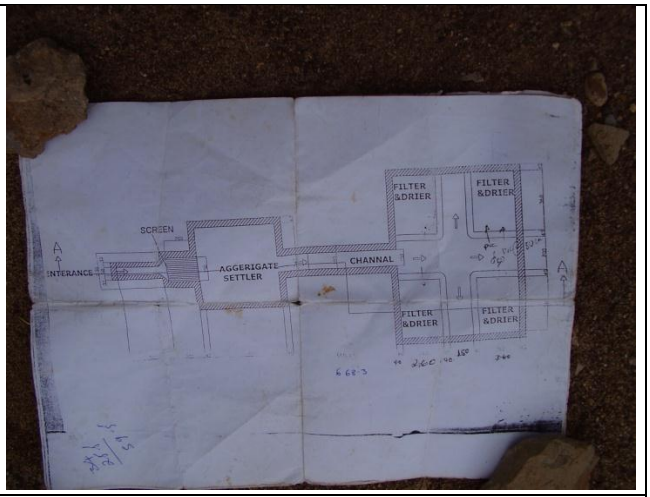



Figure 3-9 d. Improved plan for official dumping site

As part of this study, the consultant team tries to investigate the type and the scale of fecal sludge treatment plant required for such type of city that could be feasible and sustainable for long term solution.
It is widely believed that having a vacuum truck and a treatment plant to be used only for one city having similar population and development pattern with a present annual sludge production of only less than 11,000 m3/day will not be feasible in short term (refer to Annex.13).

### 3.1.12 FS end re-use in the three cities

The FS reuse is mainly done by low income group who depend on small scale farm. It is done by group of people who do not have formal education. The profile of the sample interviwed group is as indicated on the following three tables. Table 3.18. presents the profile of the FS re-users. Table 3-19 breifly describes the sources of the Fecal sludge that is re-used on the one hand, while it presents the purposes of the sludge re-use (either for crop producion, gardening or for bio-gas production) on the otherhand.

**Table 3-14 Survey Response on Reuse of FS (profile of some of the FS re-users in Addis Ababa.)**

| City | Name of FS user | Name of respondent | Sex | Level of education | Total yrs in the service | Current Job | years on this job |
|---|---|---|---|---|---|---|---|
| Addis Ababa | Myungsung Hospital | Tadegew Birhanu | M | Formal Ed. | NR | Biogas Technician | 2 |
| | Women's Cooperatives | Hayat Bedri | F | None | 2 | Farmer & Daily Labourer | 2 |
| | NR | Birtchiko Tarekegn | F | None Formal | 20 | Farmer & quarry development | 4 |
| | Tadesse Abera | Tadesse Abera | M | None Formal | | Farmer & Guard | 25 |
| | Kality Farmers' Association | Not willing | M | Formal school | 1 | laborer & Farmer | 1 |
| | | | | | | | |

The fecal sludge is used either for agriculture crop, gardening or for biogas production.

Currently there is no transaction as such, to obtain the fecal sludge for re-uses, except some pocket money is given to the truck operators to discharge at plots of farm lands outside of the city centers. In Addis Ababa fecal sludge loaded polluted stream flows are diverted to grow vegetables and for gardening, while in the furthest rural parts, farmers request for the fecal sludge to be discharged on their plots of land. For this service, there is no formally fixed payment at present. But some of the

farmer pay pocket money (informally) to the truck operators and encourage/ convince FS emptier to bring the sludge all along to their farm sites.

Institutions like hospitals and service providers(hotel) use the FS generated within their own compound, or from sludge dumping sites and do not buy or accept FS form outside, except rare cases do occur some times.

**Table 3- 15 Sources of the material and Purpose of FS reuse**

| City | Name of organization | How do you get F S | | | Relationship with Municipality | | | Mode of application | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | From House Hold | Mechanical Emptier | Sludge treatment plant/ polluted River diversion | No relation | Have free access | I pay for treated sludge | Direct Dumping | Burry and cover | Sow as fertilizer | surface Irrigated |
| **Addis Ababa** | Myungsung Hospital | X | | | X | | | X | | | |
| | Women's Cooperatives | | | Sludge treatment plant | X | X | | | | | X |
| | NR | | | Sludge treatment plant | | X | | | | X | |
| | | | | Polluted river diversion | | X | | | | | X |
| | Kaliti Farmers' Association | | | X | | X | | | | | |
| **Dire Dawa** | Tsehay Hotel | X | | | X | | | | | | |

However, currently there are investors coming up with development plans to re-use FS for large scale bio-gas production. An investor Known as 4R - Energy PLc is working towards establishing entrepreneurships to use urban wastes (both municipal solid waste and fecal sludge in combination) for bio-gas production.

4R Energy PLC is a privately owned company established in Ethiopia in 2010 with the objective of engaging in the business of production and supply of upgraded biogas, bio-CMG (Compressed bio-Methane Gas) to households and other consumer applications. 4R Energy is the first company in its kind preparing to develop a large and medium size waste to energy projects in major cities in Ethiopia; and hoping to become a major player in the waste to energy management and production to create a new environmentally sound business and affordable alternative fuel market.

There are series of projects prepared by 4R Energy PLC ready for implementation; among which one is selected and proposed for Melinda and Gates foundation for financial support. This project when fully implemented will accept 500m3/day FS and 160m3/day MSW and treat it by anaerobic digestion, while bio-fuel and sludge slurry is produced as useful products (as energy source and organic fertilizer respectively). Details of the project proposal are attached under the Annex section.

### Likely Health Impacts of FS Re-use

The sludge reuse for crop production is suspected of causing public health risks, and is recommended to be done under strict supervision and monitoring. The findings of the sample survey, however, demonstrate that no significant health impact has been experienced so far. Table 3-20 presents the response from the sample interviewed re-users, as regards to health impacts they have experienced so far.

The sludge reuse is suspected of causing public health risks, and is recommended to be done under strict supervision and monitoring. The findings of the sample survey, however, demonstrate that no significant health impact has been experienced so far. Table 3.20 is the response from the users.

The sludge reuse is suspected of causing public health risks, and is recommended to be done under strict supervision and monitoring. The findings of the sample survey, however, demonstrate that no significant health impact has been experienced so far.

**Table 3-16 Survey Response on Health Risk (health implications of FS reuse)**

| City | Name of respondent | What Risk are you encountering using FS | | | | Do you use specialized protective clothing/device when using FS | | |
|---|---|---|---|---|---|---|---|---|
| Addis Ababa | | None | Some time I get sick | Frequently I get sick | other | Yes | Some time I use | No |
| | Tadegew Birhanu | X | | | | X | | |
| | Hayat Bedri | X | | | | | X | X |
| | Birtchiko Tarekegn | X | | | | | | Trail Stage |
| | Tadesse Abera | | X | | | | | X |
| | Not willing | X | | | | | | X |
| Dire Dawa | Tesfaye Legesse | X | | | | | | |

## 3.2 Market analysis per city

Basic types of household sanitation currently in use are: Conventional flush toilet, pour flush toilet, unventilated pit latrine, ventilated pit latrine & indiscriminate defecation. Non domestic institutions use septic tanks and sewer systems.

### Addis Ababa

The findings of the household survey show that 9.2 % of the respondents do not have a sanitation facility, and either public toilets or open spaces as their basic sanitation facilities. Whereas, 90.8% have a sanitation facility in their respective compounds 9.8% are connected to the municipal sewer system.

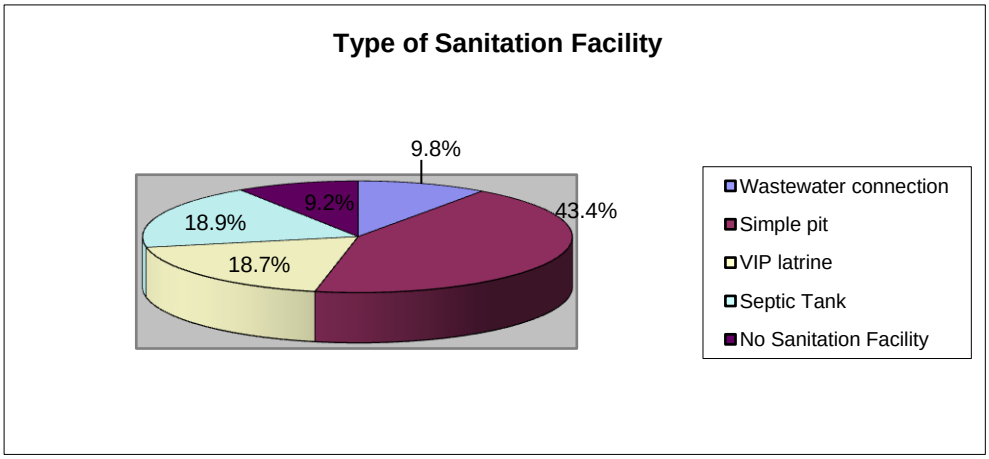



**Figure 10 Types of Sanitation Facilities in Addis Ababa**

Based on the household survey and by using the projected proportion of facilities from the Public Utility (base year 2007 of national census) type of sanitation collection facilities is as follows:

**Table 3- 17 Type of sanitary facility in Addis Ababa**

| | City 1 (Addis Ababa) |
|---|---|
| **Type of sanitation collection facility** | |
| % HH with direct connection to sewerage | 11% |
| % HH with cesspools | 12% |
| % HH with pit latrines | 41% |
| % HH with VIP | 20% |

| | |
|---|---|
| % HH with Other (describe "other") septic tank | 7% |
| % HH with no sanitation | 9% |

Considering the emptying frequency and size of collection facilities the total volume of sludge to be emptied per year (according to the household survey) is 793,235 m3. A 30 %[6] was added to the result of the household survey to consider the non domestic sludge amount.

The theoretical amount of total volume to be emptied per year was computed using two assumptions:

Lower scenario Latrine = 0.3l/c/day and ST = 0 .7l/c/day , total volume of sludge to be emptied 448,695 m3

Higher scenario Latrine = 0.6l /c/day and ST= 1 .0 l/c/day total volume of sludge to be emptied 788,615 m3

The analysis shows that the higher version assumption is very close to the household survey result the difference being less than 1%. Further the lower scenario is very unrealistic since the total collected amount was much higher than the computed amount. Further the higher scenario is closer to the planning parameter used by the public Authority which assumed that for 2010 the sludge produced in Addis Ababa should be 1,187,145m3 per annum. The survey findings and the parameters provided by the Foundation were very close while the Public Utility estimate is too high and the lower scenario is too low compared to actual collected and the result of the survey. Therefore, the higher scenario with some adjustment has been considered for sludge production computation.

**Dire Dawa**

The type of sanitation collection facilities for Dire Dawa City is as follows:

**Table3-18 Type of sanitary facility in Dire Dawa**

| | Dire Dawa |
|---|---|
| **type of sanitation collection facility** | |
| % HH with direct connection to sewerage | 0% |
| % HH with cesspools | 8% |
| % HH with pit latrines | 61% |
| % HH with VIP | 11% |
| % HH with Other (describe "other") septic tank | 5% |
| % HH with no sanitation | 15% |

Considering the emptying frequency and size of collection facilities the total volume of sludge to be emptied per year (according to the household survey) is 44,959 m3. A 21 % was added to the result of the household survey to consider the non domestic sludge amount.

[6] The proportion of non domestic was estimated based on their water consumption and availability of fecal collection and transportation means. For example in Addis Ababa 48% of water is consumed by non domestic when we assume that 30% could use sewer systems the other non domestic has to use onsite facilities. Accordingly, an expert estimate was made that nondomestic sludge can be around 30% of domestic sludge. For the other cities similar estimates were made based on water consumption and availability of fecal collection facilities. In Dire Dawa and Hosaena non domestic water consumption is not so high and accordingly 21% and 11% was assumed.

