SFD Report

Tema Metropolitan
Ghana

Final Report

This SFD Report - Comprehensive - was prepared by
Centre for Science and Environment

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SFD Promotion Initiative

sustainable sanitation alliance

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

On behalf of Federal Ministry for Economic Cooperation and Development

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Bill & Melinda Gates foundation

SFD Report: Tema Metropolitan, Ghana

Produced by: Centre for Science and Environment

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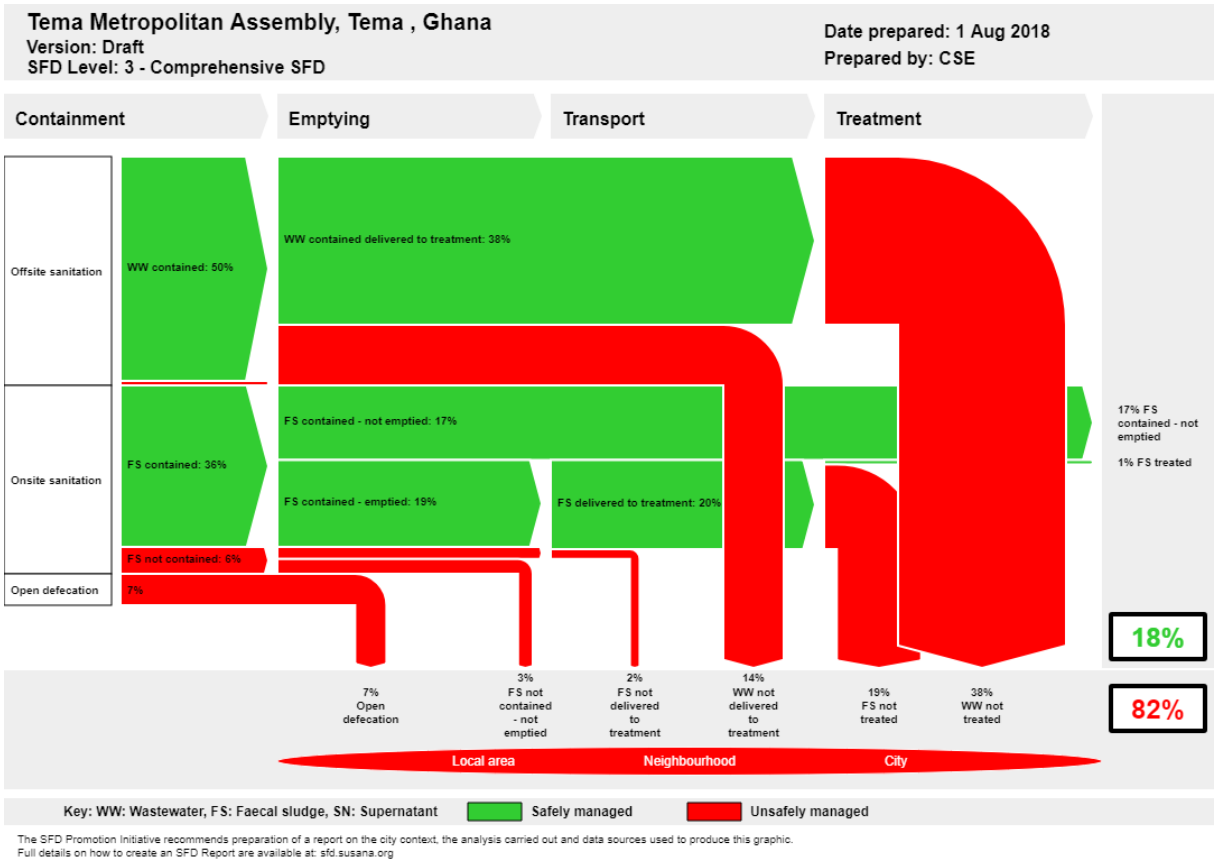
1. The SFD Graphic



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

2. Diagram information

SFD Level:

Comprehensive

Produced by:

Centre for Science and Environment (CSE), New Delhi

Collaborating partners:

Ministry of Sanitation and Water Resources (MoSWR), Waste Management Department, Tema Metropolitan Assembly (TMA)

Status:

This is the final SFD

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3. General city information

The Tema Metropolitan area (TMA) is a coastal metropolis located in the Greater Accra Region of Ghana. TMA is located approximately 25 km east of Accra, the capital city of Ghana. TMA shares boundaries on the North-East with the Kpone Katamanso and Ningo-Prampram Districts, South-West by Ledzokuku Krowor Municipal, North-West by Adentan Municipal and the Ga East Municipal, North by the Akuapim South District and the South by the Gulf of Guinea.

The Ashaiman Municipal is enclosed enclave within the Tema Metropolis. The Metropolis covers an area of about 396km^2 with Tema as its capital and lies within the coastal savannah zone.

According to the 2010 Population and Housing Census, the total population of the Tema Metropolitan Assembly was 292,773. According to Ghana Statistical Service (GSS) the population of TMA is 3,10,853, considered for preparing SFD. The population density of Tema is 784 people/sq.km which is considerably higher than the national average of 124 people/sq.km.

4. Service outcomes

Containment: Tema has sewerage network, that was established in 1960, and is spread in communities 1 to 9,11 and some parts of 10 and 12. The official data says that 23,000 households are connected to this network. According to Tema Waste Management Department, there might be an additional 2,000 households that are illegally connected to the system (WSUP, 2017). Hence, the final population connected to sewerage system considered for preparation of SFD is 108,799. The sewerage system however, experience frequent blockages resulting into wastewater overflowing onto streets, open drains and sometimes into residential facilities (MTDP, 2017).

Half of the population of Tema is dependent on onsite sanitation system. Around 34% of the population is dependent on septic tanks. The tanks have vents and have varying number of chambers (normally >2). It was noted that the chamber numbers directly co relate to the number of lids on the tank. This technology is used for both individual household toilets, public toilets and institutional toilets (i.e. schools). The design of private septic tanks is subjected to acquired knowledge of artisans who construct them. It was informed during KII, FGD and field observation that generally the private and public septic tanks are connected to soak away. During field visit it was observed that there are households that have fully lined tanks without outlet/over flow. The design of public and institutional septic tanks is controlled by TMA and generally incorporates a soakaway, which is under the final chamber of the tank. In terms of the SFD preparation, it is assumed that 2/3rd of the households have septic tanks with soakaways and rest are fully lined tanks with no outlet or overflow.

Apart from septic tanks, there are households that are dependent on lined pit with semi permeable walls, locally called as Kumasi Ventilated Improved Pit (KVIP) or unlined pits. A minor population still use bucket/pan latrines. During the field visit to the selected sites it was observed that households in the low-income settlement are provided toilets under government scheme of 'Get a Complete Toilet at 1,100 GHC'. The containments provided under this scheme are fully lined tanks with no outlet/overflow.

Practice of open defecation is prevalent in Bankuman, Acheampong Village, Manhean, Tema Newtown, Ziguinchor. During FGD, the TMA officials informed that at Tema New Town, Adjeikojo and Lashibiklagon, many households do have toilets but they prefer to practice open defecation. It is estimated that around 7% of the population is still practicing open defecation.

Figure 1: Septic tank with soak away, at last chamber, being emptied by vacuum tanker (Shantanu/CSE, 2018)

Emptying and transportation: No data was available on the actual volume of sewage going to sewage treatment plant (STP), it was observed that sewage pumping station (SPS) and STP were out of order. Thereby, no current records of the effluent quality and quantity could be obtained, as these parameters are not being monitored due to a lack of capacity and budget (EPA, 2015).

In TMA, emptying service is managed by private emptiers. TMA has a truck mounted tanker which is only used as a sewer jetting machine to remove clogging and blockages in sewerage network. Examples of motorised emptying in TMA can be seen in Figure 1. Private vacuum tankers are not registered with TMA. As per FGD conducted with TMA and private operators, around 20 private emptying vehicles are plying in the assembly area (Champion, 2018 and TMA, 2018). In which, Zoomilion Company has three trucks, Sanitation International has two trucks, Champion Company has five trucks, Adom Waste Company has three trucks and there are seven individual private operators. Private emptiers from Accra also provide service in the Tema region. A vacuum tanker operator charges emptying fee from the customer depending on the capacity of tanker requested by a customer. Usually, the emptying charges are as follows 350 Cedi for a $10m^3$ tanker, 400 Cedi for $12m^3$ tanker and 500 Cedi for $>12m^3$ capacity of the tanker. The emptying frequency varies from one containment system to the other; for a septic tank in public toilet emptying frquency is 3 months to 1 year, for septic tanks in households is 6 months to 1 year, for fully

lined tank it is 3 months to 6 months and for various pits it is 1 to 3 year (Champion, 2018 and TMA, 2018).

FS discharging fee (tipping fee) which is paid by the operators is based on axle of the tanker; for double-axle vehicle it is 20 Cedi/ per entry and for

Figure 2: Vacuum tanker owned by private emptier (Shantanu/CSE, 2018)

single axle tanker it is 15 Cedi/ per entry to the treatment plant. The trips made by trucks in the year of 2017 are 2373 trips by double-axle and 1914 by single axle tankers. Total volume of septage which is discharged by vacuum tankers at septage treatment facility is 62987 m^3 (TMA, 2018a). The emptying fee ranges from 350 Cedi to 400 Cedi/ per trip for a single axle truck and it is 500 Cedi per trip for a double-axle truck (Champion, 2018). Manual Emptying in TMA is very clandestine, although it is acknowledged that it exists. As only a limited number of the population rely on basic latrines, it is therefore possible that there are only a few manual emptiers.

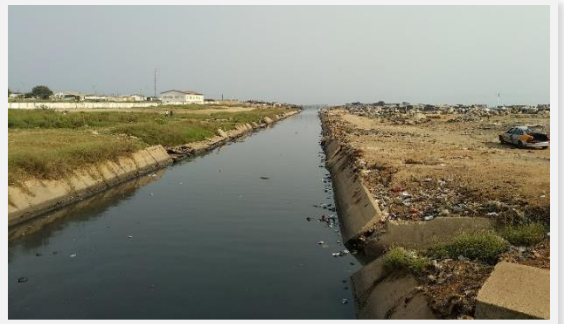

Figure 3: Wastewater from industries and open drains is carried by Chemmu lagoon, terminating into sea (Shantanu/CSE, 2018)

It was observed during field based study that grey water from the households is discharged into storm water drainage system. The storm water drainage system conveys grey water into two lagoons of the city- Sakumonu lagoon and

Chemu lagoon or directly into the sea. The lagoons also overflow into the sea, however, the open drains/nullahs that fill the lagoon are all filled with plastic waste.

Treatment and end use: Tema Metropolitan assembly has three treatment facilities. The Tema STP is based on waste stabilization pond technology which has the capacity to treat 20,000 m3/day of waste water from the Tema metropolis. The plant has not been in operation for about 15 years due to breakdown of equipment on site. The area looked abandoned with ponds overgrown with weeds. Wastewater which is carried through sewer network is pumped and directly discharged into the sea without being treated.

The second treatment plant, septage treament facility, located at Nungua farms was built to cater to population dependent on onsite sanitation system. The septage treatment plant at Nungua Farms serves both the public and private emptying service providers. This plant is the only designated site for discharging septage. The plant is based on stabilization pond technology which has the capacity to treat about 300 m^3 of faecal sludge per day. Currently, the plant receives on an average 20 trucks daily. The defunct plant also serves as the disposal site of faecal sludge for trucks operating outside the boundary of Tema Metropolitan Assembly.

The third treatment plant, septage treatment plant; a co-composting plant, located at Bortyemen. This plant is established on public-private partnership model between Jekora Ventures Ltd (JVL) and Tema Metropolitan Assembly. The plant is facilitated by International Water Management Institute (IWMI) and technical support is provided by Council for Scientific and Industrial support from Research (Institute of Industrial Research) (CSIR-IIR). The capacity of the plant is 12,500 m^3 for faecal sludge, of which one-third is targeted to be collected from public toilets (septic tanks) and two-thirds to come from household septic tanks and pits. At full capacity, the plant is designed to cater over the year the faecal sludge from an equivalent of 65,000 to 100,000 people. Through, a key informant interview conducted with (IWMI), it was reported that from June, 2017 to March 2018, the plant has received 2,313 m^3 of faecal sludge

5. Service delivery context

National Environmental Sanitation Policy, 2010: In 2010, the Ministry of Local and Rural development (MLGRD) revised the Ghana National Environmental Sanitation Policy which was initially published in 1999. The aim of the policy is to improve the living conditions and quality of life of the citizens of Ghana. The policy seeks to promote sustainable development through ensuring a balance

between economic development and natural resource conservation.

National Environmental Sanitation Strategy and Action Plan (NESSAP), 2010: The NESSAP is a reflection of the objectives of the Environmental Sanitation Policy (MLGRD, 2010).