The theoretical amount of total volume to be emptied per year was computed using two assumptions:

Lower scenario Latrine 0 .3 l/c/day and ST .7l/c/day ,total volume of sludge to be emptied 45,990m3

Higher scenario Latrine 0.6l/c/day and ST 1l/c/day , total volume of sludge to be emptied 84,315 m3

The analysis shows that the lower scenario assumption is very close to the household survey result the difference being less than 6%. According to the waste water study for Dire Dawa the estimated sludge generation for 2010 was 36,870 m3. The wastewater study is also closer the lower scenario and survey result (20% lower) as a result the survey result seemed a reasonable figure considering the three projections.

**Hosaena**

The type of sanitation collection facilities for Hosaena City is as follows:

Table3- 19 Type of sanitary facility in Hosaena

| | Hosaena |
|---|---|
| **type of sanitation collection facility** | |
| % HH with direct connection to sewerage | 0% |
| % HH with cesspools | 8% |
| % HH with pit latrines | 70% |
| % HH with VIP | 9% |
| % HH with Other (describe "other") septic tank | 6% |
| % HH with no sanitation | 7% |

Considering the emptying frequency and size of collection facilities the total volume of sludge to be emptied per year (according to the household survey) is 12,136 m3. An 11 % was added to the result of the household survey to consider the non domestic sludge amount.

The theoretical amount of total volume to be emptied per year was computed using two assumptions:

Lower scenario Latrine=0 .3l/c/day and ST .7l/c/day , total volume of sludge to be emptied 9855m3

Higher scenario Latrine= 0.6l /c/day and ST =1.0 l/c/day total volume of sludge to be emptied 18068 m3

The analysis shows that the lower scenario assumption is close to the household survey result the difference being less than 20%. There are no other studies carried out by the City or any other organization. In the absence of other studies the only verification mechanism is to compare it to the theoretical calculations.Based on the above analysis the market for sludge 2011 is as follows:

Table 3-20 Market Analysis for the three Cities

| | Addis Ababa | Dire Dawa | Hosaena |
|---|---|---|---|
| **Sludge Generation per annum** | | | |
| Population using septic tank | 570,000 | 48,750 | 10,500 |
| Population using pit latrines | 1,830,000 | 270,000 | 59,250 |

| | | | |
|---|---|---|---|
| Sludge from Septic Tank | 239,184 | 10,843 | 3,359 |
| Sludge from Latrine | 372,789 | 29,770 | 6,513 |
| Non Domestic | 181,266 | 8,719 | 1,100 |
| Total Sludge Generated in m3 | 793,239 | 49,333 | 10,972 |

Based on the above analysis and estimated sludge production the present sludge transportation capacities with existing performance levels are not matching the demand for service. In the case of Addis Ababa the major problem for mismatched demand/supply is the low performance of the vacuum trucks (average trip per truck per day being around 3 if all vacuum trucks are considered). In the case of Dire Dawa the vacuum capacities are sufficient but due to management problems (two trucks from the public company are not used because drivers are not hired) and technology related problems the supply cannot match the supply. In the case of Hosaena there is no vacuum truck so the demand is not matched with a supply. The treatment capacity of Addis Ababa is working over the design capacity and requires expansion of capacity to match the demand. The treatment plants of the two cities are no yet fully operational and will be able to match the demand for the foreseeable future.

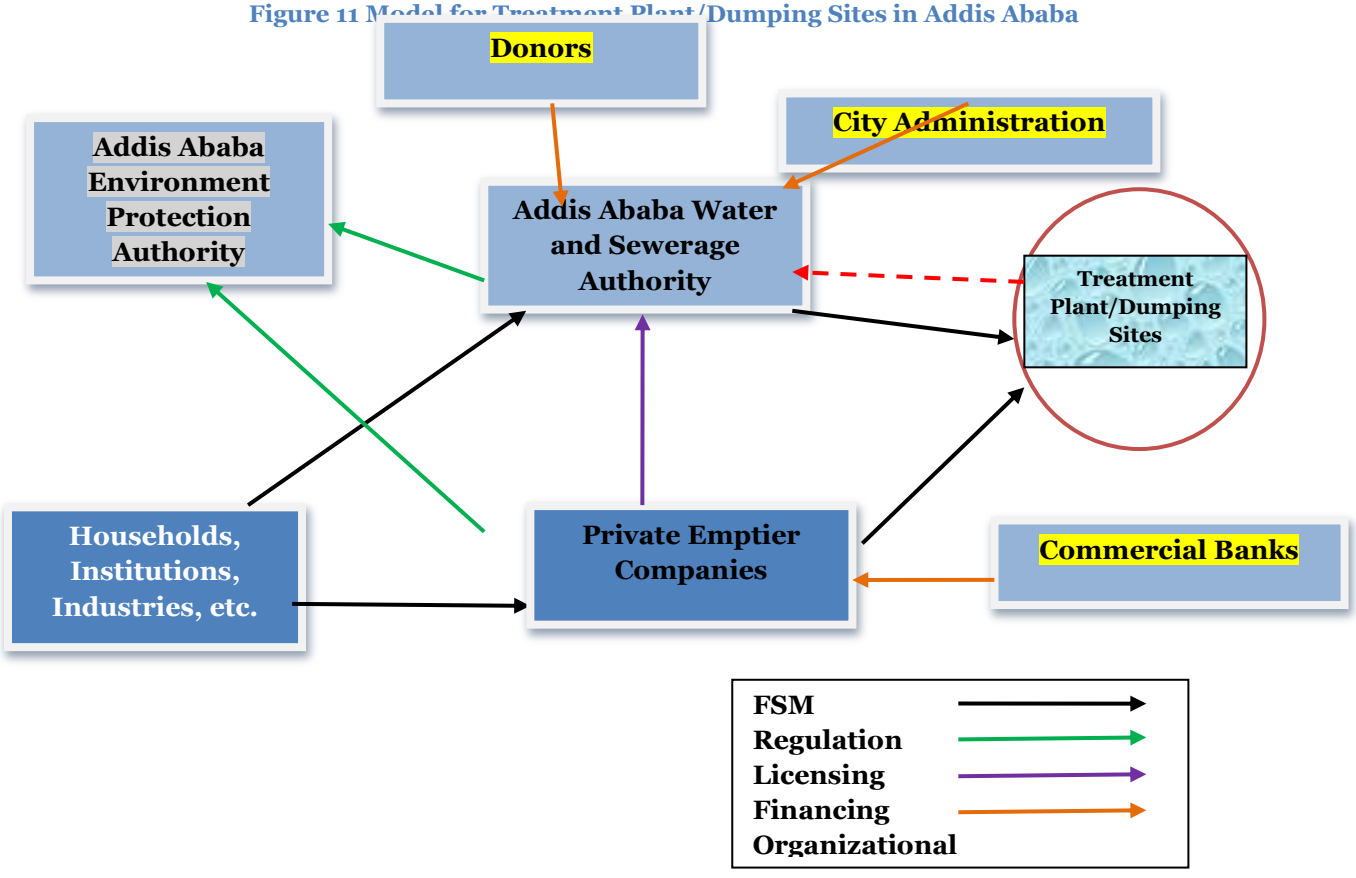
## 3.3 Service delivery models review

### 3.3.1 Overview of existing models

**Addis Ababa**

Sewage treatment plants and fecal sludge dumping sites in Addis Ababa are operated by Addis Ababa Water and Sewerage Authority (AAWSA). The finance for the construction of these facilities is obtained either from the City Administration and/or donors. The environmental quality the operation is controlled by Addis Ababa Environmental Protection Authority. Both AAWSA and private operators transport the sludge from households, institutions, and industries. The model is as shown in Figure 15 below.

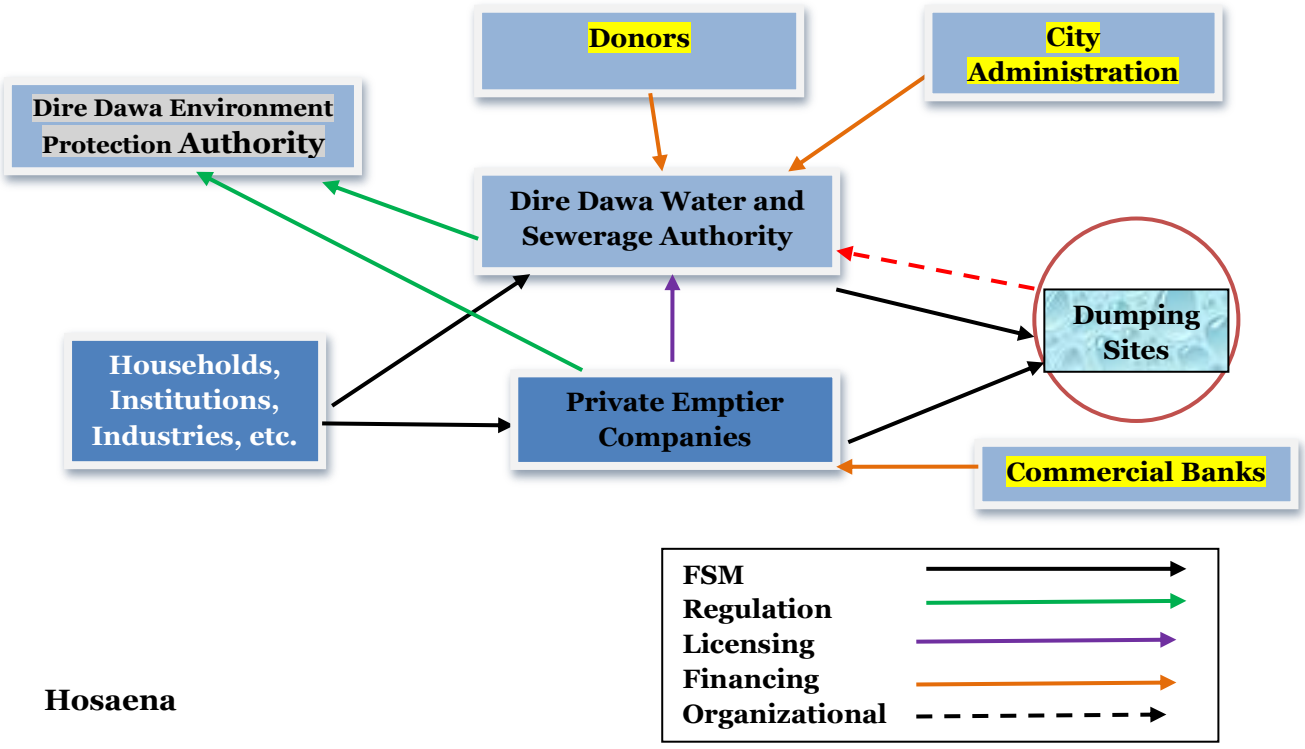
Figure 11 Model for Treatment Plant/Dumping Sites in Addis Ababa



### Dire Dawa

The Model for Dire Dawa is similar to Addis Ababa except that there is only dumping site and only one private company. Figure 4 below shows the general setup of the service.