National Urban Policy: Framework and Action Plan, 2012: The National Urban Policy includes several objectives which directly pertain to sanitation. The policy aims to balance the distribution of urban population through promoting growth in small and medium-sized towns, and promoting urban economic growth through improved urban services and infrastructure. The policy advocates for better planning of greater metropolitan regions and the provision of affordable housing through private sector delivery of affordable housing; the promotion of indigenous building materials and appropriate construction technologies; the provision of social or low-income rental housing through public and public-private partnership arrangements; and the upgradation of slums and dilapidated housing stock, especially in urban areas selected as growth centres.
Till 2016, the water and sanitation sectors responsibilities were divided between Ministry of Water resources for water services and Environmental Health and Sanitation Directorate are responsible for implementing the District Water and Sanitation Plan (WSP, 2011). (EHSD) Sanitation Team, comprising of members from the Works, Health and Planning Departments under MLGRD for sanitation services. EHSD was in charge of policy formulation and implementing national level activities. Regulatory functions were shared by EHSD, Ghana Environmental Protection Agency (EPA) and the MMDAs, under the oversight of the Ministry of Environment, Science, Technology and Innovation (MESTI) (WSUP, 2017a). Towards the end of 2017 the water resources and sanitation related responsibilities were allocated to the newly established Ministry of Sanitation and Water Resources.

The Ministry of Education (MoE) is responsible for school sanitation and jointly responsible with the Ministry of Health (MoH) for sanitation and hygiene education. The Ministry of Environment, Science and Technology ensures that sector activities are consistent with environmental policies and objectives (WSP, 2011).

National Environment Policy, 2013: The Ghana National Environment Policy was formulated in 1995 and revised in 2013. The lead agency envisions to move from the conservative mind frame to sustainable development paradigm. The policy identifies issues and emphasises the importance of bringing about a behavioural change through education and public awareness of environmental sanitation problems in order to bring about improved urban environmental conditions as well as the sustainable use and maintenance of sanitation facilities (MLRGD, 2013).

Public Private Partnership Policy (PPPP) has been produced by the Ministry of Finance and Economic Planning (MoFEP) and covers all aspects of public private partnerships (PPPs) in the public sector including sanitation (MoFEP, 2011) (WEDC, 2015).

6. Overview of stakeholders

Ghana has a well-defined legal and policy framework for sanitation services. The country's legal framework clearly assigns to Metropolitan Municipal Development Authorities the responsibility to prepare infrastructure development plants for sanitation and implement them (WSUP, 2017a).

At a regional level the Metropolitan Assembly (i.e. TMA) is responsible for delivering sanitation services using the private sector for infrastructure delivery and/or management, and for developing the District Water and Sanitation Plan (WSP, 2011). The District Water and

Key Stakeholders	Institutions / Organizations
Public Institutions	Ministry of Local Government and Rural Development (MLGRD) Ministry of Sanitation and Water Resources (MSWR) Ministry of Environment, Science, Technology and Innovation (MESTI) National Development Planning Commission (NDPC) Ministry of Finance and Economic Planning (MFEP) Ghana Water Company Limited Community Water & Sanitation Agency (CWSA) Waste Management Dept. TMA Environmental Health & Management Dept. TMA Metropolitan & Works Dept. TMA, The Council for Scientific and Industrial Research (CSIR)
Private Sector	Zoomilion, Sanitation International, Champion and Individual private operators, JVL Fortifer
Development Partners, Donors	World bank, Bill and Melinda Gates Foundation (BMGF) and International Water Management Institute (IWMI)
Others	Local Masons and Manual Emptiers

Table 1: Key stakeholders (Source: compiled by CSE, 2018)

District Environmental Health Officers (DEHOs) educate communities on sanitation and hygiene, and enforce regulations regarding the construction, use and management of public, institutional and household facilities (WSP, 2011). CSIR is mandated to efficiently and effectively exploit science and technology in its Research and Development (R&D) activities.

7. Credibility of data

Data is collected through secondary sources. The city is visited to conduct the surveys, FGDs and KIIs with relevant stakeholders, to fill in the data gap and to crosscheck the data collected.

The service delivery context has been developed through a literature review and reviewing nationally important policies and plans available in the public domain and data collected from various departments. TMA documentation has been obtained from local agencies, with results triangulated through key informant interviews and observations.

The data is fed into the SFD graphic generator to calculate the excreta flow in terms of percentage of the population and also to produce the SFD graphic.

8. Process of SFD development

Data is collected through secondary sources. The assembly area is visited to conduct the sample surveys, FGDs and KIIs with relevant stakeholders, to fill in the data gap and to cross check the data collected.

The service delivery context has been developed through literatures review of nationally important policies and plans available in the public domain. TMA documentation has been obtained from local agencies, with results triangulated through key informant interview and observations.

The data is fed into the SFD graphic generator to calculate the excreta flow in terms of percentage of the population and also produce the SFD graphic.

9. List of data sources

Below is the list of data sources used for the development of SFD.

- Published reports and research papers:
  - Census, 2010, Population and Housing Census, District analytical report Government of Ghana
  - WSUP, 2017 Situational analysis of the urban sector in Ghana
- Unpublished reports:
  - Mid-term development plan-2017, Tema
  - EPA, 2015, Draft status report on sewage treatment plants in Greater Accra Region
- KIIs with representatives from
  - Development Planning Officer
  - Regional Chief Manager.
  - Research Officer, International Water Management Institute
  - Local mason
- FGDs
  - Waste management department
  - Private emptiers (Champion)
  - Slum dwellers in Tema new town

Tema Metropolitan, Ghana, 2017

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Abbreviations

CSIR-IIR	Council for Scientific and Industrial support from Research - Institute of Industrial Research
CT	Community toilet
CWSA	Community Water & Sanitation Agency
DEHOs	District Environmental Health Officers
DESSAP	District Environmental Sanitation Strategy and Action Plan
DESSAPs	District Environmental Sanitation Strategy Action Plans
EHSD	Environmental Health and Sanitation Directorate
EPA	Environmental Protection Agency
FGDs	Focus Group Discussions
GAMA	Greater Accra Metropolitan Authority
GSGDA	Ghana Shared Growth and Development Agenda
IWMI	International Water Management Institute
JVL	Jekora Ventures Ltd
KIIs	Key Informant Interviews
KVIP	Kumasi Ventilated Improved Pit
LGA	Local Governance Act
M&E	Monitoring and Evaluation
MESSAP	Metropolitan Environmental Sanitation Strategic Action Plan
MESTI	Ministry of Environment, Science, Technology and Innovation
MLGRD	Ministry of Local and Rural development
MMDA	Metropolitan, Municipal District Authority
MoE	Ministry of Education
MoFEP	Ministry of Finance and Economic Planning
MoH	Ministry of Health
MSWR	Ministry of Sanitation and Water Resources
MTDP	Mid Term Development Plans
NDPC	National Development Planning Commission
NESSAP	National Environmental Sanitation Strategy and Action Plan
NGOs	Non-Governmental Organisations
OSS	Onsite Sanitation Systems
PPPP	Public Private Partnership Policy
PT	Public Toilet
RCC.	Regional Coordinating Council's
SESIP	Strategic Environmental Sanitation Investment Plan
SPS	Sewage Pumping Station
STP	Sewage Treament Plant
TMA	Tema Metropolitan Area
VALCO	Volta Aluminum Company
WC	Water closet
USD	US dollars (conversion rate: 1 USD= 4.80 Cedi)

1 City context

The Tema Metropolitan area (TMA) is a coastal metropolis located in the Greater Accra Region of Ghana. TMA is located approximately 25 km east of Accra, the capital city of Ghana. TMA shares boundaries on the North-East with the Kpone Katamanso and Ningo-Prampram Districts, South- West by Ledzokuku Krowor Municipal, North-West by Adentan Municipal and the Ga East Municipal, North by the Akuapim South District and the South by the Gulf of Guinea.

The Ashaiman Municipal is enclosed enclave within the Tema Metropolis. The Metropolis covers an area of about 396km^2 with Tema as its capital and lies within the coastal Savannah zone.

According to the 2010 Population and Housing Census, the total population of the Tema Metropolitan Assembly was 292,773. This consists of 139,958 males representing 47.8% and 152,815 females representing 52.2%. The population density of Tema is 793 people/Sq. Km which is considerably higher than the national average of 124 people/Sq. Km.

The Greenwich Meridian (i.e. Longitude 0º) passes through the Metropolitan area, which meets the equator or latitude 0° in the Ghanaian waters of the Gulf of Guinea. Due to proximity of the metropolitan to the sea, Tema was accorded as being “the Eastern Gateway of Ghana” with the construction of the harbour in 1957. Tema has a dry equatorial climate with temperature in the range of 25 degree Celsius to 30 degrees Celsius in rainy season and summer temperature varies from 34 degree Celsius to 40 degree Celsius. Tema has an average rainfall of 745 mm. Terrain in TMA is flat with highest point from mean sea level at 35 m and lowest being 0 m, making the city highly flood prone. Soils are composed of sand, clay, humus, gravel and stone. The Metropolis is underlain by the Precambrian rocks of the Dahomeyan formation: metamorphic rocks mainly consisting of granite, gneiss and schist have been probably derived from sedimentary layers (TMA, 2017).

Tema being an industrial hub, some areas were demarcated and reserved as greenbelts as a result of the absence of forest reserves (zones) to control the micro climate of Tema (climatic condition in relatively small area). However, the number of industries and waste generated has been increasing in the Metropolis without a corresponding increase in afforestation to absorb excess carbon mono-oxide generated by these factories. Also, areas reserved as green belts are being encroached upon by both residents and light industries. This has led to changes in weather condition with its associated effects such as loss of biodiversity and erratic rainfall pattern (TMA, 2017) .

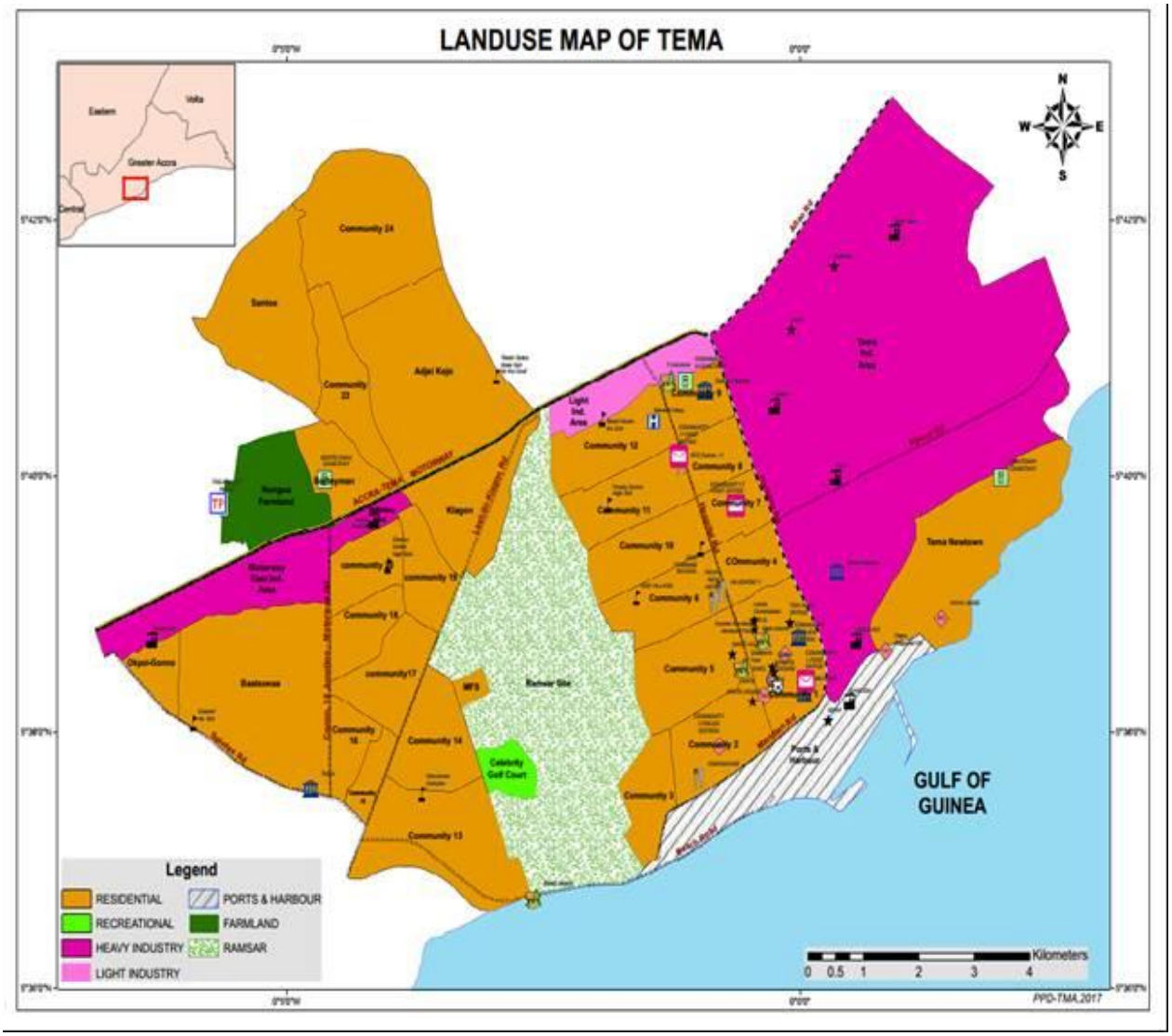

Figure 1: Map of Tema city (Source: MTDP, 2017)

2 Service outcomes

The analysis is based on data available from Census, 2010, published and (un)published reports of government. Data collected from secondary sources is triangulated in the comprehensive study. Data on the containment and types of toilet are available in Population and Housing Census, 2010. Data has been cross-checked and updated by Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs). According to the SFD promotion initiative (PI) definitions of sanitation systems, the types of containments prevalent in the communities are examined through visit to few houses and public toilets. Areas for reconnaissance survey was selected strategically from low, middle income settlements to communities connected to sewerage system. Data on emptying, transport, treatment and disposal of faecal sludge is collected through KIIs with TMA, private emptiers, local masons, published and un-published reports.