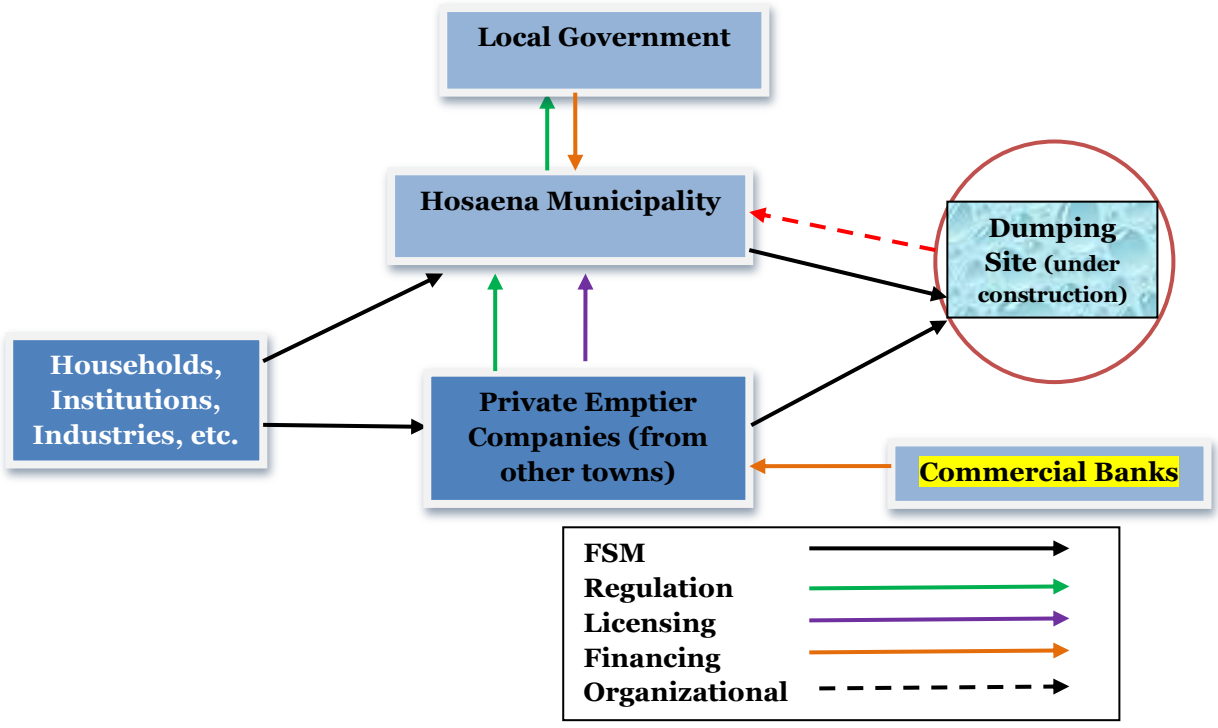
Figure 12 Model for Dumping Site in Dire Dawa




### Hosaena

Hosaena Municipality is responsible for the management of the existing FS dumping site. The existing disposal system is just two holding pits. Presently the construction of dumping site is undergoing adjacent to these pits. Since the municipality does not have its own vacuum truck or private operators are not available in the town, FS sludge extraction and transportation is done by calling either private emptier from other nearby towns/cities or by arranging from utilities from other cities. Therefore, the dumping site is not in use regularly. The model for the dumping site is as shown in Figure 5 below.

Figure 13 Model for Dumping Site in Hosaena



### 3.3.2 Comparison with solid waste management service models

In most big cities of Ethiopia the solid waste management is the responsibility of the municipality and recently the municipality forms an independent institution known as Sanitation and Beautification Agency.

These agencies are made accountable to the respective City Administration. Most of them are established in the last five years and are under direct budget subsidy from their city administration to provide solid waste management services.

Except in Addis Ababa, most agencies did not have any income generation mechanism to cover their operation and maintenance costs. From the information obtained from the different agencies the consumers pay a certain amount annually for environmental cleanness to city administrations but the revenue goes to the city administrations. Thus it is difficult to determine how much tariff the customers are paying for solid waste management. In addition the agencies do not have adequate facility to serve the existing population.

The solid waste mainly from residential, commercial and industrial premises are collected by animals pulled trailers for small cities while for major cities using standard skips of 5 to 8m3 capacities and transferred by skip loader truck and also a side loader truck which is used for house to house collection.

In most cases these wastes are dumped to open fields, improperly designed and operated landfill sites which are located on the periphery of the city mostly nearby river channel.

## Addis Ababa Case

**i. The Addis SWM Agency have the following existing resources**

- About 2400 labor force and 96 trucks for collection and disposal
- 749 Solid waste bins of size 8 & 15 m3 and 107 Solid waste bins of size 1.1 m3
- 107 Solid waste bins of size 1.1 m3 and 1917 Dust Bins

**ii. SW Collection & Characteristics**

- The government trucks made an annual trip 123,361 and collects about 1, 250, 949 m3/year solid waste which amounts of about 3,400 up to 3,700 m3 /day.
- Recently established 10 private companies' collects about 8,714 trips /year and managed to collect about 107,080 m3/ year that make their share to be 9 to 10 % at present.
- In total more than 200,000t are collected each year which is about 60% of the generated.

**iii. Sources of Waste Generated**

- 76% households, 18% institutions, commercial, factories, hotels and 6% is street sweeping

**iv. Physical Composition**

- Organic 60%, Recyclables 15 % and Others 25%

**v. Collection & Transportation**

- The Municipality Spends large proportion of its budget on collection, transport and disposal of solid waste
- Solid waste collection services performed into two systems : primary and secondary collection

- Primary collection
  - This is done on house to house collection once in a week using manually pulled wagons and fill the Solid waste bins.
  - Performed by small and micro enterprises (SMEs) 550 in nos.
  - The Payment is Volume based by the rate of 30 Birr /m3 (1.8 USD) for SMEs.
- Secondary collection
  - Mainly performed by government.
  - Private companies (10 in nos.) engaged in institutional waste collection & transportation as well.
  - The payment rate for private companies is 74 Birr/m3( 4.4USD). At present the private companies could only collect about 9- 10% of the total collected waste.

### vi. SW Collection & Payment Approach

- The city is divided in to 10 sub-city and about 549 collection zones depending on the size of House holds
- Each collection zone Constitutes about 800-1000 households
- In each collection zone one SMEs is signed a contract to give collection service at HH level twice/week
- The number of SMEs engaged on primary solid waste collection is about 550 with a total number of about 7000 operators
  - City Administration start cost sharing mechanism & set solid waste tariff
  - Service Charges are collected with water bill according to water consumption rate monthly
  - The tariff collected from communal water point is 5%, Residential houses 20%, & Non-residential 42.5% of the total water consumption
  - Government pays for SMEs & Private solid waste collection organizations on monthly basis according to the service rendered for the community

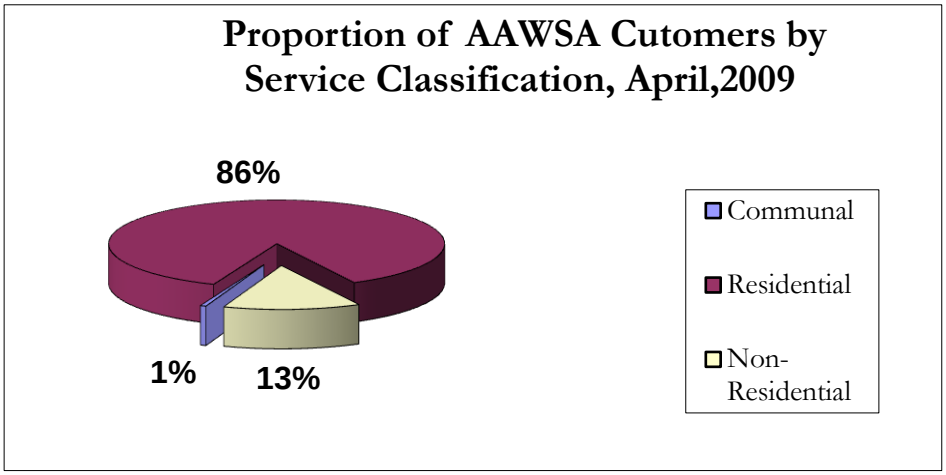



**Figure 14 Customers Classification**

### vii. Existing Disposal Site

The major problems associated with the disposal site are:

- It has a surface area of about 25 hectares.
- The present method of disposal is crude open dumping: hauling the wastes by truck, spreading and leveling by bulldozer and compacting by compactor or bulldozer
- The site is getting full
- Surrounded by housing areas and institutions

- Nuisance and health hazard for people living nearby
- More than 200 - 300 waste pickers per day, work continuously for collection of salvageable materials such as wood, scrap metals and discarded food.
- No daily cover with soil
- No leachate containment or treatment
- No rainwater drain-off
- No odor or vector control
- No fence
- No weigh bridge, inaccurate weighing of waste

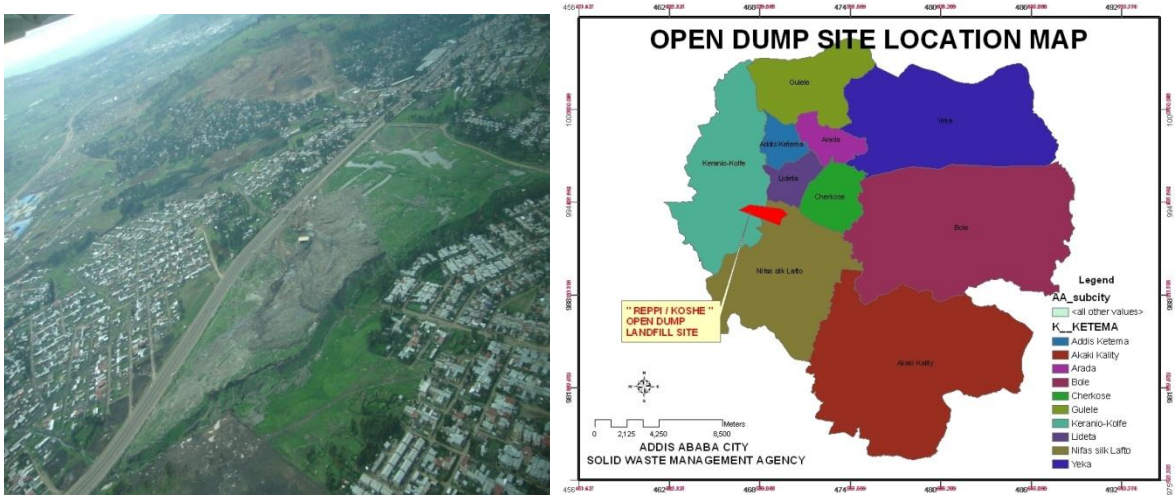



Figure 3 15 Location of Solid Waste Disposal site

### viii. Observed Problems in SWM

- Low service coverage less than 60%
- High Operational cost more than 6.0 USD/m3
- No Reuse/Recycling
- Poor Quality of Services
- Low customer Satisfaction
- Lack of Environmentally Sound, effective & efficient System for disposal

### ix. Comparison of Solid Waste with Faecal Sludge Management system

- The major part of the service in both cases is predominantly executed by the government institutions without considering the commercial aspect.

- The primary collection system of the solid waste basically provides a huge number of job opportunities for youths and women who are organized in the form of small enterprises.

- In most big towns the secondary transportation which is from the bins station up to the dumping place is performed by the government while the solid waste collection system specifically primary collection which is house to house collection is outsourced for small private enterprises.

- In both cases the service coverage is not adequate and lucks efficiency

- In both cases the transfer stations are not well managed and create environmental nonsense for the surroundings.

- The disposal system for Fecal Sludge is in relatively better condition in most cases compared to the solid waste dumping site.
- The average price for collection and disposal per m3 of solid waste is more than 6USD while for fecal sludge is not more than 3USD/m3.
- The way of collecting service fee for solid waste is directly attached to the volume water consumed for all users while for Fecal sludge is based on market price /user pay principle/ hence there is no better working experience that can be extracted from solid waste management system to fecal sludge management system at this stage.

## 3.4 Financial and Business Model analysis

### *3.4.1* City level

#### 3.4.1.1 Demand and supply in each city

**Addis Ababa**

The amount of annual total sludge generation of Addis Ababa is 793,239m3 for 2011. Non domestic sludge generation is estimated to be 30% of the domestic amount. In estimating the sludge generation the following assumptions were used[7]:

- Per capita sludge generation for septic tank users 1.15 Liter
- Per capita sludge generation for Pit latrine users 0.56 Liter
- Non Domestic sludge emptying requirement 30% of domestic

**Present production and collection**

As discussed earlier the total amount of sludge generated is 793,239m3. However, the total amount of sludge collected and transported was for the time of July 2010 to July 2011 was 528,395m3. The collected amount to the collectable sludge ratio is 66.6%.

When we look the supply side it can be noted that the City has much better and larger number of vacuum trucks compared to other cities in the Country. At present the public utility operate 67 vacuum trucks, private emptier 28 and non profit 12 vacuum trucks totalling 107.

While few truck operators are providing service for specific (own institution) clients like Ministry of Defence, Ministry of Education, Ministry of Health and Public Houses Agency, some NGOs are providing service to project areas in the City while the public utility and the private companies are providing service to the entire City.

With regard to pricing first group (own institutions' facilities) provide service for free, the public utility charges a very low tariff, NGOs are charging reasonable price[8] the private are charging the highest.

The Public Utility makes price distinction between households and non domestic; NGOs make price difference based on user's income level and distance while private companies charge based on volume and distance.

Accordingly prices per trip for the different groups are as follows:

[7] The per capita generation rates are taken from the computed amount based on the survey results and some adjustment factors as explained above.
[8] The pricing policy of NGOs is based on the income level and perceived affordability of the households of their intervention areas.

| Prices in USD | |
|---|---|
| Public Utility | 4 to 10 |
| NGOs | 15 to 21 |
| Private | 20 to 30 |

In 2010/2011 in Addis Ababa a total of 528,395 m3 sludge has been emptied and transported to the sludge dumping site. Out of the total 386,720m3 has been emptied and transported by the public utility company while the remaining 141, 675m3 was emptied by private and nonprofit companies.

### Projection in Sludge Generation

The most important assumption in projecting demand is to forecast the proportion of basic types of household sanitation in the City. Considering the urban renewal in the City where slums are demolished and modern housing units are built the proportion of sewer and septic tanks users will increase substantially while pit latrine users will decrease consequently[9]. It is assumed that the septic tank users will increase from the present 19% to 33%[10] while pit latrine users will decrease from present 61% to 33% by 2016. The households without latrine facility will also decrease from present 9% to 4% by 2016. Accordingly the total amount of sludge generated will reach 874,063m3 by 2016. The details are shown in table 3-25.

**Table 3-21 Projected Sludge Generation for Addis Ababa**

| Horizon (year) | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|
| Sewerage Domestic | 11% | 15% | 19% | 23% | 27% | 31% |
| Septic tanks Domestic | 19% | 22% | 25% | 28% | 30% | 33% |
| Pit latrine Domestic | 61% | 55% | 49% | 44% | 38% | 33% |
| Total Sanitation Facilities | 91% | 92% | 93% | 94% | 95% | 96% |
| Total Sludge Generated in m3 | 793,239 | 811,964 | 827,071 | 842,453 | 858,115 | 874,063 |

## Demand and supply analysis

#### Addis Ababa

The sludge transportation business is characterized through a limited supply of vacuum trucks and an increasing size of sludge requiring to be transported to the dumping sites. In 2011 it is estimated that out of the 793,239 $m^3$ sludge that needs to be emptied and transported only 528,395 m3 was emptied and transported with the existing capacity of mechanical emptying operators. Around **264,844** $m^3$ could not be emptied and transported with this number increasing to **345,668** $m^3$ by 2016 if existing capacity is maintained without any additional supply on vacuum trucks.

The analysis considered that the per truck sludge transportation at the existing capacity of 4938m3 per annum or 19m3 per day per truck over 250 working days. With this capacity presently the City needs additional 54 vacuum trucks if the performance rate cannot be improved. If the trucks performance remains the same the gap in generated sludge to be emptied and supply of vacuum trucks can only be solved if at least 70 additional vacuum trucks enter the sludge emptying business in the City by 2016. The details are shown table 3-26.

[9] The City Administration is planning to substantially expand the sewer networks in the next 10 years allocating huge sum of budget.
[10] The new housing construction in Addis Ababa in the periphery of the City is mostly villas and the City renewal for the next 5 years promotes condo buildings and villas that are using septic tanks. It is estimated that around 150000 new houses will be built in the next 5 years and this will have a big impact on types of sludge collector technologies.

**Table3- 22 Demand and Supply for FS Emptying and Transportation in Addis Ababa**

| | 2011 | **2012** | **2013** | **2014** | **2015** | **2016** |
|---|---|---|---|---|---|---|
| **Sludge Generation per annum** | | | | | | |
| Total Sludge Generated in m3 | 793,239 | 811,964 | 827,071 | 842,453 | 858,115 | 874,063 |
| **Collected (Existing Capacity** | 528,395 | 528,395 | 528,395 | 528,395 | 528,395 | 528,395 |
| | 67% | 65% | 64% | 63% | 62% | 60% |
| Deficit | **264,844** | **283,569** | **298,676** | **314,058** | **329,720** | **345,668** |
| **Existing Vacuum Trucks** | **107** | **107** | **107** | **107** | **107** | **107** |
| *Public Utility* | *67* | *67* | *67* | *67* | *67* | *67* |
| *Private* | *28* | *28* | *28* | *28* | *28* | *28* |
| *NGO* | *4* | *4* | *4* | *4* | *4* | *4* |
| *Non Profit* | *8* | *8* | *8* | *8* | *8* | *8* |
| **Required** | 161 | 164 | 167 | 171 | 174 | 177 |
| Gap in no of Vacuum Trucks | 54 | 57 | 60 | 64 | 67 | 70 |
| **Composition of Supply** | | | | | | |
| *Public and NP* | *67* | 81 | 81 | 81 | 81 | 81 |
| | *71%* | 66% | 60% | 56% | 52% | 49% |
| *Private* | *28* | 42 | 54 | 64 | 74 | 84 |
| | 29% | 34% | 40% | 44% | 48% | 51% |
| **Additional Vacuum Trucks Requirement per annum** | | | | | | |
| *Public and NP* | | 14 | 0 | 0 | 0 | 0 |
| *Private* | | 14 | 12 | 10 | 10 | 10 |

The additional 70 vacuum trucks shall be procured and operated primarily by private companies. It is assumed that 14 trucks (that are on pipeline) will be procured by AAWSA while 56 will be by private operators. At 2016 the proportion of capacity will shift from 71% to 29% in favor of the public company to 51% to 49% in favor of the private company. By 2020 the public company should maintain only 25% capacity to provide service to urban poor and as a strategic municipal capacity.

**Dire Dawa**

In 2011 out of the 49,333 m$^3$ sludge that needs to be emptied and transported the estimated amount of sludge collected and dumped for the time of July 2010 to July 2011 only 32,500 m3 was emptied and transported with the existing capacity of mechanical emptying operators. Around **16,833** m$^3$ could not be emptied and transported with this number increasing to**31, 107** m$^3$ by 2016 if existing capacity is maintained without any additional supply on vacuum trucks.

The analysis considered that the per truck sludge transportation at the existing capacity of 6500 m3 per annum or 26 m3 per day per truck over 250 working days. With this capacity presently the City needs additional 3 vacuum trucks if the performance rate cannot be improved. If the trucks performance remains the same the gap in generated sludge to be emptied and supply of vacuum trucks can only be solved if at least 5 additional vacuum trucks enter the sludge emptying business in the City by 2016. The details are shown table 3-27.

**Table 3-23 Demand and Supply for FS Emptying and Transportation in Dire Dawa**

| **Dire Dawa** | 2011 | **2012** | **2013** | **2014** | **2015** | **2016** |
|---|---|---|---|---|---|---|
| **Sludge Generation per annum** | | | | | | |
| Total Sludge Generated in m3 | 49,333 | 51,466 | 53,814 | 56,783 | 60,036 | 63,607 |
| **Collected (Existing Capacity)** | 32,500 | 32,500 | 32,500 | 32,500 | 32,500 | 32,500 |
| | 66% | 63% | 60% | 57% | 54% | 51% |
| Deficit | **16,833** | **18,966** | **21,314** | **24,283** | **27,536** | **31,107** |
| **Existing Vacuum Trucks** | **5** | **5** | **5** | **5** | **5** | **5** |

| | | | | | | |
|---|---|---|---|---|---|---|
| *Public Utility* | *3* | *3* | *3* | *3* | *3* | *3* |
| *Private* | *2* | *2* | *2* | *2* | *2* | *2* |
| **Required** | 8 | 8 | 8 | 9 | 9 | 10 |
| Gap in no of Vacuum Trucks | 3 | 3 | 3 | 4 | 4 | 5 |
| **Composition of Supply** | | | | | | |
| *Public* | *3* | 3 | 3 | 3 | 3 | 3 |
| | *60%* | 50% | 43% | 38% | 33% | 30% |
| *Private* | *2* | 3 | 4 | 5 | 6 | 7 |
| | 40% | 50% | 57% | 63% | 67% | 70% |
| **Additional Vacuum Trucks Requirement** | | | | | | |
| *Public and NP* | | 0 | 0 | 0 | 0 | 0 |
| *Private* | | 1 | 1 | 1 | 1 | 1 |

## Hosaena

In 2011 estimated 10,972 $m^3$ sludge needs to be emptied and transported. The total amount of sludge collected and dumped is not known because there is no recording of amount of sludge dumped and the vacuum truck operator are coming outside of the City to make any estimate based on number of trips.

The City needs on vacuum truck with a capacity of 8 m3 with 6 trips a day over 250 days to satisfy the demand of the City. The details are shown table 3-28.

Table 3-24 Demand and Supply for FS Emptying and Transportation in Hosaena

| **Hosaena** | 2011 | **2012** | **2013** | **2014** | **2015** | **2016** |
|---|---|---|---|---|---|---|
| **Sludge Generation per annum** | | | | | | |
| Total Sludge Generated in m3 | 10,972 | 11,439 | 11,946 | 12,494 | 13,089 | 13,735 |
| **Collected (Existing Capacity** | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0% | 0% | 0% | 0% | 0% | 0% |
| Deficit | **10,972** | **11,439** | **11,946** | **12,494** | **13,089** | **13,735** |
| **Existing Vacuum Trucks** | **0** | **0** | **0** | **0** | **0** | **0** |
| *Public Utility* | *0* | *0* | *0* | *0* | *0* | *0* |
| *Private* | *0* | *0* | *0* | *0* | *0* | *0* |
| **Required** | 1 | 1 | 1 | 1 | 1 | 1 |
| Gap in no of Vacuum Trucks | 1 | 1 | 1 | 1 | 1 | 1 |
| **Composition of Supply** | | | | | | |
| *Public* | *0* | *0* | *0* | *0* | *0* | *0* |
| | *0%* | 0% | 0% | 0% | 0% | 0% |
| *Private* | *0* | 1 | 1 | 1 | 1 | 1 |
| | 0% | 100% | 100% | 100% | 100% | 100% |
| **Additional Vacuum Trucks Requirement** | | | | | | |
| *Public* | | 0 | 0 | 0 | 0 | 0 |
| *Private* | | 1 | 0 | 0 | 0 | 0 |

### 3.4.1.2 Company level financial analysis: (for manual vs. small/medium/ Large mechanical businesses

#### 3.4.1.2.1 Income statements

##### A. General Assumptions and parameters

In carrying out the financial projections, the following assumptions were considered:

**Analysis Period**

The analysis period is assumed to be 5 years starting at 2012 and stretched up to 2016.