2.1 Overview

To start with, a relationship between sanitation technologies defined in Census and the variables defined in the SFD glossary is established. Then the population dependent on those systems is represented in terms of percentage of the population. According to Ghana Statistical Service the population of TMA is 3,10,853, this population has been considered for preparing SFD. Households and corresponding percentage of population dependent on different types of sanitation facilities is taken from Census, 2010. Data in terms of percentages is used to generate the SFD as it has information on types of sanitation facilities, and is more reliable, so was deemed to reflect the current situation more accurately.

Table 1: Households and corresponding percentage of population dependent on different types of sanitation facilities

Population of TMA		***2,92,773***
No. of Households		70,797
Types of sanitation facilities	**Households**	**Percentage**
No facility (bush/beach/field)	6,701	9.5
Water closet (WC)	37,626	53.1
Pit latrine	1,465	2.1
Kumasi Ventilated Improved Pit	2,498	3.5
Bucket/Pan	115	0.2
Public toilet (WC KVIP Pit Pan etc)	21,775	30.8
Other	617	0.9

Source: *Population and Housing Census, 2010*

The technology definitions given in the national census focus on the user interface or external features i.e. the presence of a vent pipe or if the toilet is flushed by water. This gives little indication of how the containment or technology interfaces with the environment. Within the context of the census a WC is used to represent a flushing (pour-flush or automatic flush) toilet with a water seal, but no information is available for the sanitation technology that it discharges to. Many terms are used interchangeably by stakeholders in Tema to describe the same technology. Therefore in-depth discussion was carried out with stakeholders to reach agreed definition of technologies that could be mapped onto the SFD.

Sanitation technologies and corresponding percentages of the population obtained from Census is triangulated with key informant interviews conducted with relevant stakeholders and further data extracted from a report on Medium term development plan (MTDP) of TMA. The

study revealed the type of containment systems with the corresponding population and is depicted in Table 2 the systems used for preparation of SFD and corresponding population have been agreed upon with the stakeholders.

Table 2: Sanitation technologies and corresponding population used to prepare SFD graphic

Sl. No.	Final systems assumed	Descriptions of assumptions made on selection of types of containment system	Population (avg. HH size=4.1)	Population (%)
1	Sewerage system	Data collected from TMA[1]	108,799	35
2	Public toilet (sewerage-50%)	According to *Population and Housing census, 2010* the total population that is dependent on PT/CT is 30.8%. Due to lack of data available on the no. of PT/CT connected to sewerage and OSS, it is substantially assumed to be 50% each.	47,871	15.4
3	Lined pit with semi permeable walls and open bottom	Within the context of census, this is the population that is dependent on Kumasi Ventilated Improved Pit	10,880	3.5
4	Bucket/Pan	According to Census 2010, bucket/pan latrine system are used by 0.2% households. As the percentage of the population using this technology is < 1% it is not included in the SFD.	622	0.2
5	Unlined pit	According to Census 2010, population dependent on 'Pit Latrine' is correspondingly used to be unlined pit for SFD.	6,528	2.1
6	Public toilet (septic tanks to soak away-50%)	According to *Population and Housing Census, 2010* the total population that is dependent on PT/CT is 30.8%. Due to lack of data available on the no. of PT/CT connected to sewerage and OSS, it is substantially assumed to be 50% each. Based on observation, it was found that toilets connected to septic tank have soak pit.	47,871	15.4
7	Open defecation	According to *Population and Housing Census, 2010,* the households have 'No facility (bush/beach/field)' is 9.4%. In terms of SFD, this data is used for population that practices open defecation. Under a national scheme 1400 HHs are provided toilets and thus have been deducted from it. (28374-(1400*4.1)	23,314	7.5
8	Other (Don't Know where)	According to *Population and Housing Census, 2010,* the households dependent on other systems is unknown. Hence, in terms of SFD, 1% of the population is assumed that have types of toilet facilities connected to don't know where'	2,798	0.9
9	Septic tank connected to soak pit	After sorting out all types of certain sanitation facilities, the remaining population i.e 20% is assumed to be dependent on Septic tanks or fully lined tanks. It is assumed that 2/3rd of the 20% is dependent on septic tanks	40,411	13
10	Fully lined tanks without outlet or overflow	It is substantially assumed that 1/3rd of 20% (dependent on septic tank or fully lined tanks) population is dependent on fully lined tanks without outlet/overflow.	21,760	7

[1] Goufrane Mansour & Harold Esseku July 2017 Situation analysis of the urban sanitation sector in Ghana

2.1.1 Sanitation facilities

Community/public toilet: a facility strategically located within a large community, used daily by community members; public toilets are usually located where space is available in low-income areas, but it is not uncommon for residents to walk up to one kilometre to reach the facility (WSUP, 2017).

There are 65 public toilets which are located at vantage points in the metropolis to serve the commutating and the underserved population. These public toilets are primarily patronised by households with no access to toilet facilities. Indiscriminate open defecation is rampant in areas which have inadequate public and private toilet facilities thereby posing health risk to the public (MTDP, 2017). Around 48 public toilets are functional (TMA, 2018)

User fee charged for using public toilet is 50 pesewas per use (KII, 2017). It is reported in the year 2014, that residents of Tema New Town have resorted to open defecation as managers of public toilets in the community increased their fees. Managers of the facilities which were built by VALCO and donated to the community adjusted the fees from 30 pesewas to 50 pesewas per person (Anon., 2016).

Most public toilets are constructed on government-owned lands allocated for the construction of toilets. Public toilets (constructed by local authorities) are either managed by the local authority or delegated to private operators (usually local influential individuals) through franchises or lease-type contracts. There is, generally, fierce competition among local leaders and political entities to obtain these contracts. Some, but few, public toilets have been constructed on private land and are privately-owned and managed. Regulation over public toilets maintenance is weak (WSUP, 2017). The capacity of septic tanks in public toilets ranges from 15-20 m^3 (TMA, 2018).

TMA region has harbors and many industries. The faecal waste generated in the region is focus of the current study. Industrial wastewater generated by the region is excluded in this research.

In all, there are a total of 474 educational institutions comprising 164 kindergardens, 166 primary, 134 junior high schools, and one technical / vocational and 9 senior high schools in the metropolis. Most of the privately owned basic educational facilities are also concentrated at the southern part of the metropolis. This is largely due to the high population and the vibrant economic activities of these areas. Apart from schools there are universities and colleges-Methodist University, Presbyterian University College and Data Link University; making tertiary education physically accessible to almost all in the metropolis. Under Greater Accra Metropolitan Authority (GAMA) project construction/rehabilitation of toilets in 38 Schools in the Metropolis are targeted (MTDP, 2017).

The Metropolis has a total number of 72 health facilities. These comprise 62 private health facilities and 10 public facilities. And they have their own toilets built by the respective health facility (MTDP, 2017).

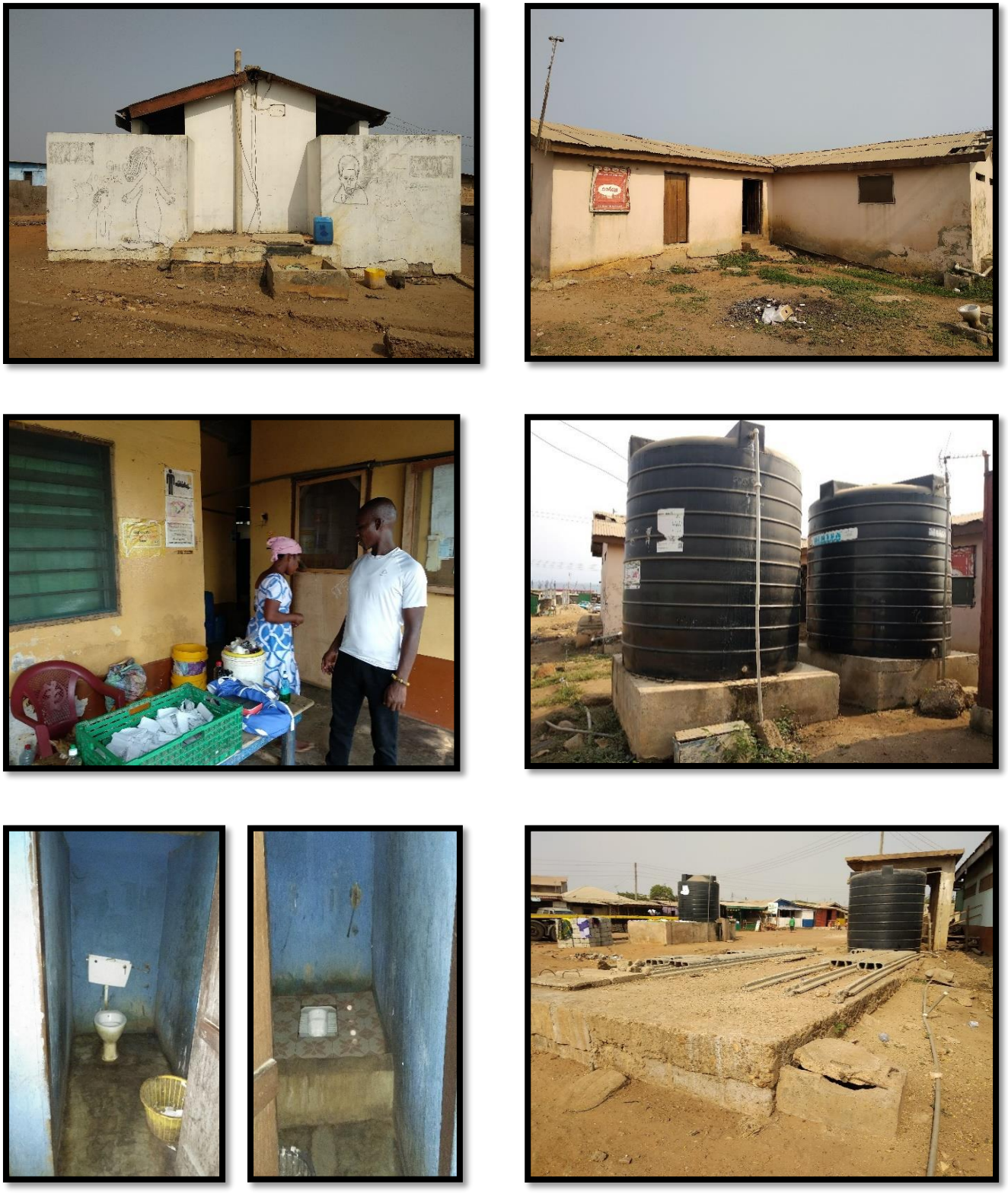

Figure 2: Public toilet facilities available in Tema New town (Shantanu/CSE, 2018)

2.1.2 Containment

Offsite sanitation system

Sewerage system in Tema was established in 1960, and covers Communities 1 to 9,11 and parts of 10 and 12. Please refer table 14 for the corresponding population of communities. The official data says that 23,000 households are connected to a sewerage network. According to Tema Waste Management Department there may be an additional 2,000 households that are illegally connected to the sewerage system (WSUP, 2017). Hence, the final population connected to sewerage network, considered for preparation of SFD, is 108,799. The sewerage system however, experience frequent blockages leading to sewers overflowing onto streets, open drains and sometimes into residential facilities (MTDP, 2017).

Within the context of the census a WC means a flushing (pour-flush or automatic flush) toilet with a water seal, but no information is available to the sanitation technology that it discharges to. In Tema's context, wastewater is majorly conveyed through sewers. Around 50% of the population is dependent on sewerage system.