**Exchange Rate**

The exchange rate is fluctuating from one year to another. Therefore, the current exchange rate of 1 USD = 16.9 Birr has been applied with an annual adjustment factor of 2.5% for the USD.

**Interest Rate**

Borrowing rate has been assumed to be 10.5% over a 5 year repayment period.

**Social Contribution**

Social contribution is assumed 6% of gross salary.

**Equity rate**

Equity rate has been assumed as 20% total investment

**Vacuum Related parameters**

| | |
|---|---|
| Depreciation rates for trucks up to 10 years | 10% |
| Depreciation rates for trucks older than 10 years | 5% |
| Fuel cost per liter | 17.5 Birr |
| Vacuum Truck fuel consumption | 3.5Km/liter |
| Maintenance expense | 5% of truck price |
| Insurance expense | 1% of truck price |
| Annual Tires depreciation cost | 1398 USD |

##### B. Manual emptying businesses

According to the household survey conducted in June 2011 (as part of this study) 7 out of 600 households acknowledged that they use manual emptying. The manual emptier are informal business accessed by the households through casual communication. They use daily labourers from their areas. They admitted to have paid between Birr 30 and Birr 100 for the service. The present charges are between 1.75 USD and 5USD. These prices will not be profitable unless the emptier employs family members as helpers for free.

Assuming that 2% households require manual emptier with 2031 households requiring the service in the City per annum, in the each Sub City at least with 4 Emptier there could be 40 Emptier. Because of the size of the Sub Cities at least 4 emptier would be required to be accessed by residents in the area.

Accordingly, with an emptier working with 3 helpers the wage cost per emptying would be 12 USD and with other operating expenses assumed 0.4 USD per emptying. Emptying transport per latrine assumed 3 USD and 1 USD for disinfectants, the actual expense excluding the emptier input will be 15.8 USD. When his labour and management is considered as 30% of all costs the charge will 20.5 USD of which 4.75 USD is net income of the manual emptier coordinator/owner.

**Table 3-29 Income Statement of for Manual emptier**

| Item | Units | Annual amount | Monthly amount | Cost per emptying |
|---|---|---|---|---|
| **Capital Costs** | | | | |
| Wages for all employees | USD | 406.28 | 33.86 | 6.77 |
| Small equipment (wheelbarrows, shovels, buckets, etc.) | USD | 10 | 0.83 | 0.17 |
| Safety equipment (gloves, boots, etc.) | USD | 10 | 0.83 | 0.17 |
| Others (specify) | USD | 10 | 0.83 | 0.17 |
| Subtotal | USD | | | 7.27 |
| **Operating Costs** | | | | |
| Fees paid for emptying support | USD | | | |
| Transport support fees paid | USD | | | |
| Disinfectants | USD | 10 | 0.83 | 0.07 |
| Medicine used | USD | 10 | 0.83 | 0.07 |
| Material renting | USD | 5 | 0.42 | 0.03 |
| "baksheesh" for Harassment | USD | | | |
| If sold for re-use: Transportation costs to buyer | USD | | | 7.45 |
| **Total Expenses** | | **461.28** | | |
| **Revenue** | | | | |
| Emptying (HH) | USD | **700** | 58.33 | 12 |
| If sold for re-use: Income from sale to buyer | USD | | | |
| * Other uses of the equipment (specify) | USB | | | |
| Subtotal | USD | | | |
| Total | USD | | | 12 |
| **Profit/ Loss** | | | | |
| Profit / Loss | USD | **238.72** | | 4.55 |

## C. Small mechanized services

Preliminary financial analysis (revenue versus expense) for one private company operating in Addis Ababa (Zequala Sludge Emptying and Transportation Company) has been conducted. The analysis was made for one company because the other companies do not have records of their accounts.

The Company did not allocate depreciation for pump, office equipment and tires. The cost for depreciation was assumed 5% (because the trucks are older than 10 years), while tire depreciation is computed based on the parameter. Based on the analysis of the Company's the annual expenses of the company were 26,984 USD or 27 USD per trip. Its annual revenue for 2002 EC (2010/11) was 32,544 USD. Its unit price is 33 USD per trip.

Accordingly, for the year the company made a gross profit of 5560 USD and net profit of 3892. The analysis showed that the fuel expenses were the major expense accounting 57% of unit costs. Investment costs accounted 16% while total operational expenses were 67%.

**Table 3-30 Income Statement of Small Company (Ziquala)**

| Item | In USD |
|---|---|
| **Personnel Costs** | |
| Wages | 4331.4 |
| Daily workers | |
| Administration charges | |
| Medical/social security expenses | 260 |
| **Subtotal** | **4591** |
| **Proportion of Personnel cost to total cost** | **17%** |
| **Operating and Maintenance costs** | |
| Registration fees of company | 71 |
| Licensing fees for truck | 18 |
| Office rent | 1420 |
| Parking garage | |
| Marketing pubs | |
| Telephone | |
| Electricity/water | |
| Offices supplies, computer | |
| Truck Maintenance / Repair | 1213 |
| truck license tax | |
| Truck servicing | |
| Pump servicing | |
| Safety Equipment | |
| Fuel (pumping & transport) | 15385 |
| Sludge dumping/tipping Fees | |
| Frais de route | |
| Hidden costs (eg police) | |
| Others (specify) | |
| **Subtotal** | **18107** |
| **Proportion of O &M cost to total cost** | **67%** |
| **Equipment Capital costs** | |

| | |
|---|---|
| **Loan interest to bank** | |
| Insurance costs for trucks | 87 |
| If used, costs to refurbish truck (one time- upfront) | 1775 |
| Truck Depreciation Cost | 435 |
| Tires depreciation Cost | 1398 |
| Pneumatic amortization (Pump) | 591 |
| Suction pipes depreciation Cost | |
| Office equip depreciation | |
| | **4286** |
| **Proportion of Equipment Capital cost to total cost** | **16%** |
| **Grand Total Expense** | **26984** |
| **Revenue Sources** | |
| Emptying (Households only) | |
| Emptying (other) | |
| **Subtotal** | **32544** |
| **Profit /Loss** | |
| **Revenue before Tax** | **5560** |
| **Revenue Tax** | **1668** |
| **Profit (loss) after Tax** | **3,892** |

## D. Medium mechanized services

Preliminary financial analysis (revenue versus expense) for two private companies operating in Addis Ababa (NAHA Sludge Emptying and Transportation Company (4 trucks) and Dadimos Sludge Emptying and Transportation Company (2trucks)) and one public (3trucks) and one private (2) from Dire Dawa has been conducted.

Based on the analysis of the Companies' financial information[11] all 3 private companies were making operating surplus and net profits while the Dire Dawa Public Utility was making loses.

While fuel expenses were major expenses for the companies in Addis Ababa with 49% and 42% of costs for the companies in Dire Dawa fuel cost was not the major expenditure with 25% and 23% of all costs.

The companies had tariffs ranging from 18USD for Naha to 41USD for Java in Dire Dawa. The public company in Dire Dawa charges 30 USD equal to the private company Dadimos in Addis Ababa.

NAHA has bought 4new trucks 10 years ago and has high depreciation expenses however the Company had paid back the loans it has taken from a commercial bank. Even though the company profits are low as shown in the statements the company has definitely used depreciation allowances for bank payments. The company is planning to procure additional 2 vacuum trucks through loan finance.

[11] Dadimos has shown depreciation costs while the other did not and accordingly estimates were made. Maintenance cost was given by Dadimos and NAHA while JAVA had not. In cases where costs are shown in the statements these figures were taken only in their absence was estimates were made based on the parameters.

JAVA has also bought new vacuum trucks but was able to make substantial profit through high price and relatively low fuel expense in Dire Dawa. The public company in Dire Dawa should have made surpluses if it did not have such high down time of estimated to be around 50%. The individual income statements are shown in annexes.

An analysis of the financial situation of a medium sized mechanical company was carried out based on the data from the three private companies to show how the costs would on average. Personnel costs account 10%, operation 47% and equipment capital costs 43%.

The reason for high equipment capital cots is because except Dadimos the other two companies have vacuum trucks which are new and their purchasing price and depreciation cost (10%) are very high with purchase price around 118,000USD.

**Table 3-25 Income Statement for average of three medium sized private companies**

| Item | In USD |
|---|---|
| **Personnel Costs** | |
| Wages | 6504 |
| Daily workers | 0 |
| Administration charges | 0 |
| Medical/social security expenses | 949 |
| **Subtotal** | 7453 |
| | **10%** |
| **Operating and Maintenance costs** | 0 |
| Registration fees of company | 225 |
| Licensing fees for truck | 36 |
| Office rent | 0 |
| Parking garage | 0 |
| Marketing pubs | 0 |
| Telephone | 627 |
| Electricity/water | 359 |
| Offices supplies, computer | 536 |
| Truck Maintenance / Repair | 4433 |
| Truck license tax | 0 |
| Truck servicing | 0 |
| Pump servicing | 0 |
| Safety Equipment | 0 |
| Fuel (pumping & transport) | 30318 |
| Sludge dumping/tipping Fees | 70 |
| Frais de route | 0 |
| Hidden costs (eg police) | 0 |
| Others | 100 |
| **Subtotal** | 36704 |
| | **47%** |
| **Equipment Capital costs** | 0 |
| **Loan interest to bank** | 0 |
| Insurance costs for trucks | 2169 |
| If used, costs to refurbish truck (one time- upfront) | 1243 |

| | |
|---|---|
| Truck Depreciation Cost | 24765 |
| Tires depreciation Cost | 4217 |
| Pneumatic amortization (Pump) | 1380 |
| Suction pipes depreciation Cost | 0 |
| Office equip depreciation | 197 |
| | 33971 |
| | **43%** |
| **Grand Total Expense** | 78128 |
| **Revenue Sources** | |
| Emptying (Households only) | 42182 |
| Emptying (other) | 23290 |
| **Subtotal** | 82730 |
| **Profit /Loss** | |
| **Revenue before Tax** | 4602 |
| **Revenue Tax** | 1381 |
| **Profit (loss) after Tax** | 3221 |

## E. Large mechanized services/Public Utilities

Addis Ababa Water and Sewerage Authority (AAWSA) is the only operator with more than 5 vacuum trucks. AAWSA is a public company organized as an autonomous entity under the Municipality to provide water and wastewater services in the City. The Utility operates 67 vacuum trucks.

The Utility's financial data does not show the expenses of sludge emptying and transportation business separately. Therefore, the financial analysis was carried out by using different sources and making assumptions..

The assumptions were made with regard to fuel expense, personnel costs, maintenance cost, depreciation, tire depreciation costs and other equipment capital costs. Personnel costs were computed based on base salaries and number of staff engaged in sludge business. Depreciation was assumed 5% because average age of trucks is 15 years, maintenance, fuel, tire costs were computed by using with same parameters as other companies.

The study team analyzed the Utility's financial statements, recent study undertaken by the Utility to revise Sludge emptying tariffs, the draft 10 year business plan and interviews with different staff in the Authority.

Based on the analysis the annual expenses of the company were **1,597,953**USD or 24 USD per trip. Its annual revenue for 2002 EC (2010/11) was 301,574 USD. Its trip charge as computed in the analysis was 4.81 USD.

Accordingly, if the company captures all costs it was making a loss of **1,296,379**USD per annum. The analysis showed that the fuel expenses were the major expense accounting 47% of unit costs. Investment costs accounted 23% while operational costs are 51% of the total cost.

Table 3-26 Income Statement of AAWSA

| Item | In USD |
|---|---|
| **Personnel Costs** | |
| Wages | 333684 |
| Daily workers | |
| Administration charges | |
| Medical/social security expenses | 53389 |
| **Subtotal** | **387073** |
| **Operating and Maintenance costs** | |
| Registration fees of company | |
| Licensing fees for truck | 476 |
| Office rent | |
| Parking garage | |
| Marketing pubs | |
| Telephone | |
| Electricity/water | |
| Offices supplies, computer | 12899 |
| Truck Maintenance / Repair | 79290 |
| Truck license tax | |
| Truck servicing | |
| Pump servicing | |
| Safety Equipment | |
| Fuel (pumping & transport) | 752635 |
| Sludge dumping/tipping Fees | |
| Frais de route (what's this?) | |
| Hidden costs (eg police) | |
| Others (specify) | |
| **Subtotal** | **845300.349** |
| **Equipment Capital costs** | |
| **Loan interest to bank** | |
| Insurance costs for trucks | 24852 |
| If used, costs to refurbish truck (one time- upfront) | |
| Truck Depreciation Cost | 187600 |
| Tires depreciation Cost | 93661 |
| Pneumatic amortization (Pump) | 39644 |
| Suction pipes depreciation Cost | |
| Office equip depreciation | 19822 |
| | **365579** |
| **Grand Total Expense** | **1597953** |
| **Revenue Sources** | |
| Emptying (Households only) | |
| Emptying (other) | |
| **Subtotal** | **301574** |
| **Profit /Loss** | |
| **Revenue before Tax** | **-1296379** |

| | |
|---|---|
| **Revenue Tax** | |
| **Profit (loss) after Tax** | **(1,296,379)** |

The details are shown in annex 12.

#### 3.4.1.2.2 Breakeven analysis

The break-even analysis establishes a relationship between operation costs and revenues. It indicates the level at which costs and revenue are in equilibrium. For the FS business the important revenue variables for breakeven analysis are the number of trips and the unit price.

Accordingly, a breakeven analysis for a one truck company was carried out and in order the company to become break even it has to make **1500** trips and charge 32.6 USD.

**Table 3-27 Breakeven analysis for a one truck company**

| **Operating costs - Fixed** | | | **Operating costs – Variable** | |
|---|---|---|---|---|
| Fixed annual salary costs | 4260 | | Fuel | 3.5 |
| Office building rent | 1420 | | Variable wages | 2 |
| Telephone | 213 | | TOTAL VARIABLE OPEX | 5.5 |
| Electricity | 178 | | | |
| Annual maintenance provision (% of I cost) | 11834 | | | |
| Insurance (% of value at beginning of year) | 1183 | | | |
| Misc other costs | 500 | | | |
| TOTAL FIXED OPEX | 19589 | | | |
| Interest | 9223 | | | |
| Depreciation | 11834 | | | |
| Total | 40646 | | | |
| | | | | |
| | | | | |
| Unit Price | 32.624 | | | |
| Trips | 48900 | 48896.4101 | **1500** | |

For a medium sized company of 3 trucks the breakeven price is 31 USD with 1500 trips per annum. Breakeven price and trips do not vary substantial in relation to size because the main cost of operation is fuel which is dependent on number of trips rather than the size of the company.

The detail analysis is shown in annex 12.

#### 3.4.1.2.3 IRR, NPV, Cash Flow and ROE

The objective of financial analysis is to provide with financial information that will guide investors to decide on the profitability of the project from financial perspective. Financial analysis is carried out to determine the financial viability of the project. It assess whether the revenues of the project will be sufficient to amortize the project loan, pay operation and maintenance costs and meets interest and other financial obligations.

The financial analysis will show the financial profitability of the project, which means whether the project is profitable or deficits are likely to come.

The result of financial analysis shows that the project is financially viable for both scenarios, which are carried out in two scenarios (investment through loan and investment without debt).

**Project scenario with debt**

The FS business project financed through bank loan with one truck is financially viable with a positive financial NPV of USD 64,344 and IRR of 59% (post tax), 107% (pre-tax).

**Project scenario with no debt**

The FS business project financed through owners equity with one truck is financially viable with a positive financial NPV of USD 45,217 and IRR of 30% (post tax), 40% (pre- tax).

**Return on Equity**

The FS business project has a five year annual average ROE of 13% if the project is financed through own equity, while the ROE for loan financed project is 27%

**Cash Flow**

The FS business project shows positive cash flow for the entire 5 years with the bank loan scenario while for the equity scenario it shows negative cash flow for 2 years but a fat positive cash flow surplus over the total of the five years period.

**All the above values are adequate to justify the financial viability of the FS transportation business with one truck if the tariff rate is 40 USD and an annual 1500 trips is achieved.**

#### 3.4.1.3 Sensitivity and risk analysis for:

The sludge emptying and transportation business is exposed to a number of potential risks like any other business. The important issue is to identify the potential risks and develop mitigation measures or prepare to address them.

**Potential risks:**

**Operational**

- The trucks being over used and exposed to frequent break down
- Lack of qualified personnel to maintain the pumps
- Lack of spares to the Trucks
- Long distance to sludge dumping sites
- Traffic accidents and associated expenses
- Limited capacity of sludge dumping sites

**Financial**

- Increase in capital investment costs
- Increase in operational costs as a result of high inflation or price increase in fuel prices
- Decrease in sales
- Lack of access to finance from commercial banks or high interest rates

Sensitivity analysis has been carried in order to test the business vulnerability to possible changes. Sensitivity analysis investigates impacts of changes in the plan variables on the base case.

The base case scenario incorporates several variables that could affect the plans outcome if change on the variables occurs. However, among the variable the key elements have to be identified for scrutiny.

Accordingly, sensitivity analysis will be conducted with the following variables:

- Reduction of tariff to 25USD
- Decrease in trips to 1000

The result shows under both changes the profitability of the company will be significantly affected.

The IRR for the first scenario (Reduction of Tariff) will go down to -25% while for second scenario (decrease in trips) to -27%. Also the NPVs will substantially decrease reaching negative figures of -36,614 and -39,345.

The details are shown in annex 12.

#### 3.4.1.4 Access to finance

There are different sources of finance that are being accesses by the fecal sludge emptying and transportation companies and builders and operators of the dumping sites.

The following financing sources are available:

- Treasury budget
- Grant from Donors
- Loan from International Financiers
- Loan from Commercial banks

The first three financing sources are only available for the public utility for procurement of vacuum trucks and building of fecal sludge dumping sites. Private operator companies can only make use of loans from commercial banks.

The borrowing rates from commercial banks are 10.5% and payment period stretches from 5 to 10 years. The major constraint in accessing the finance is however to provide collateral for the borrowed amount. For companies with limited capital the access to finance is very difficult.

#### 3.4.1.5 Role of public sector in business sustainability

**Addis Ababa**

In the City of Addis Ababa the Public Sector encompasses broad mixture of institutions including the following:

- Municipality
- City Environment Protection Authority
- Addis Ababa Water and Sewerage Authority
- Addis Ababa Health Bureau

At present the role of the public sector stretches from operating the emptying and transportation business to building and operating disposal sites, and regulating the business in general.

The public sector is involved in planning the sector, building and operating sludge disposal sites, licensing of other operators, providing incentive mechanisms and general oversight and regulatory activities.

At present there are discussions to clearly identify the role of the public sector in fecal sludge management.

The study is analyzing the role and expectation of all stakeholders, strength and weakness of the stakeholders, review the ongoing public debate and recommend the public sector role in fecal sludge management.

#### 3.4.1.6 Business analysis of Treatment Plants in the cities

The FS treatment plants in Addis Ababa and Dire Dawa are operated and managed under the water and sewerage public utilities. The FS treatment plants are not managed as business units. In the case of Addis Ababa the FS treatment plants are considered as units of the Sewerage Business Units. But the treatment plants are not cost centers and their cost of operation and equipment are not known.

While the Addis Ababa FS treatment plant charges 13 USD per truck per annum the Dire Dawa provides the service for USD 0. 86 /trip. In both cases the FS treatment plants are subsidized by revenues from water business.

The concept of the treatment plant as a business does not exist at all. Before any business concept is developed the institutional issue needs to be addressed. The responsibility for operating and managing FS treatment plants lies with Municipalities and before other options are developed and implemented developing business models will be difficult.

The only viable option being discussed as a business strategy at present is to charge for the dumping sites that would cover costs of operation.

#### 3.4.1.7 Recommendations for sustainable business models per city

### a) Addis Ababa

#### Pricing and tariff structure

An effective allocation of resources and improved service in FSM can be achieved if appropriate pricing and tariff structures are put in place. The sludge emptying and transportation tariff shall reflect actual costs. The first important issue is how to structure the tariff. Presently, different tariff structures are implemented in Addis Ababa. The main tariff structures will be Distance Based

It is proposed to classify tariff structures as City centre and fringe area domestic. For domestic it is assumed that one trip cannot exceed 8 m3.

The proposed tariff rate for household and non domestic is weighted 1:1.5.

Accordingly initially city centre users will be **30 USD** while non domestic users' fee will be **45 USD**.

#### Cost and revenue optimization

The major costs of faecal sludge emptying and transportation business are the following:

- Fuel
- Maintenance
- Depreciation
- Loan Payment

The investment costs can only be optimized if **access to finance is made cheaper and convenient**. Further, land acquisition and customs can also affect investment costs. In Addis Ababa the City Administration provides land to mechanical emptier. Further, the Federal Government provides customs privilege to the FS business. Therefore, there are no areas for improvement. The major stumbling block is access to finance. Existing sources of finance to private emptier is limited to commercial banks that require collaterals and have strict and high repayment

modalities. **Longer periods of repayment with lower interest rates can reduce investment costs substantially. In line with the experience in Ethiopia the Government and Donors can set up a special fund (like water fund[12]) that will be made available for private and public FSM companies to borrow under suitable conditions.**

Fuel cost can only be optimized if the trips are shortened and the efficiency of the vehicles is improved. In order to shorten the size of the distance more **transfer stations shall be built**. Further to reduce maintenance costs **specialized private repair facilities need to be encouraged**. At present the maintenance facilities for pumps are either public owned or importing companies. The first is not very efficient while the later charges high prices.

Revenue optimization can be achieved if the emptier companies can work at 100% capacity. This would require as discussed earlier 6 trips per day for 300 days. This means that it should attract more market by offering **users friendly and flexible commercial practices**.

One area for improvement is to **change payment modality.** The operators shall offer more options like **50% upfront payment and 50% of payment in specific period**. Another area for intervention is to register Clients and provide improved price rates and better services for registered Clients.

**Expanding fleets of private companies and reducing the fleet of AAWSA**

This proportion of vacuum truck fleets of private and public can only be changed in favour of private companies if AAWSA shows a 100% commitment to change its role. This is already being discussed and there is a principal agreement. The next step is for AAWSA to sale old vacuum trucks to private investors. The commitment made in its 10 year business plan to reduce its truck capacity in the City to 25% can only be achieved if the older trucks are sold and no new trucks are bought. The risk in this is what if private companies will not be interested. Private investors will be interested if there is higher rate of return than in other businesses. This can be achieved if AAWSA improves its prices and reduce the gap between public and private company prices. AAWSA is committed to do so and increase the price from present 4 USD to around 15 USD. This is a step in the right direction. AAWSA shall also not involve in emptying of businesses because they do not need subsidized services.

**Improving the demand side of the business**

A business needs to sale its services or products. Unless it has a demand for its services it cannot sustain as a business. Therefore, interventions on the side of the demand/households and businesses must also be addressed. Households and businesses that do illegally connect their toilets to public infrastructure like drainage and to rivers should be regulated and penalized.