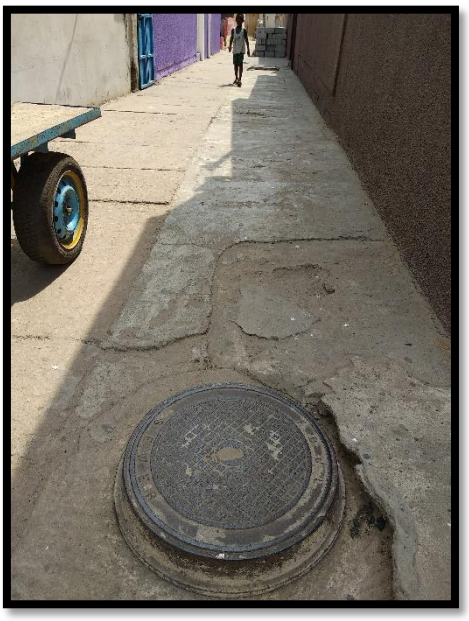

Figure 3: Sewer access cover at Community 1 (Shantanu/CSE, 2018)

During the focus group discussion conducted with TMA, it was informed that even though industries are supposed to treat their industrial wastewater before discharge but there are instances where industries discharge their wastewater with or without treatment into sewers and lagoons. It was quite evident visually from the field observation that Chemu lagoon and Sakumonu lagoon receives industrial wastewater and domestic waste water from Tema New Town area, Tema Industrial area, Sakumonu and Tema Central.

Onsite sanitation system

Half of the population of Tema is dependent on onsite sanitation system (OSS). Around 34% of the population is dependent on septic tanks. The tanks have vents and have varying number of chambers (normally >2). It was noted that the chamber numbers directly co relate to the number of lids on the tank. This technology is used for both individual household toilets, public toilets and institutional toilets (i.e. schools). The design of private septic tanks is subjected to

acquired knowledge of artisans who construct them. It was informed during KII, FGD and field observation that generally the private and public septic tanks are connected to soak away. During field visit it was observed that there are households that have fully lined tanks without outlet/over flow, see Figure 5. The design of public and institutional septic tanks is controlled by TMA and generally incorporates a soakaway, in the final chamber of the tank. In terms of the SFD preparation, it is assumed that 2/3rd of the households have septic tanks with soakaways and rest have fully lined tanks with no outlet or overflow.

Apart from septic tanks, there are, households that are dependent on lined pit with semi permeable walls, locally called as Kumasi Ventilated Improved Pit (KVIP) or unlined pits. A minor population still uses bucket/pan latrines. During the field visit to the selected sites it was observed that households in the low income settlement are provided toilets under Government scheme of 'Get a Complete Toilet at 1,100 GHC'. The containments provided under this scheme are fully lined tanks with no outlet/overflow.

Figure 4: Septic tank with soak away at last chamber (Shantanu/CSE, 2018)

Figure 5: Toilet constructed under scheme with fully lined tank (Amrita/CSE, 2018)

KVIP is a semi-lined twin pit system. These pits are alternatively used. It takes more than two years for the pit to fill. When one pit is ready to be emptied, the material in the pit is like dry compost, this is then dug out manually and disposed of in the local environment or used in gardens. For the SFD, KVIP is considered to be a lined pit with semipermeable walls and open bottom. According to the Census 2010, 3.5% of the population is dependent on KVIP technology.

Buckets latrines/toilets are basically vessels that are emptied daily. These were introduced in Kumasi in the colonial period when collection was organised via local government (Amoako & Korboe, 2011). This practice is illegal in Ghana since 2010. From the census data, it appears that this system is being used by < 1% of the population, hence this technology is not included in the SFD graphic.

Open defecation

According to Population and Housing Census, 2010, the households that have 'No facility (bush/beach/field)'are 6701. Open defecation is prevalent in Bankuman, Acheampong Village, Manhean, Tema Newtown, Ziguinchor. During FGD, the TMA officials informed that at Tema New Town, Adjeikojo and Lashibiklagon, many households do have toilets but they prefer to practice open defecation.

2.1.3 Emptying and transportation

With growing population, the sewer networks have not expanded in the region accordingly. Only 40% of the sewage of the population dependent on sewerage system goes to sewage treatment plants (TMA, 2018). Remaining sewage from 60% of the population is conveyed through sewers connected to open drains. During the field visit, it was observed that sewage pumping station (SPS) and sewage treament plant (STP) were out of order. Also, no current records of the effluent quality could be obtained, as they are not currently being monitored due to a lack of capacity and budget (EPA, 2015).

In TMA, emptying service is majorly managed by private emptiers. TMA has a truck mounted tanker which is used as a sewer jetting machine to remove clogging and blockages in sewerage network. Examples of motorised emptying in TMA can be seen in Figure 7. Private vacuum tankers are not registered with TMA. As per FGD conducted with TMA and private operators, around 13 private emptying vehicles are plying in the assembly area (Champion, 2018 and TMA, 2018). In which, Zoomilion Company has 3 trucks, Sanitation International has 2 trucks, Champion Company has 5 trucks, Adom waste company has 3 trucks and and 7 individual private operators. Private emptiers from Accra also provide service in the Tema region. A vacuum tanker operator charges emptying fee from the customer depending on the capacity of tanker requested by a customer. Usually, the emptying charges are 350 Cedi for a $10m^3$ tanker, 400 Cedi (80 USD) for $12m^3$ tanker and 500 Cedi (104 USD) for $>12m^3$ capacity of the tanker. The emptying frequency varies from one containment system to the other; for a septic tank in public toilet emptying frequency is 3 months to 1 year, for septic tanks in households it is 6 months to 1 year, for fully lined tank it is 3 months to 6 months and for various pits it is 1 year to 3 year (Champion, 2018 and TMA, 2018).

Figure 6: Vacuum tanker cum sewer jetting machine owned by WMD (Amrita/CSE, 2018)

Figure 7: Vacuum tanker owned by private emptier (Shantanu/CSE, 2018)

It has been estimated that close to 90% of the residents of TMA have utilized the services of vacuum tankers (motorized emptying) either indirectly thorough public toilets or directly by households having their house or compound‘s toilets emptied. A practice of using a chemical reagent ‘Aqua Kem Blue’ was observed in the households dependent on OSS, see figure 8. During an interview with a resident and a local mason, it was revealed that the chemical reagent enhance the digestion in the containment thus reducing the emptying frequency. Quarterly report of the TMA, states that many trucks parked at Afariwa and school junction parking bays for days without getting jobs to do. Many trucks operating in Teshie and Nungua do not deliver to the septage treatment plant, instead they discharge at MF top in Lashibi (TMA, 2018a).

Figure 8: Chemical reagent used in OSS to reduce emptying frequency (Amrita/CSE, 2018)

Figure 9: Tipping fee toll at Borteymen (Shantanu/CSE, 2018)

There are two types of emptying vehicles prevalent in the metropolitan area, these are double – axle truck mounted with a capacity of 15 m^3 of tank and single axle truck mounted with a capacity of less than or equal to 13 m^3 of tank. For disposal of faecal sludge, the vacuum tanker operators are then charged a standard tipping fee at the septage treatment plant depending on the tanker volume. A toll has been introduced at 50m off the main Ashley-Botwe road to collect fee for discharge of septage. It is a punishable offence if any emptier is found

discharging faecal sludge at any place other than treatment plant. The offenders are prosecuted with monetary fine. Hence, it is estimated that 90% of the FS collected is delivered to the septage treatment plant. Remaining 10% is attributed to the emptiers who are discharging FS in a hideous manner due to distant location of the plant from the household served. FS discharging fee (tipping fee) which is paid by the operators is based on axle of the tanker; for double-axle vehicle it is 20 Cedi/ per entry and for single axle tanker it is 15 Cedi/ per entry to the treatment plant. The trips made by trucks in the year of 2017 are 2373 trips by double-axle and 1914 by single axle tankers. Total volume of septage which is discharged by vacuum tankers at septage treatment facility is 62987 m^3 (TMA, 2018a). The emptying fee ranges from 350 Cedi to 400 Cedi per trip for a single axle truck and it is 500 Cedi per trip for a double-axle truck (Champion, 2018).

Manual emptying in TMA is very clandestine, although it is acknowledged that it exists. As only a limited population rely on containment systems which are not approachable for emptying by mechanical emptiers. It is therefore possible that there are only a few manual emptiers. Through discussion with a resident in low income settlement and an artisan it was informed that they use general labourers rather than specialised manual emptiers to empty their pits, but the FS emptied is then disposed of in the local environment (TMA, 2018).

Figure 10: Open drain/storm water is also used to transport grey water *(Shantanu/CSE, 2018)*

It was observed during field based study that grey water from the households is discharged into storm water drainage system. The storm water drainage system conveys grey water into two lagoons of the city- Sakumonu lagoon and Chemu lagoon or directly into the sea. The lagoons also overflow into the sea, however, the open drains/nullahs that fill the lagoon are all filled with plastic waste. The whole stretch of the lagoon is filled with heavy sand and plastic waste making the water stagnant. The walls serving as barricades for the lagoon has broken, due to which water often overflows whenever there is heavy rainfall.

Figure 11: Wastewater from industries and open drains is carried by Chemu lagoon and Sakumonu lagoon terminating into sea (Shantanu/CSE, 2018)

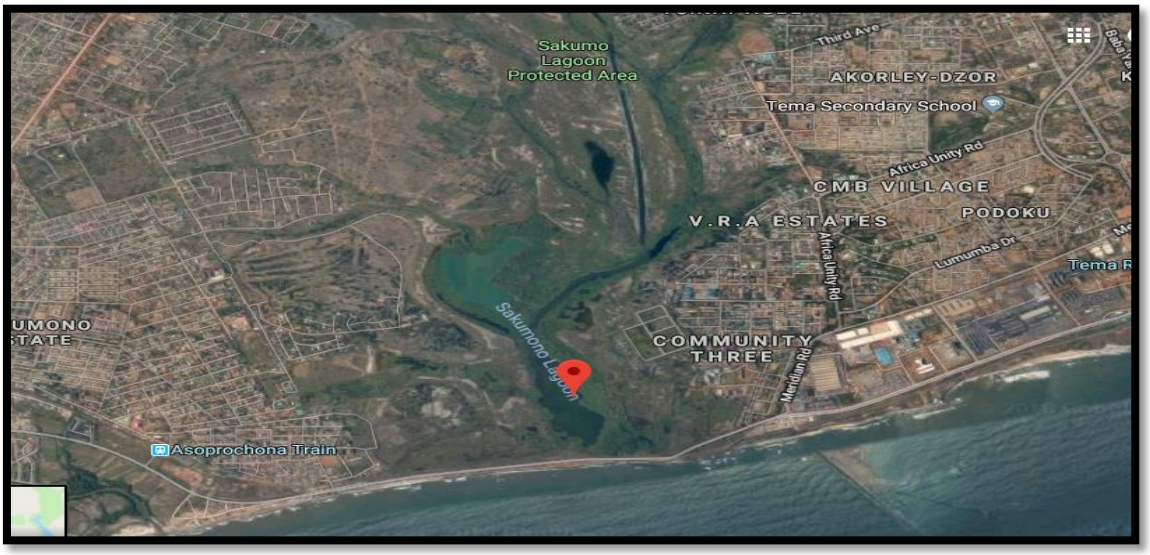

Figure 12: Sakumonu lagoon (Google satellite map/2018)

2.1.4 Treatment and disposal

Tema Metropolitan assembly has three waste treatment facilities. The Tema STP is based on waste stabilization pond technology which has the capacity to treat 20,000 m^3/day of waste water from the Tema metropolis. The STP comprises of two aerated lagoons, two facultative ponds and three maturation ponds. The sewerage system includes two pumping stations (PS). PS 1 receives the bulk of sewage from Communities 5, 8 and 9 and parts of 1 to 7, 10 and 11 while PS 2 collects sewage from the harbor area and part of Community 2. The PS and STP is currently shut down, the plant has not been in operation for about 15 years due to breakdown of equipment on site. The area looked abandoned with ponds full of overgrown weeds. Wastewater which is conveyed through sewer network is pumped and directly discharged into the sea without treatment.

Figure 13: PS1 at Africa Utility road (Shantanu/CSE, 2018)

Figure 14: PS2 at Meridian road (Shantanu/CSE, 2018)

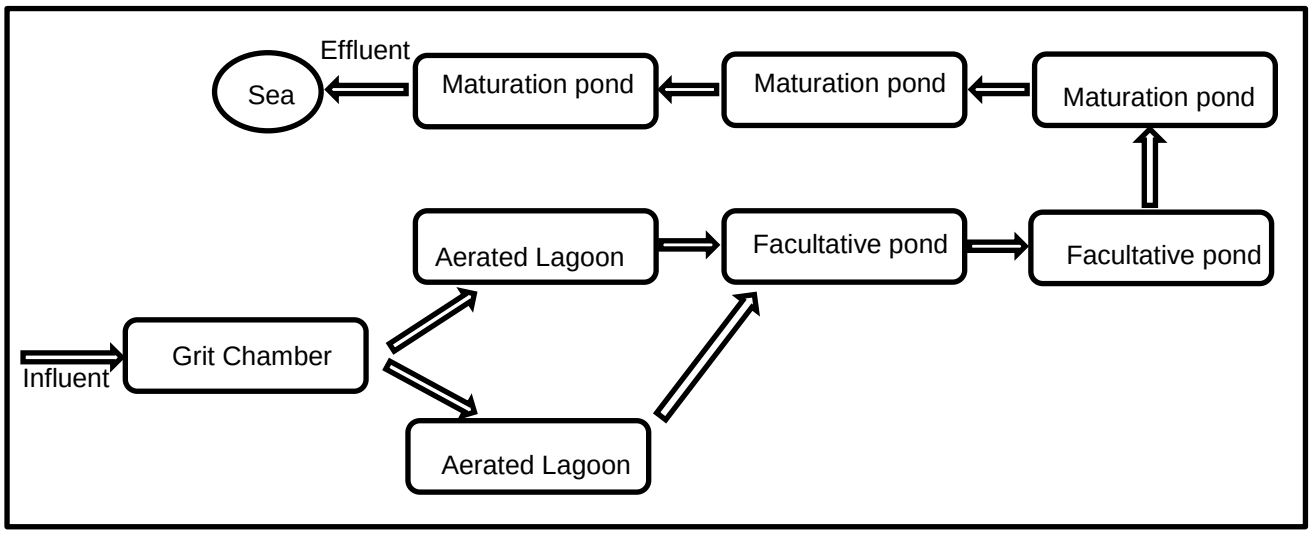

Figure 15: Schematic diagram of STP

Figure 16: Wastewater disposal from Sakumonu STP to the sea (Shantanu/CSE, 2018)

Figure 17: FS disposal site: Nungua farms (Shantanu/CSE, 2018)

The second treatment plant, septage treament facility, located at Nungua farms which was built to cater to population dependent on OSS. The septage treatment plant at Nungua Farms serves both the public and private emptying service providers. This plant remains the only approved site for discharging septage. The plant is based on stabilization pond technology which has the capacity to treat about 300 m^3 of faecal sludge per day. Currently, the plant receives on an average of 20 trucks daily. The defunct plant also serves as the disposal site of faecal sludge for trucks operating outside the boundary of Tema Metrpolitan assembly.

Figure 18: FS disposal at Nungua farms (Shantanu/CSE, 2018)

The third treatment plant, septage treatment plant; a co-composting plant, located at Bortyemen. This plant is established on public-private partnership model between Jekora Ventures Ltd (JVL) and Tema Metropolitan assembly. The plant is facilitated with technical support by International Water Management Institute (IWMI) and Council for Scientific and Industrial support from Research (Institute of Industrial Research) (CSIR-IIR). TMA has invested US$ 151,162 (650,000 Cedi) and also contributed 1 ha of land for building the establishment and JVL has invested US$90,060 (387,258 Cedi) for plant's operation and maintenance. The capacity of the plant is 12,500 m^3 for faecal sludge, of which one-third is targeted to be collected from public toilets (septic tanks) and two-thirds come from household septic tanks and pits. At full capacity, the plant is designed to cater the faecal sludge from an equivalent of 65,000 to 100,000 people per year. Through, a key informant interview conducted

with IWMI, it was reported that from June, 2017 to March 2018, the plant has received 2,313 m^3 of faecal sludge.

Figure 19: Septage treatment facility – a co composting plant at Bortyemen

Table 3: Treatment and its status at a glance

S.No.	Treatment facility	Location	Year of commencement	Capacity	Status
1	Tema Sewage Treatment Plant	Community 3, Tema	1994/5	20,000 m^3/day	Abandoned
2	Septage Treatment Plant	Nungua farms	2004	300 m^3/day	Defunct
3	Septage Treatment facility (JVL Fortifer Compost plant)	Borteyman	2017	200 MT/Year	Functioning

Source: EPA, 2015

2.1.5 End use/ reuse

It is reported in the quarterly report of the TMA septage treatment that farmers from the nearby areas of the Nungua treatment plant uses the wastewater from the defunct plant to irrigate the crops. At JVL Fortifer Compost plant: The amount of compost produced during last year (June, 2017 to March 2018) is 108 MT. As part of the process, the plant can recycle 700 tonnes of organic food waste. Currently, the plant receives segregated organic waste from the parts of Greater Accra Metropolitan Assembly. Also, the plant has nominal capacity of the pellet processing which is 0.5 metric tonne per hour of operation (IWMI, 2018).

Table 4: Selling price of compost by JVL plant

Product	Size or Weight (Kg)	Price (GHC)
Co-compost & Enriched Fortifer	20	15.00
Co-compost & Enriched Fortifer	50	30.00
Pellets Fortifer	20	20.00
Pellets Fortifer	50	35.00

Source: IWMI, 2018

2.2 SFD matrix

The final SFD for TMA is presented in appendix 7.5.

2.2.1 SFD matrix explanation

The final percentage of corresponding population dependent on different types of sanitation system is used from Table 1. Definition and estimation of different variables (used to make SFD) are explained below in Table 5 and 6. Assumptions made were negotiated and agreed upon with stakeholders (TMA, 2018). The data from Table 2 was then transposed into Table 5, which was used to generate the SFD found in the executive summary and appendix. The SFD includes technologies that are used by >1% of the population and flows that represents >1% of the total population. The flows at all stages of the sanitation service chain are rounded so the total at each stage is 100%. The proportion of the contents of each type of onsite container which is faecal sludge (Solid content) is assumed to be 50% in case of septic tanks and lined pits and 100% in case of fully lined tanks without outlet/overflow.

Table 5: Variables used for defining containment systems

S. No.	Variables	Description (Region context)	Percentage of population
1	T1A2C2	Toilet discharges directly to a centralized foul/ separate sewer.	50
2	T1A2C5	Septic tank connected to soak pit	29
3	T1A3C10	Fully lined tank (sealed), no outlet or overflow	7
4	T2A5C10	Lined pit with semi-permeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	4
5	T2A6C10	Unlined pit, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	2
6	T1A1C9	Toilet discharges directly to 'don't know where'	1
7	T1B11C7	Open defecation	7

Source: CSE, 2018

Table 6: Variables used in SFD

System type	Variables	Description (Region context)	% of pop.
Offsite	WW contained	Wastwater from the sewerage system (T1A2C2)	50
	WW not contained	Wastewater from the 'don't know where' (T1A1C9)	1
	WW contained delivered to treatment	The wastewater of population connected to sewerage system, which is delivered to sewage treatment plants (W4a=75%).	38
	WW contained not delivered to treatment	Remaining 25% of the population whose WW is not delivered to treatment plant due to leakages, blockages and dilapidated sewerage system.	14
	WW not treated	Proportion of wastewater delivered to sewage treatment plants, which is treated (W5a) is 0%, therefore all the ww that reaches plant is not treated	38
Onsite	FS contained	Faecal sludge from the onsite sanitation technology (T1A2C5 and T1A3C10), where the depth of groundwater is low and there is 'low risk' of groundwater pollution	36
	FS not contained	Faecal sludge from the onsite sanitation technology (T2A6C10 and T2A5C10), where the depth of groundwater is high and there is 'significant risk' of groundwater contamination The above system are selected as it is informed during FGD that low income settlement where these type of systems are prevalent are also dependent on groundwater, which can be used for drinking and non-drinking purpose both.	6
	FS contained – not emptied	Faecal sludge from onsite sanitation technology (T1A2C5 and T1A3C10) that FS is contained, and is not emptied accounts for FS which remains in the system and infiltrate into ground and thus cannot be emptied.	17
	FS contained – emptied	Faecal Sludge emptied from the onsite sanitation technology (T1A2C5 and T1A3C10). It is asumed that 90% of FS is emptied	19
	FS not contained not emptied	Faecal sludge from the onsite sanitation technology (T2A6C10 and T2A5C10), that is not contained and, 10% not emptied which accounts for FS which remains in the system and infilterate into ground and thus cannot be emptied	3
	FS not contained emptied	Faecal sludge from the onsite sanitation technology (T2A6C10 and T2A5C10), it is substantially assumed that 90% of the FS is emptied	1
	FS contained delivered to treatment	Faecal sludge contained - emptied from OSS (T1A2C5 and T1A3C10). 90% of the FS emptied is delivered to treatment plant	19
	FS not contained delivered to treatment	Faecal sludge from the onsite sanitation technology (T2A6C10 and T2A5C10). It is assumed that 90% of FS emptied is delivered to treatment	2
	FS not treated	90% of FS is delivered to treatment but only 5 % of the proportion total FS generated is treated in the JVL co-composting plant	19
	FS treated	5 % of the proportion total FS generated is treated in the JVL co-composting plant which is equivalent to 1% of FS of the population dependent on OSS	1
Open defecation	Open defecation	With no user interface, users defecate in water bodies or on open ground; consequently the excreta is not contained.	7

Source: CSE, 2018

2.2.2 Risk of groundwater contamination.

The Tema Metropolis is served with a network of water connections from the Kpong Water Works. The source of water supply is majorly from River Volta and the remaining demand is met from deep bore wells. Currently, about 90% of households in Tema have access to pipe borne water compared to 64.4% for the Greater Accra Region (MTDP, 2017).

From the data presented in Section 2.2, a conservative estimate is that the stabilized water table is 5 to 10 mbgl. It was informed through interviews that less than 25% of sanitation facilities is either <10 meters from, or uphill of ground water extraction points. This is due to prevalence of public toilets, construction of which is well regulated by TMA. Furthermore, very few households are dependent on ground water sources for drinking water. It is estimated that up to 1-25% of drinking water is produced from ground water, as 90% of the population receive their drinking water from a piped supply, which originates from surface water. Using these data sets, a low ground water pollution risk was estimated by the SFD matrix. But for the population dependent on pit systems (T2A6C10 and T2A5C10), it is considered that risk of groundwater contamination is high.

2.2.3 Discussion of certainty/uncertainty levels of associated data

There were three major challenges to develop the SFD. Census and published/unpublished reports were not able to provide completely (i) up-to-date data on containment (ii) detailed typology of containment and (iii) actual information about FSM services provided to households. For this reason, field-based studies were conducted to validate the data and triangulation of data provided by secondary sources.

The Census and published/ unpublished reports mostly differentiate between different types of user interfaces and pit latrines but not about the design of the actual containment systems on ground level. Therefore, a random household survey was conducted in each ward of the city to identify and cross check the data collected from the Census, 2010. The census data was solely derived from the responses of head of the household that they provide to the enumerators. Since there is no mechanism to cross verify the responses, there could be misreporting of the information due to various reasons including inadequate knowledge of the respondents or enumerators

CSE's representatives have conducted the KIIs, FGDs and random sample surveys.

The assumption regarding the volume of FS emptied as compared to FS generated has a high impact on the overall SFD. A reliable method for estimating quantities of FS generated on a citywide scale do not yet exist, and it is complicated because the containment size and emptying period greatly vary. Since there is no clear differentiation between the volume of effluent/supernatant and septage generated from septic tanks and lined tanks, hence it's assumed to be 50% each.

3 Service delivery context

3.1 Policy, legislation and regulation

3.1.1 Policies, legislations and regulations at national level

National Environmental Sanitation Policy, 2010

In 2010, the Ministry of Local and Rural development (MLGRD) revised the Ghana National Environmental Sanitation Policy which was initially published in 1999. The aim of the policy is to improve the living conditions and quality of life of the citizens of Ghana. The policy seeks to promote sustainable development through ensuring a balance between economic development and natural resource conservation. As per the environmental policy, principal components of environment sanitation are as follows:

(a) Collection and sanitary disposal of wastes, including solid wastes, liquid wastes, excreta, industrial wastes, health-care and other hazardous wastes;

(b) Storm water drainage;

(c) Cleansing of thoroughfares, markets and other public spaces;

(d) Control of pests and vectors of disease;

(e) Food hygiene;

(f) Environmental sanitation education;

(g) Inspection and enforcement of sanitary regulations;

(h) Disposal of the dead;

(i) Control of rearing and straying of animals;

(j) Monitoring the observance of environmental standards.

In order to associate with all levels of the society as well address challenges faced in the sector, 8 broad themes have been identified for the policy to be holistic, the themes are: Capacity Development; Information, Education and Communication; Legal and Regulatory Issues; Levels of Service; Sustainable Financing and Cost Recovery; Research and Development; Monitoring and Evaluation (MLGRD, 2010a).