## Role of public utility

The public utility role should be limited to the following:

- Planning of sanitation infrastructures
- Building and operation of sludge dumping and treatment plants
- Capacity building to the private mechanized operators
- Provision of emptying and transportation service to the urban poor (in the short-term)
- Trigger community awareness of sanitation and promote demand for services

[12] Water fund is a special fund dedicated for borrowing urban water utilities under a soft loan condition (5%, 5 years grace period over 25 years repayment) to improve the water supply situation in the Cities.

- Limitation of public utility role to providing service to urban poor

**B) Dire Dawa**

Emptying of dry pit latrines in Dire Dawa is proving very difficult much of the volume is thought to be water added to the pit to enable the sludge to be pumped or left in the pit especially after a number of years is solid, this procedure is failing to remove a substantial amount of the sludge which in most cases turns the client to opt for manual emptier. This is also manifested with a huge health and environmental problems where the geology of soil material is highly dominated by sandy soil and the construction of pit walls (if there is any) is practiced with limestone rocks of dry masonry.

The present practices of using pumper vacuum truck has only served for those having septic tanks and wet latrines otherwise most people living in such kind of cites use manual emptier or dig another pit if they have a space.

The recommended procedure elsewhere in the world is to use a high performance vacuum truck, which removes the dry material using air to convey the material. The sludge can be moved up to 100m away using this procedure.

It must be appreciated that use of high performance vacuum trucks will increase the volume of sludge collected from individual dry pit latrines thus increasing the intervals between de-sludging. The dry material would be disposed of to a sanitary landfill.

Therefore, a sustainable FS emptying business can only be achieved with the introduction of high performance trucks and capacity building for all mechanical emptiers.

**C) Hosaena**

Like Hosaena most small towns with an average population between 50, 000 to 70,000 are zonal centers in most cases have no any form of mechanical empting service within the city instead they got such service with scheduled call from the bigger cites after a long waiting list even though most of them has an official dumping site but no vacuum truck in the city.

The present practices of using vacuum truck from Addis Ababa or Hawassa cities which both far more than 250km from the town makes the service very expensive and unbearable specifically for the urban poor.

In this context, it is proposed to buy one vacuum to be used for two or three neighboring towns until the capacity of using full time resource is reached within the town.

Due to limited demand from one City like Hosaena a FS emptying business can only be sustainable and profitable if the business is established in one of the Cities with geographical proximity to provide service to all adjacent Cities. The municipalities of the Cities should agree on mode of cooperation.

### 3.4.2 Country level (across cities)

#### 3.4.2.1 Difference in parameters across the three cities

The major differences in parameter across the three cities are the following:

- Fuel cost
- Number of trips
- Maintainance costs

- Tariff

**Fuel cost**

The fuel cost in Addis Ababa is the highest because of the size of the City and corresponding location of dumping sites. Dire Dawa has the lowest fuel cost because of the small size of the City.

**Number of Trips**

The number of trips in Addis Ababa is much lower than Dire Dawa because of the distance to dumping site and traffic jamming.

**Maintenance Cost**

The maintenance cost in Addis Ababa is relatively lower than in Dire Dawa because of the availability of repair workshops in the City. Trucks from Dire Dawa have the disadvantage of traveling 500 Km to Addis to get maintenance service.

**Tariff**

The tariff rate in Addis Ababa is relatively lower than the other Cities because of the low tariff applied by the Public Utility. Private companies in Dire Dawa have easier to increase price because the public company charges over 30USD. Hosaena has also the disadvantage of having no company in the City as a result charging much higher than the two cities.

## 3.5 Details and recommendation of at least one business ready for investment and growth

The proposed business is the utilization of **Dire Dawa Municipal Waste for the production of Bio-methane and Organic fertilizer pilot project including emptying and transportation of FS through high performance vacuum truck.**

- To produce biogas or bio-CMG (Compressed bio-Methane Gas) and bio-fertilizer.
- Help in addressing waste disposal problems and utilization.•
- To specialize in designing and customizing biogas production including biogas upgrading technologies.
- To conduct R and D in bio fuel technologies.
- Emptying and transportation of FS through high performance vacuum truck.

**Expected Results**

- The construction of the pilot project for anaerobic digesters that can process 100 to 160 tons of Solid waste per day including 500m3 daily trucked in household liquid waste.
- The waste then processed through anaerobic digestion system that can produce out 35,000 $m^3$ raw biogas per day.
- Emptying and transportation of 12,000 m3 FS.
- The raw biogas then is upgraded to compressed methane gas (CMG) by utilizing water scrubber and PSA technologies for purification of raw biogas resulting in a product with a minimum content of 94% methane and less than 1000 ppm of $H_2S$ content. The biogas upgrading plant will be erected close to anaerobic digesters on the site made available for the planned project.
- The bio-CMG then will be compressed and filled into steel cylinders for distribution.

- The estimated total investment of the biogas production and upgrading plant including cost of machinery and equipment, civil works, erection, testing and commissioning including technical knowhow as well as pre-operational and working capital is to the tune of USD 3.5 Million.
- The annual sales revenue of the upgrading plant is estimated to reach USD 1.7 million per year at full capacity of the plant.
- The revenue of the upgrading plant will increase with sales revenues from other by-products such as organic fertilizer.
- Additional potential revenue could be generated from carbon credits by applying for CDM.

### 3.5.1 Current service levels

Currently (in the year 2011) the city of Dire Dawa has a population of about 331,500. The total volume of solid waste generated in the city is about 166 (81) tons per day or 60,590 tons per year based on previous studies. About 70% of the total solid waste generated is organic matter. Thus the total volume of organic matter or volatile solids (VS) is 116 tons per day. The municipal solid waste is collected and dumped near the FS dumping site.

Around 50,000 m3 fecal sludge is being produced of which 32,500 is being collected and dumped in the dumping site.

Both wastes are dumped without being further utilized for any purpose. There is also no high performance truck being utilised. As a result households are forced to use manual emptier.

### 3.5.2 Current profitability

As noted in section 3.5.1 the municipal waste has not been reused for any purpose, therefore, it cannot generate any revenue what so ever. There is also no high performance truck being utilised.

### 3.5.3 Projected profitability in 3-5 years

Assumptions made during the financial analysis of the proposed business are the following:

- Financing: It is assumed that the project will be mainly financed by grant from donor agencies. However, as the project is forecasted to be profitable it can be financed by a private company PLC and from bank loan. The grant is to cover the machinery and equipment costs only. This arrangement could also help to show the donors the existence of commitment from the project promoters' side.
- Interest rate for bank loan will be 12.5% per annum.
- A plot of land of about 9,000 sq.m. will be availed free.
- Raw materials (municipal wastes) will be delivered to the plant site free of charge and to have guarantee the company will also empty and transport FS (12,000m3 per annum).
- Municipal waste from other Cities (Harar and surrounding) will be brought to the site with the cost of the Company.
- The pilot plant will only handle about 50% of the current municipal waste generated in Dire Dawa City.
- The plant would sell upgraded biogas and bio-fertilizer at Birr 250 (USD 14.5) per a 15 kg cylinder, and Birr 400 (USD 23) per tone, respectively, including VAT.
- No carbon credits are assumed.
- Exchange rate of USD$ to Birr 17.4.

## Profit & Loss Statement

('000 Birr)

| Description | Production Years | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| **Total Sales Revenue** | **32,651** | **40,814** | **54,418** | **54,418** | **54,418** | **54,418** | **54,418** | **54,418** | **54,418** | **54,418** |
| Less net VAT | 4,259 | 5,323 | 7,098 | 7,098 | 7,098 | 7,098 | 7,098 | 7,098 | 7,098 | 7,098 |
| **Net Sales** | **28,392** | **35,490** | **47,320** | **47,320** | **47,320** | **47,320** | **47,320** | **47,320** | **47,320** | **47,320** |
| **Less Cost of Goods Sold** | **22,889** | **20,965** | **20,264** | **19,534** | **18,054** | **16,870** | **15,923** | **15,165** | **14,559** | **14,074** |
| **Gross Profit** | **5,503** | **14,525** | **27,057** | **27,786** | **29,266** | **30,450** | **31,397** | **32,155** | **32,761** | **33,246** |
| **Gross Profit Margin** | **24%** | **69%** | **134%** | **142%** | **162%** | **180%** | **197%** | **212%** | **225%** | **236%** |
| Less Administrative Expenses | 6,339 | 6,096 | 5,901 | 5,905 | 5,780 | 5,681 | 5,602 | 5,539 | 5,488 | 5,448 |
| **Profit (loss) before Interest, Sales Cost & Tax** | **-836** | **8,429** | **21,155** | **21,882** | **23,486** | **24,769** | **25,795** | **26,616** | **27,273** | **27,798** |
| Less Interest (Financial Costs) | 3,654 | 3,265 | 2,767 | 2,270 | 1,773 | 1,276 | 779 | 389 | 0 | - |
| **Profit (loss) before Sales Cost & Tax** | **-4,490** | **5,165** | **18,388** | **19,612** | **21,713** | **23,493** | **25,016** | **26,227** | **27,273** | **27,798** |
| Less Selling & Distant Costs | 1,084 | 1,256 | 1,542 | 1,542 | 1,542 | 1,542 | 1,542 | 1,542 | 1,542 | 1,542 |
| **Profit (loss) before Tax** | -5,574 | 3,909 | 16,846 | 18,070 | 20,171 | 21,951 | 23,475 | 24,685 | 25,731 | 26,256 |
| Less Income Tax (30%) | * | * | 5,054 | 5,421 | 6,051 | 6,585 | 7,042 | 7,406 | 7,719 | 7,877 |
| **Net Profit (Loss)** | **-5,574** | **3,909** | **11,792** | **12,649** | **14,120** | **15,366** | **16,432** | **17,280** | **18,012** | **18,379** |
| Cumulative Net Profit (Loss) | -5,574 | -1,665 | 10,127 | 22,776 | 36,896 | 52,262 | 68,694 | 85,974 | 103,986 | 122,365 |
| **Profit (loss) before Tax (w.o. ex. financing)** | -1,920 | 7,174 | 19,613 | 20,340 | 21,944 | 23,227 | 24,253 | 25,074 | 25,731 | 26,256 |
| Less Income Tax, w.o. ex. financing (30%) | - | * | 5,884 | 6,102 | 6,583 | 6,968 | 7,276 | 7,522 | 7,719 | 7,877 |
| **Net Profit (Loss), w.o. ex. Financing** | **-1,920** | **7,174** | **13,729** | **14,238** | **15,361** | **16,259** | **16,977** | **17,552** | **18,012** | **18,379** |
| Cumulative Net Profit (Loss) | -1,920 | 5,253 | 18,983 | 33,221 | 48,582 | 64,841 | 81,818 | 99,370 | 117,382 | 135,761 |

The proposed business will become profitable with in the second year on making net profit every year for the next 9 years. It will also be able to pay the bank loan.

The financial performance of the high performance truck as a buiness unit is also anlysed and it was found that it will also make USD 5216 net profit after tax.