National Environmental Sanitation Strategy and Action Plan (NESSAP), 2010

The NESSAP is a reflection of the objectives of the Environmental Sanitation Policy (MLGRD, 2010). Hence all the principles underlying the policy also apply to the NESSAP. NESSAP will be based on the following:

- Decentralised planning and implementation of interventions based on District Environmental Sanitation Strategy and Action Plan (DESSAP) and Metropolitan, Municipal, District Authority (MMDA) Mid Term Development Plans (MTDP)
- Pursuing institutional strengthening and capacity enhancement of the sector in line with programmes of the Local Government Service;
- Strategic Sanitation Approach – matching facilities with housing segments and affordability of residents;

- Targeting to reach total access for environmental sanitation through incremental achievements;
- Transparent means of sector performance assessment involving all stakeholders including civil society, NGOs, traditional authority, religious bodies and other professional associations;
- Enabling public-private-partnerships to flourish amid public regulation and fair refereeing by all stakeholders;
- Recognising the Public-and-Private "Good" nature of environmental sanitation services;
- Enhancing collaboration among key sector actors, especially harnessing the comparative strengths of regional-level entities for effective facilitation of MMDAs within the coordinating mandates of Regional Coordinating Councils (RCC).

National Urban Policy: Framework and Action Plan, 2012

The National Urban Policy includes several objectives which directly pertain to sanitation. The policy aims to balance the distribution of urban population through promoting growth in small and medium-sized towns, and promoting urban economic growth through improved urban services and infrastructure. The policy also sets as an objective to improve the quality of urban life, with the following initiatives to be promoted:

- Development and management of infrastructure systems with the appropriate technology needed to provide basic hygienic conditions in towns and cities;
- Preparation and implementation of sanitation action plans for all leading urban centres, including related statutory regulations and bye-laws for ensuring effective collection, disposal and treatment of solid, liquid and toxic waste;
- Generation of environmental awareness by increasing mass media public education programmes on sanitation in schools and public places.

The policy advocates for greater planning of greater metropolitan regions and the provision of affordable housing through private sector delivery of affordable housing; the promotion of indigenous building materials and appropriate construction technologies; the provision of social or low-income rental housing through public and public-private partnership arrangements; and the upgradation of slums and dilapidated housing stock, especially in urban areas selected as growth centres.

National Environment Policy, 2013

The Ghana National Environmental Policy was formulated in 1995 and revised in 2013. The policy has changed from a conservative mind frame to sustainable development paradigm. It identifies issues and emphasises the importance of bringing about a behavioural change through education and public awareness of environmental sanitation problems in order to bring about improved urban environmental conditions as well as the sustainable use and maintenance of sanitation facilities (MLRGD, 2013).

Public Private Partnership Policy (PPPP) has been produced by the Ministry of Finance and Economic Planning (MoFEP) and covers all aspects of public private partnerships (PPPs) in the public sector including sanitation (MoFEP, 2011) (WEDC, 2015). Details of PPPP have been elaborated in section 3.1.4.

It should be noted that the term "Sanitation" in the Ghanaian context refers to a wider sanitation approach: It goes beyond human excreta management and covers solid waste management, storm water drainage, the cleaning of streets and public areas, food hygiene, and the disposal

of dead animals and people. Therefore excreta management is only a small part of sanitation policy, legislation or regulations. Human waste management is referred to as excreta or liquid waste management and generally falls within the remit of Solid Waste Management Departments (WEDC, 2015). Details of the roles and responsibility of different para-statal bodies has been elaborated in section 3.1.3.

3.1.2 Policies, legislations and regulations at metropolitan and municipal level

Tema Metropolitan Assembly has a set of bye laws prepared in 2017 under the Section 181 of the Local Governance Act, 2016 (Act, 936), the act mandates that the sub-metros manage and operate public toilets, set public toilet fees, construct and maintain sewerage systems, and manage the removal and treatment of faecal sludge. The bye laws related to sanitation with a focus on the management of sewage and septage have been enlisted as follows:

Containment and emptying

- Under this by-law, the TMA prohibits any patron from disposing refuse, any offender identified shall be fined, and in case any offender is not found, the building to which the substance is found closely lying shall be held as the offender [Environmental sanitation: Section 1]
- If during the conveyance of filth, dust, ashes, refuse or litter fall off from the vehicle or any object being used, the person undertaking such conveyance shall cause same to be removed and clean the place, on which such filth, dust, ashes, refuse or litter falls [Cleaning: Section 7]

Transportation and treatment/re-use:

- No person or body shall provide environmental sanitation services within the area of authority of the assembly without a licence issued by the assembly for the category of service provided [Licensing of Service Providers: Section 2]
- The categories of service and classification of service providers are as defined in Schedule 1 of these bye-Laws. [The schedule includes desludgers, pan latrine emptying service [Licensing of Service Providers: Section 2]
- Licensing requirements for providers of environmental sanitation services shall be defined in guidelines issued by the Assembly [Licensing of Service Providers: Section 2]

Assembly to issue licences and keep a register

- The assembly shall license any person or body, wishing to provide environmental sanitation services, who applies to the assembly for a licence. The issuing of licence is dependent on the fulfilling of terms and conditions laid by the assembly [Licensing of Service Providers: Section 2].
- The assembly shall record the names of all licensed providers of environmental sanitation services in a register kept for that purpose [Environmental sanitation: Section 1]

Certification of plant and equipment

- All licensed providers of environmental sanitation services shall cause their vehicles, plant and equipment to be inspected annually for appropriateness and suitability and certified by an authorising officer of the assembly [Licensing of Service Providers: Section 2]

Monitoring of service providers

- All licensed providers of environmental sanitation services shall at all times allow access to the assembly's staff or designated agents to their premises, equipment or records relating to the services licensed [Licensing of Service Providers: Section 2]

Responsibility for the management of waste

- The registered agents, franchise or contractors shall be exclusively responsible for environmental sanitation services within the entire area of the assembly's jurisdiction [Licensing of Service Providers: Section 2]
- All occupiers or owners of premises with the exception of household premises shall designate a member of their staff to be directly responsible in all matters relating to wastes management to liaise with the Assembly and its licensed service providers [Licensing of Service Providers: Section 2]

Offences and penalty

Any person who:

(a) engages in the provision of environmental sanitation services without being licensed by the assembly [Environmental sanitation: Section 1]

(b) being licensed, fails to obtain an inspection certificate from the Assembly for the vehicles, plant and equipment used for providing such Services [Environmental sanitation: Section 1]

(c) refuses access to the Assembly's staff or designated agents to their premises, equipment or records relating to the services licensed, commits an offence.

3.1.3 Institutional roles

Ghana has a well-defined legal and policy framework for sanitation services. The country's legal framework clearly assigns to Metropolitan Municipal Development Authorities the responsibility to prepare infrastructure development plants for sanitation and implement them (WSUP, 2017a). Till 2016, the water and sanitation sectors responsibilities were divided between Ministry of Water resources for water services and Environmental Health and Sanitation Directorate (EHSD) under MLGRD for sanitation services. EHSD was in charge of policy formulation and implementing national level activities. Regulatory functions were shared by EHSD, Ghana Environmental Protection Agency (EPA) and the MMDAs, under the oversight of the Ministry of Environment, Science, Technology and Innovation (MESTI) (WSUP, 2017a). Towards the end of 2017 the water resources and sanitation related responsibilities were allocated to the newly established Ministry of Sanitation and Water Resources.

The Ministry of Education (MoE) is responsible for school sanitation and jointly responsible with the Ministry of Health (MoH) for sanitation and hygiene education. The Ministry of Environment, Science and Technology ensures that sector activities are consistent with environmental policies and objectives (WSP, 2011).

At a regional level the Metropolitan Assembly (i.e. TMA) is responsible for delivering sanitation services using the private sector for infrastructure delivery or management, and for developing the District Water and Sanitation Plan (WSP, 2011). The District Water and Sanitation Team, comprising of members from the Works, Health and Planning Departments are responsible for implementing the Districts Water and Sanitation Plan (WSP, 2011). District Environmental Health Officers (DEHOs) educate communities on sanitation and hygiene, and enforce

regulations regarding the construction, use and management of public, institutional and household facilities (WSP, 2011). More details of the institutions and their roles can be found in Table 7.

Table 7: Roles and responsibilities in water and sanitation sector in Ghana

Institution	Roles and responsibility
Ministry of Local Government and Rural Development (MLGRD)	-Coordination and formulation of policy including monitoring and evaluation (M&E) -Development of technical guidelines -Promulgation of national legislation -Mobilisation of funds - Oversight responsibility
Ministry of Sanitation and Water Resources (MSWR)	- Reducing gaps and ensuring better provisioning of services for the WASH sector in Ghana - Prioritising water and sanitation -Promoting market-based approach to service delivery - Improving the water resources information and knowledge base by investigating hydrogeological and groundwater base - Promote water use efficiency and conserve water with focus on water reuse and recycling - encourage the MMDA's to promote decentralised sewerage system for high density communities, construction of toilet by enforcing bye-laws
Ministry of Environment, Science, Technology and Innovation (MESTI)	-Ensuring all new policies made are in coordination with the ones already existing - Monitoring of regulatory functions for the sector undertaken by Environmental Protection Agency, Environmental Health and Sanitation Directorate and MMDA
National Development Planning Commission (NDPC)	NDPC provides guidelines for the development of the MMDAs' medium-term plans for sanitation known as District Environmental Sanitation Strategy Action Plans (DESSAPs)
Ministry of Finance and Economic Planning	-Fund mobilisation -Direction on PPP
Environment Protection Agency (EPA)	Guide development to prevent, reduce, and as far as possible, eliminate pollution and actions that lower the quality of life.
Ghana Water Company Limited	-Establishment of water safety plans at sub-sector levels -Improve water production and distribution network -Build new water supply systems in unserved and underserved communities -Create an enabling environment for private sector participation in safe water delivery
Community Water & Sanitation Agency (CWSA)	-Provision of sustainable potable water and related sanitation services as well as hygiene promotion to rural communities and small towns through resource mobilization, capacity building, standards setting and quality assurance with the active participation of all stakeholders -Water and sanitation facility delivery, coordination, advocacy, monitoring and evaluation (including water quality monitoring), research, and knowledge management, capacity building, hygiene promotion.
Waste Management Dept. TMA	-Provision of sanitation services -Compliance with regulations
Environmental Health & Management Dept. TMA	-Public health monitoring -Sanitation education -Implementation through EHOs in collaboration with the EPA
Metropolitan & Works Dept. TMA	-Provision of infrastructure
Sub Metropolitan Assemblies	-Sanitation education -Inspection and monitoring of facilities -Implementation through local agents such as EHOs
CSIR-IIR	- To encourage the national interest scientific and industrial research of importance for development of Agriculture, health, medicine, environment, technology and other service sectors and to this end to encourage close linkage with the productive sectors of economy; - To coordinate all aspects of scientific research in the country and to ensure that the Council, the research institutes of the Council and other organization engaged in research in Ghana, coordinate and cooperate in their research effort; - To exercise control over the research institutes and projects of the council and to have power after consultation with the Minister to create reconstitute, merge or dissolve any institute, Centre, unit or project of the council; - To review, monitor and periodically evaluate the work of the institutes administered by the Council in order to ensure the research being carried out by the institute directly benefits identified sectors of the economy and is within the national priorities;

Source: Embassy of The Kingdom of The Netherlands, 2018; WSMP, 2010; WEDC, 2015; WSUP, 2017b

3.1.4 Service provision

The NESSAP sets the national sanitation agenda, including the agenda for excreta management (MLGRD, 2010a). This includes a framework for funding the strategies proposed. These financial plans for improving service provision were further developed in the Strategic Environmental Sanitation Investment Plan (SESIP) which intends to provide a sustainable financing plan for implementing the NESSAP (MLGRD, 2010b).Through the ESP, provision is made for private sector involvement in desludging of all facilities, construction and management of public toilets (MLGRD, 2010a).This is reiterated in the subsequent national and local plans and policies. The Ghana Shared Growth and Development Agenda (GSGDA) 2010-2014 contains sections on private investment in Ghana, which is pursued through the Private Sector Development Strategy in GSGDA (NDPC, 2010), NESSAP (MLGRD, 2010b) and SESIP (MoFEP, 2011).

PPPP creates a structure to encourage the development of PPPs for infrastructure and services, including those required for excreta management. It harmonizes the policy guidelines and creates a PPP framework which can be followed. It states that all PPPs are to be governed in accordance with clear objectives and output requirements, accountability and transparency. It establishes six guiding principles for PPPs within Ghana which are: value for money, transfer of risk to the private party, ensuring end users ability to pay, promotion of local companies and technologies, safeguarding the public and conforming to national laws (MoFEP, 2011).