### 3.5.4 Investment required

The total investment required for the proposed business is 3.3 Million USD. The detail cost break down is shown in the following table.

| Item | USD |
|---|---|
| Civil Works | 340,000.00 |
| Site preparation | 30,000.00 |
| Fence and Gate | On site |
| Street Work | On site |
| Civil Works in general - digester operation | 100.000.00 |
| Biogas upgrading installation | 160,000.00 |
| Commissioning support | 50,000.00 |
| Receiving pit | 212,000.00 |
| Mixing tank with percolation system | 107,000.00 |
| Pasteurizer | 65,000.00 |
| Digester | 610,000.00 |
| Secondary digester & Covers | 370,000.00 |
| Gas System | 127,000.00 |
| Control Room Building (warehouse) | 75,000.00 |
| Equipment | 135,000.00 |
| Gas, Heating System Installations* | 135,000.00 |
| Waste Sludge management | 100,000.00 |
| Biogas upgrading equipment | 616,000.00 |
| Gas Storage tank | 100,000.00 |
| Bio-methane bottling equipment | 66,500.00 |
| High Performance Vacuum Truck | 200,000.00 |
| Permitting management | 55,000.00 |
| Sum, net | 2,978,500.00 |
| Contingency (10%) | 297,850.00 |
| Total Cost | 3,276,350.00 |

### 3.5.5 Risk analysis

The major risk of the Bio-methane and Organic fertilizer pilot project is the ability to sell the product as projected in the financial analysis. A reduction of sales by 20% will force the company to make two years deficit then for 8 years profit. However, if the sales amount decrease substantially the business profitability is highly questionable.

Another major risk is the availability of the raw material (waste) particularly from other Cities. The Cities' municipalities need to cooperate and be convinced of the importance of the project.

**Constraints and Barriers in FSM**

The constraints in fecal sludge management in Ethiopia are multifaceted. There are limitations in awareness and due attention is not being given to the service and to the environmental sanitation issues in general. As result limitations in financing, enforcing rules and regulations, prioritizing as an independent sectoral issue, etc. is low at all level. At community level, lack of proper knowledge has led to neglecting the issue as being vital to human life, and is put at low profile in prioritizing both in budgeting for the service and in availing standard sanitation facilities for use.

The FS operator owners and FS emptiers (truck operators) have highlighted their complaints and opinions. Some of the complaints gathered during the site survey and interviews are summarized as follows:-

- Lack of policy that supports and encourages private FS operators.
- Institutional capacity issues
- Inadequate Public awareness on FSM
- Lack of adopted standard design and/or none compliance to standard designs of pits and septic tanks construction.
- Competition by public utility service providers for the market.
- Lack of experience and established methodology for safe re-use of fecal sludge
- Deficiencies in enforcement of sanitary rules and regulations
- Financial constraints and lack of loan for investment.
- Lack of proper management style and office facilities by some of the private operators.
- Lack of associations for private operators
- Lack of discussion forum for all stakeholders and operators
- Lack of designated, independent unit for FS management within the structure of some of the utility owners. Overuse of the existing sanitation facilities and/or illegal connection of the overflow to storm water drainage system.
- Entry of extraneous solid waste material into pit latrines
- Access problems to on site sanitation facilities
- Shortages of spare parts for trucks
- Lack of space for garage and workshops for private operators
- Lack of incentives and support for private operators
- Deficiencies in occupational safety and workers health

## 3.6 Constraints and Problems of FMS

The constraints in fecal sludge management in Ethiopia are multifaceted. There are limitations in awareness and due attention is not being given to the service and to the environmental sanitation issues in general. As result limitations in financing, enforcing rules and regulations, prioritizing as an independent sectoral issue, etc. is low at all level. At community level, lack of proper knowledge has led to neglecting the issue as being vital to human life, and is put at low profile in prioritizing both in budgeting for the service and in availing standard sanitation facilities for use.

Based on the outcome of household survey, stakeholders' interview, operators and owners' inputs and observation of FS infrastructures and the team's analysis, the following major areas of constraints and problems have been identified.

### a) Legal and Institutional

- Lack of policy that supports and encourages private FS operators.
- Inadequate capacity and lack of prioority by by public utilities for FSM
- Inadequate Public awareness on FSM
- Deficiencies in enforcement of sanitary rules and regulations
- Lack of designated, independent unit for FS management within the structure of some of the utility owners.
- Lack of discussion forum for all stakeholders and operators
- Too many institutions involved in FSM with out clear manadates

**b) Technology**

- Lack of adopted standard design and/or none compliance to standard designs of pits and septic tanks construction.
- Lack of experience and established methodology for safe re-use of fecal sludge
- Overuse of the existing sanitation facilities and/or illegal connection of the overflow to storm water drainage system.

**c) Emptying and Transportation Operation**

- Very high down time and idele time of vacum trucks
- Absence of transfer stations (limited number with access to public company only)
- Access problems to on site sanitation facilities
- Entry of extraneous solid waste material into pit latrines
- Shortages of spare parts for trucks
- Lack of space for garage and workshops for private operators
- Deficiencies in occupational safety and workers health

**d) Business and Finance**

- Difficulty of accesing loan for capital investement
- High cost of fuel
- High cost of maintainance
- Inadequate revenue due to low price
- Lack of proper management style and office facilities by some of the private operators.
- Lack of associations for private operators
- Competition by public utility service providers for the market.
- Lack of incentives and support for private operators

**e) Capacity Building**

- Capacity constraint in FS operation of private comapnies
- Inadequate skill in financial management
- Lack of capcity in FS treatment and dumping site design and operation
- Lack of skill in FS business management

# 4. Conclusion and Recommendations

## 4.1 Recommendations

### 4.1.1 Legal and Institutional

- The rules and regulations in general are adequate to control the pollution and health risks associated with FSM. However, the implementation of these rules and regulations should be closely followed and the mechanisms to promote and enforce them should be well monitored.
- Establsihing clearly delinated institutional framework with clear manadates and City specificality considered in its implemenatation.
- Demarcating area of operation and limiting the scope of service of the public utility is one of the requests posed by the private operators. In this way the two can go hand in hand and become efficient.
- The provision of emptying and transportation of FS shall be provided by private comapnies, while the role of public utilities shall be limited to regulation, licensing, oversight and provision of service to urban poor.

### 4.1.2 Operational

- Organising and strengthening maintainance workshops and supply chain of spares to reduce down time and idle time of vacuum trucks
- Construction of well designed transfer stations on selected sites with access to private operators.
- Development of urban infrasyructure through integrated approach to facilitate access to households with narrow roads.
- Creation of awareness for proper use of latrine facilities to avoid/reduce entry of extraneous solid waste material into pit latrines
- Enacting of regulations that will ensure the provision of occuptional safety and workers health involved in FSM
- The inefficiency observed with the public utility service is related to management problems and lack of motivation. This has to be tackled with strong management system in place and clear policy direction.
- The FS manual operators engaged in Dire Dawa are providing significant services to the community, but at the expense of their health and safety, as well as risk to the environment. Improvements in the methods of manual operation have to be researched and defined with set of methodology established, if such operation has to continue. This requires assistances and support both for the software aspects of capacity building and for availing basic working facilities ( improved tools, safety devices and equipment) for those engaged on the business.

### 4.1.3 Technical

- Use of the raw sewage for agriculture, though practiced in both urban and rural areas, is unsafe for the public health and for the environment, as it is currently being done. Improvements in the handling and re-use has to be pursued. Use of fecal sludge for bio-gas production has multiple benefits; if sustainable bio-gas production plant is put in operation social, economic and environmental benefits can be earned. So, it is proposed that attemepts being made by investors to engage in FS re-use for bio-feul (bio-methane gas production) should be encouraged and promoted.

- Fecal Sludge is rich in organic nutrients required for plant growth, and can be used as organic fertilizer /soil amendment and for bio-feul production. There are attempts being made for reuse of this resource in the country, but is not in a sustainable and fruitfull way.
- The need for standadization and regular control on type and location of latrine construction
- Montoring of illegal connection to the storm drainage and regullar emptiying when it fills
- Standardization on the purchase of feasible and sustanable type and size of vacuum trucks and major accessories.
- Construction of well desigined addtional transfer station on the selected areas inorder to reduce transportation cost.( reff. Annex.10)
- Expansion of the existing fecal sludge treatment plants with due consideration of having an improved way of managing the facilites.
- Introduction of the use of raw fecal sludge for forestery development around the prephery of the cities. ( reff. Annex.10)
- Introduction of high performance vacuum trucks to be used for dry pit latrine emptiyng service as the existing pumper trucks are not suitable to take all the sludge from the pit. ( ref. Annex.10)

### 4.1.4 Business and Finance

- Recognize the private sector as a strategic partner in dealing with FSM in providing services in emptying, transportation and treatment of FS
- Establsihing special FS fund to provide private and public companies with loan that have lower interest rates and longer repayment periods under a convinient conditions.
- Conduct research and provide private and public companies with innovative emptying and transport technologies that would reduce fuel costs
- Construct additional transfer stations and dumping sites in appropriate sites in the city to reduce fuel cost
- Encourage the establsihment of maintainance workshops by private investors to reduce cost of maintainance
- Develop coherent and targeted subsidies so that the low income households are benefiting and families that do afford higher prices should be execluded from subsidy
- Introduce appropriate pricing structure and rates that do recover full cost and generate acceptable rate of return (20%)
- Encourage and enforce operators to have office facilities
- Organize FS emptiers to form business associations for private operators
- Provide adequate incentives and support for private operators like allocation of plot, technical support, tax incentive and creating productive forum for public private idea sharing

### 4.1.5 Capacity Building

- Build capacity of operators in FS operation of private comapnies
- Train and build capacity of private operators FS business and financial management
- Develop capacity in FS treatment and dumping site design and operation
- Develop national capacity in FS technology
- Conduct research on sludge charachtersics and suitable technologies for emptying and treatment

## 4.2 Conclusions

Even though the proper disposal of liquid waste in general more of a health and environmental issue and it is a collective benefit to the society, the 'polluter pays' principle should be applied to cover either the full or the partial cost of the capital, operation and maintenance cost of the treatment and/or dumping site of the waste.
As observed during the survey, vacuum trucks are effective for sludge from septic tanks as the content is not highly solidified and can be easily be pumped out. It is found out that pit latrine sludge always require to add additional water to dilute it but in most cases not so effective resulting either a small portion of the sludge is pumped out or takes very long extraction time for a pit. This condition negatively affects either the customer or the client. It is also a cause for misunderstanding between the parties to the service.
The owning and operating of a vacuum truck is very expensive and requires a large organizational set up. This implies that a small town cannot afford to provide the extraction and transportation service for its habitat. To overcome such problems, private or government operators should be able to cluster adjacent towns to provide sustainable service.

Resulting from the studies and surveys conducted in this research study regarding the fecal sludge service improvement, it has been tried to formulate several projects that can improve the service in general, but due time and resource limitation few projects are listed in **annex.10** to be considered.

The constitution, general policies, proclamations and regulations of the country clearly state, the protection of the environment, the health of the citizens and clearly specifies duties of the different organs of the government for implementation. Specific to fecal sludge management regulations are addressed by different ministries and authorities. The proclamation on environmental pollution control stipulates that all urban administrations are indebted to the collection, transportation, proper disposal and as appropriate recycling of both liquid and solid wastes. Therefore, the regulatory aspect fecal sludge management is properly formulated in the country. The enforcement and implementation aspect, however, differs in many ways in the different cities and towns depending on the priorities given by the specific authority of the locality. Even though the regulations do not clearly specify the role of private sector in the fecal sludge management, only on the collection and transportation aspect of the sludge is the only field that the private sector so far involved.

FSM in the urban centers has not developed and does not meet the level of standards required. The current FS extraction service provision is shared among profit oriented institutions (private operators), public utility service providers and welfare organizations (NGOs).

The recent developments of involving private operators have some degree of contribution to assist in improving the FS extraction service provision. However, much remains to enhance their participation and involvement in the sector. Being an environment and social issue FSM deserves additional support and incentives, until it has got full understanding among the community and until it is able to run by the revenue it can generate from the services provided. In this regard, the FS operator owners and FS emptiers (truck operators) have highlighted their complaints and opinions as discussed in above sections.