Greater Accra Metropolitan Authority Project, 2013: The Government of Ghana (GoG) has received funding from the World Bank towards the cost of implementation of the Greater Accra Metropolitan Area (GAMA) Sanitation and Water Project. The objective of the GAMA S&W Project is to increase access to improved sanitation and improved water supply in the GAMA, with emphasis on low-income communities; and to strengthen management of environmental sanitation in the GAMA.

The GAMA Project supports eleven (11) Metropolitan and Municipal Assemblies (MMAs) spread across the Greater Accra Region. The project has four components:

- **Component 1** – Provision of water and environmental sanitation services to priority low income areas of GAMA;
- **Component 2 –** Improvement and expansion of the water distribution network in the GAMA;
- **Component 3 –** Improvement and expansion of waste water and faecal sludge collection, transportation and treatment in GAMA;
- **Component 4** – Institutional Strengthening (GAMA S&W Project).

Provision of improved sanitation and water supply facilities in schools in each of the eleven (11) MMAs in GAMA, including hygiene education and campaigns for awareness raising and behavioural changes in low income communities, is part of the strategies under Component 1 of the Project.

3.1.5 Service standards

1. Environment Protection Agency Effluent Guidelines, 2012: General standards are notified with respect to parameters for safe discharge of effluent to inland surface water/public sewers/land for irrigation/ marine coastal areas.

2. Ghana Building Code, 2018: The Ghana Building Code contains regulations which can be immediately adopted or enacted for use by various departments, metropolitan, municipal and district assemblies, private and public bodies. It lays down a set of minimum regulations designed to protect the safety of the public with regard to structural efficiency, fire hazards and health aspects of buildings. The building code does not provide design specifications and hence refers to ISO standards for specifications of design of septic tanks.

3.2 Planning

3.2.1 Service targets

Nationally the main plans relating to excreta management are: Ghana Shared Growth and Development Agenda (GSGDA) 2010-2013 (NDPC, 2010) and NESSAP (MLGRD, 2010b). These are then translated into local plans, such as the Tema Metropolitan MTDP for Tema (TMA, 2017) and Metropolitan Environmental Sanitation Strategic Action Plan 2008 to 2015 (MESSAP) (TMA, 2014). The GAMA Sanitation and Water Project supports the Tema Metropolitan Assembly through construction, reconstruction and lining of drains and to improve environmental sanitation in the Metropolis. The project is for Zinginshore, Abonkor and Bankuman, all suburbs of Tema Newtown. The project was launched in 2016 (MLGRD, 2016)

The Metropolitan Environmental Sanitation Strategic Action Plan (MESSAP) 2008 to 2015 provides current assessment of the services delivered and the projected needs based on the population growth, economic development and planned improvements in levels of service, provided as follows:

Table 8: Service targets as per MESSAP 2008-2015

Category of service	Current status		Projected need	
	Service Levels	Gap (Minimum level)	2015	2016
Premises inspection	75%	25%	75%	80%
Vector and pest control	65%	35%	80%	85%
Food hygiene safety	70%	30%	80%	85%
Solid waste collection coverage	92%	8%	50%	15%
Domestic toilets	85%	15%	15%	0%

Source: MESSAP for TMA, 2008

3.2.2 Investments

The major investment in upgradation of sanitation is taking place under GAMA project. Details of investment have been deliberated as follows:

Table 9: Financial estimates of 2017 for TMA

Type/ Name of Project	Details or Program Components	Sponsor	Time Period	Quantity/ Budget
Tema Sewarage Improvement Project	Rehabilitate the sewerage system in the Tema Metropolis and improve environmental conditions	AFD	Submitted Proposal to AFD	US$ 7m
Construction of toilets in institutions	Construction/rehabilitation of 38No. institutional toilets in 38 Schools in the Metropolis under the GAMA Project	N/A	2018-2021	38 toilets
Construction of toilets in households of lower income areas	Construction of subsidized household toilets in low income communities under the GAMA Project		2018-2021	1000 toilets

Source: (TMA, 2017) (MLGRD, 2017)

As per the MTDP, TMA has budgeted a total of 6,280,000.00 Cedi for interventions from 2018-2021 (TMA, 2017). The past projections of expenditure on environment and sanitation has been provided as follows:

Table 10: Expenditure on environment and sanitation as per MTDP 2017

Year	Environment and sanitation expenditure	Percentage of overall budget
2013	1,11,715.05	2.4
2014	1,14,396.16	2.4
2015	1,17,141.67	2.46
2016	1,19,953.10	2.52
2017	1,22,831.90	2.58

Source: (TMA, 2017)

3.3 Reducing inequity

In Tema, urban poor are well defined as per the socio – economic conditions and work to uplift the sanitation situation in the underserved areas have been put in focus in the MTDP 2018-2021. Projects under the MESSAP such as community engagement, design and implementation supervision for improved sanitation and water in low income communities, Manhean community and design report on centralized sewer system for Bankuman even focuses on reducing inequity.

3.3.1 Current choice of services for the urban poor

The current choice of services for the urban poor currently include open defecation and use of toilets connected to fully lined tanks without outlet. In the case of fully lined tanks without outlet, the households use cleaning liquids which dissolve the FS, henceforth increasing the emptying period of these systems. The entry of vacuum tankers is rather difficult due to the organic growth of the poor areas.

3.3.2 Plans and measures to reduce inequity

Tema Metropolitan Authority defined its course of action as per the guidance of the MESSAP and the implementation is as per the mid term development plan. Following are the projects/objectives identified under the MTDP:

Table 11: Objectives/ projects focusing on sanitation as per MTDP

Broad objectives/projects	Progress
Construction of storm drains to alleviate floods in Tema Central, Tema East and Tema West (GAMA Project)	Storm drains to alleviate floods in Tema Central, Tema East and Tema West (GAMA Project) to be constructed
Construction subsidized household toilets in low income communities under the GAMA Project	1,000 household toilets to be constructed of which 622 have been constructed
Provide support for the construction of a 20 seater WC toilet at Adjei Kojo	80% work complete
Undertake slum upgrading scheme in low income communities	Identification of slums in process

Source: MTDP, 2017

There are measures in place in the legislature to ensure services reach the urban poor i.e. the control of the public toilet pricing by local government. There is also legislation in place to ensure the affordability of private sector services and to safeguard the vulnerable groups (MoFEP, 2011)

3.4 Outputs

3.4.1 Capacity to meet service needs, demands and targets

TMA has sufficient funds to meet the demand of providing basic sanitation services and amenities through the revenue it is generating and foreign grant under projects such as GAMA.

Shortage of human resource can be witnessed in the TMA. It largely relies on staff hired on a contractual basis to provide the daily service needs to the public. The staff has training on basic know-how.

3.4.2 Monitoring and reporting access to services

Monitoring of the progress of projects in Tema are spearheaded as per the MTDP and the monitoring for the sanitation projects is done by the wastewater management and Environmental Health department of TMA. Currently monitoring regarding the toilets built is done, and monitoring at the septage plants is done where the trucks discharge the FS.

3.5 Expansion

3.5.1 Stimulating demand for services

TMA is currently striving to complete the target of building 2000 toilets under the GAMA project for Tema city. The city envisages to refurbish the sewer system laid in the city as it faces frequent break downs. Treatment of faecal sludge is done at Nungua farms, while the part of the city served by the sewer system discharges wastewater into the ocean, as the STP is defunct.

Software aspects are built into local programs. In the national budget for sanitation, the public sector budget is predominately for capacity building (WSP, 2011).

3.5.2 Strengthening service provider roles

The GoG is providing a legislature to strengthen the role of service providers and to encourage private investment in the sector. Additionally NESSAP and SESIP provide a framework and budget for strengthening service providers which is then translated locally into the DESSAP and city level programs (WEDC, 2015).

4 Stakeholder engagement

Permission to engage with stakeholders and undertake this research was gained from the Ministry of Sanitation and Water resources, Ghana (MoSWR) and Head of Waste Management Department, Tema. The FGDs and KIIs were conducted with the relevant stakeholders. On arrival, a meeting was held with the officials of Waste Management Department of TMA, who are the primary stakeholders and collaborative partners in this research (TMA, 2018). This meeting was attended by the Head of the Waste Management Department (WMD), Public Health Engineer and staffs of WMD. The researchers also visited Planning Department and met Planning officer and Regional Chief Engineer. During these meetings the concept of SFD was explained along with the type of data required.

Limited information was available, prior to the field based research about the status of the sanitation service chain of the region. The visit enabled in enhancing the data collection through stakeholder's engagement. This lead to plot the activities of identifying the key players in Tema who are involved in providing the sanitation service. This was then used to agree collectively on a plan to collect the data. At the end of the field work, an exit meeting was held with two main stakeholders the Waste Management Department and the MoSWR. In this meeting the research gaps were highlighted, the research findings were discussed. This was highly valuable and initiated the process of preparing the SFD.

4.1 Key informant interviews

The KII was conducted with the stakeholders having a role or interest in sanitation and FSM services within the city. The relevant departments were contacted through e-mail and letter, prior to a visit to the concerned departments. The purpose of the SFD study and depth of data required was conveyed through an introductory letter to respective departments. 6 KIIs were conducted with town planner, health inspector, local mason, private emptier, and STP operator (refer appendix 7.2). The visit enabled in enhancing data collection through gathering progress details of GAMA project, published and unpublished reports like DPR, maps, etc. Interview with the vacuum tanker operator and other stakeholders provided additional insight into the service delivery context

4.2 Focus group discussions

Four FGDs were conducted with TMA's administration and sanitary workers to complement, validate and challenge data collected during literature review and interviews. One fact which emerged from Focus group discussion was the lack of knowledge and awareness about the ill-effect on the environment and human health due to unchecked discharge of untreated FS and WW.

The findings from the FGD sessions revealed information that increased the understanding of the sanitation and septage management in Tema. FGDs were useful in data triangulation. Random sample survey helped in validating secondary data and data provided by different stakeholders. It resulted in actual and true SFD of the city.

5 Acknowledgement

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7 Appendix

7.1 Stakeholder identification

Table 12: Stakeholder identification

S. No.	Stakeholder group	In Tema context
1	City council / Municipal authority / Utility	Tema Metropolitan Authority
2	Ministry in charge of urban sanitation and sewerage	Ministry of Water and Sanitation, GoG
3	Ministry in charge of urban solid waste	Ministry of Water and Sanitation, GoG
4	Ministries in charge of urban planning finance and economic development	Ministry of Finance, GoG
	Ministries in charge of environmental protection/	Environment Protection Agency
	Ministries in charge of health	Ministry of Health, GoG
5	Service provider for construction of onsite sanitation technologies	Local masons
6	Service provider for emptying and transport of faecal sludge	Private Emptiers
7	Service provider for operation and maintenance of treatment infrastructure	Waste management department, TMA
8	Market participants practicing end-use of faecal sludge end products	N/A
9	Service provider for disposal of faecal sludge (sanitary landfill management)	Waste management department, TMA and IWMI
10	External agencies associated with FSM services: e.g. NGOs, academic institutions, donors.	IWMI, World bank

Source: CSE, 2018

7.2 Tracking of engagement

Table 13: Tracking of engagement

S. No.	Name of Organisation	Designation	Date of engagement	Purpose of engagement
1	Ministry of Sanitation and Water resources		15/1/2018	• Introduction of SFD and permission to conduct FGDs in the municipal wards • Data collection • FGD with administrative staff of GNPP
2	TMA	Head, wastewater department	**15/1/2018**	FGD with sanitary wing to understand the sanitary condition and analyse the level of knowledge of septage and faecal sludge
3	TMA	Coordinator	**15/1/2018**	
4	Private	Emptiers	16/1/2018	KII
5	TMA	Planner	16/1/2018	KII, collection of data
6	TMA	Treatment plant operator	17/1/2018	KII
7	community	-	18/1/2018	FGD
8	community	-	18/1/2018	FGD
9	TMA	Health inspector	18/1/2018	KII
10.	EPA	Deputy director	19/1/2018	KII
11	IWMI	Research officer	15/03/2018	KII

Source: CSE, 2018

7.3 List of communities in Tema

Table 14: List of communities in Tema

S/No	Community Name	Total
1	Tema Newtown	71,711
2	Lashibi	47,530
3	**Tema Community 1**	**32,712**
4	Sakumono	22,713
5	**Tema Community 2**	**22,547**
6	**Tema Community 4**	**14,623**
7	**Tema Community 5**	**13,043**
8	**Tema Community 7**	**12,398**
9	**Tema Community 8**	**10,958**
10	**Tema Community 9**	**8,350**
11	Kanewu And Suncity	7,721
12	Adjei Kojo	5,801
13	**Tema Community 3**	**5,691**
14	**Tema Community 11**	**5,313**
15	Tema Community 12	5,287
16	Tema Community 10	3,546
17	**Tema Community 6**	**1,504**
18	Tema Main Harbour	844
19	Tema Industrial Area	481

Communities highlighted in yellow and bold are the communities connected to sewerage system

7.4 Treatment plant in Tema: JVL Co-Compost plant

Figure 20: Birds eye view of the JVL treatment plant

Table 15: Various components of JVL FSTP

Plant components		
Drying beds	Number	5
	Surface area	240 sqm each
Sorting bay	Number	1
	Surface area	400 cu. M
Composting platform	Number	3
	Surface area	1,200 sqm (in total)
Pelletization unit	Surface area for indoor section	160 sqm
Fortifer storage	Surface area for indoor section	320 sqm
Office building	Two office rooms	50 sqm
	One storage room	
	One staff room	
	2 toilets + shower blocks	

Table 16: Process flow of JVL FSTP

Duration of the production process	**Fortifer**
Drying of faecal sludge	10 days, on average
Co-composting of dried sludge/organic waste	90 days, on average
Sieving, enrichment and palletization of the resulting composts	1 day or less

7.5 Shit flow diagram graphic of Tema city

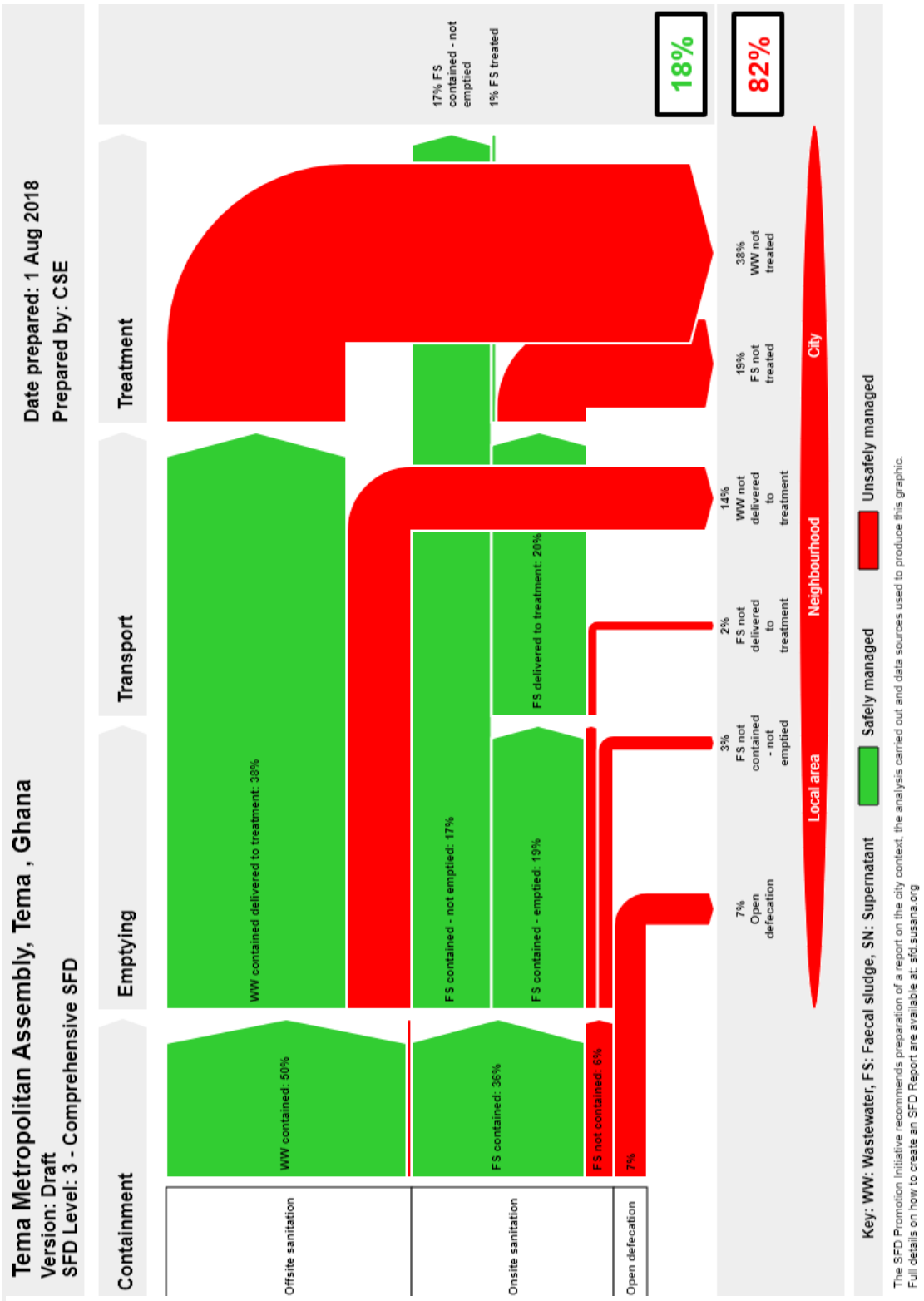

Figure 21: SFD graphic for Tema city, 2018 (Source: CSE, 2018)

7.6 Groundwater pollution risk estimation

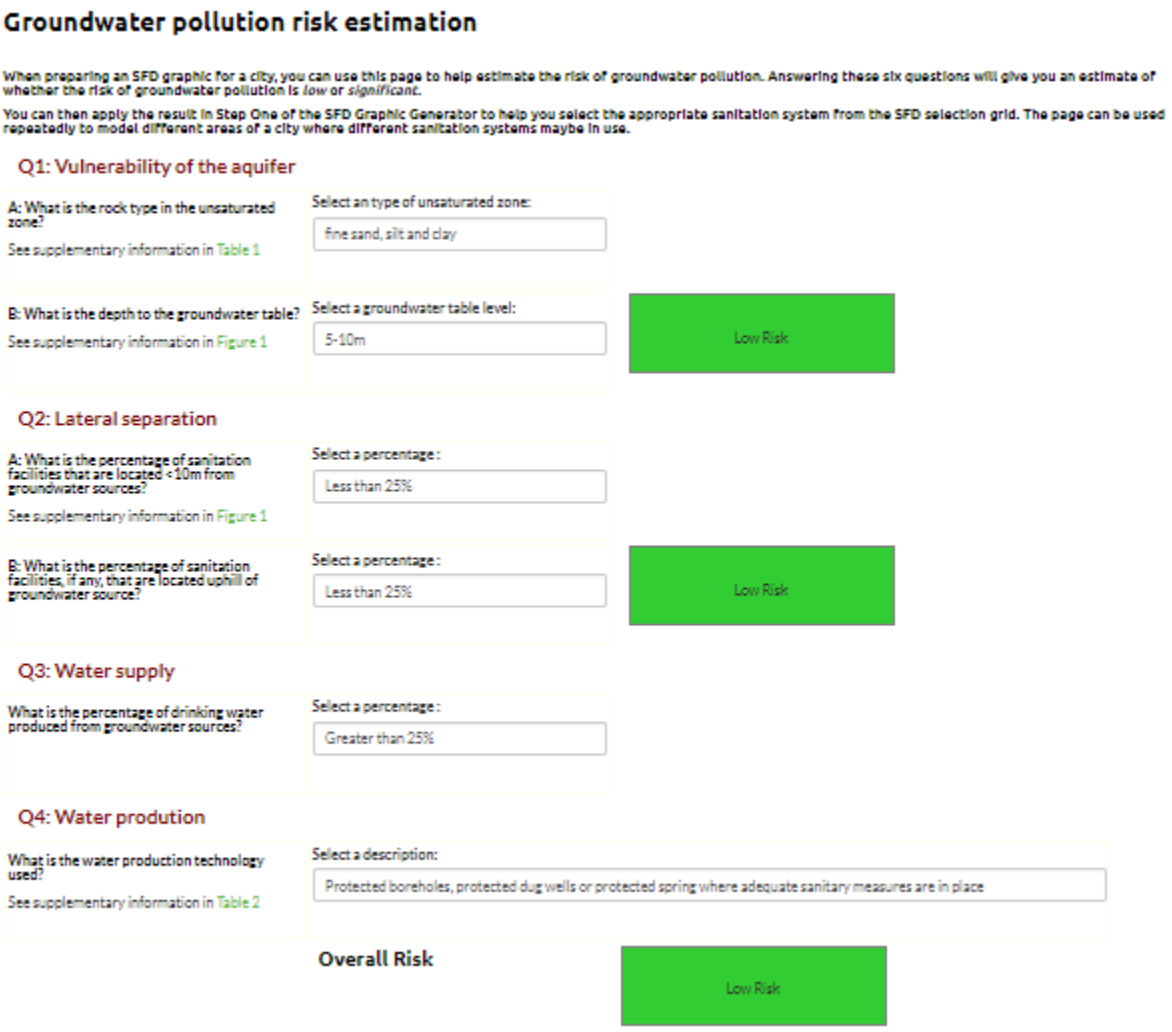

Figure 22: Groundwater pollution risk estimation

7.7 SFD selection grid

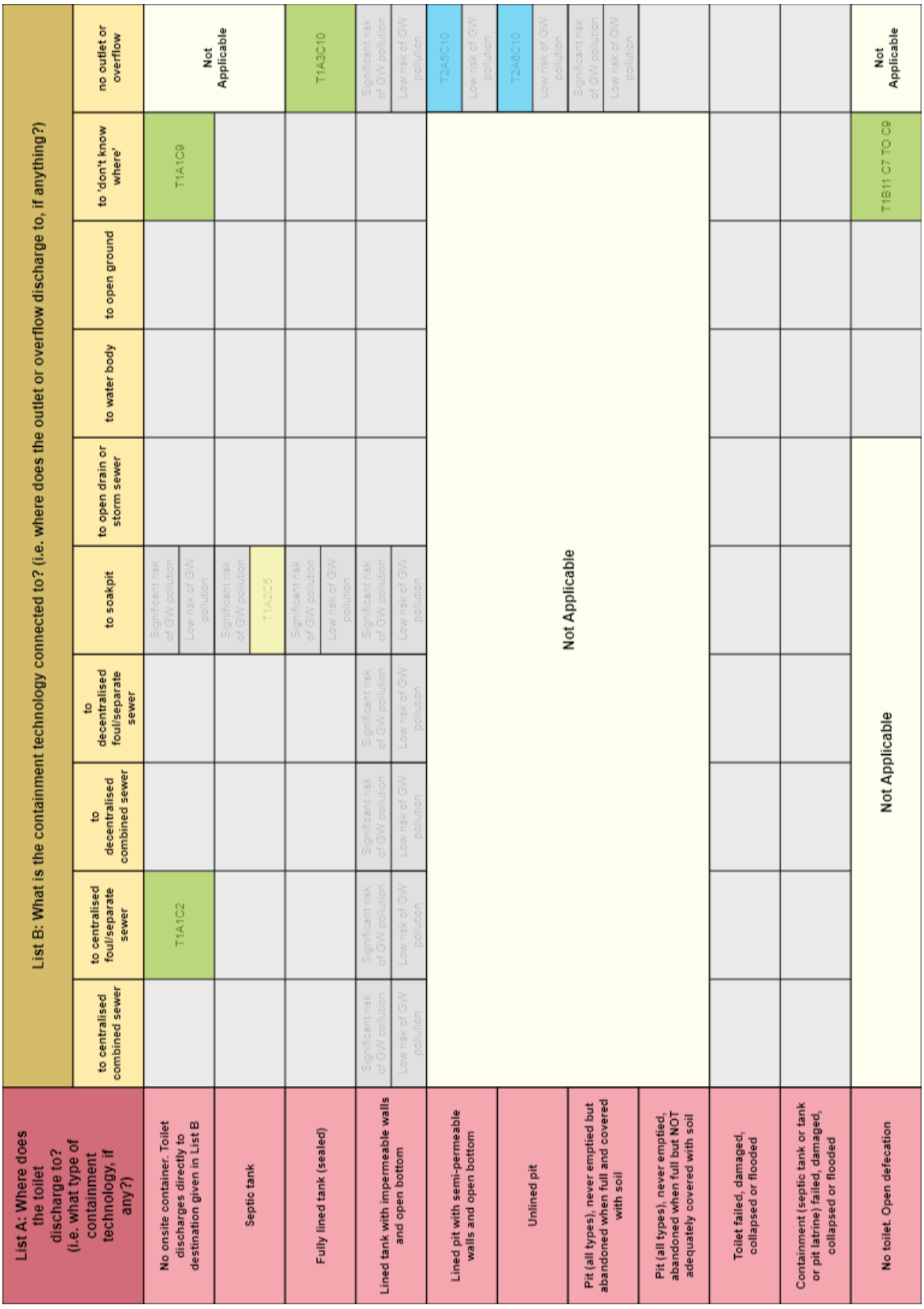

Figure 23: SFD selection grid

7.8 SFD calculation grid

Table 17: Calculation grid

Tema Metropolitan Assembly, Tema , Ghana, 1 Aug 2018. SFD Level: 3 - Comprehensive SFD
Population: 310853
Proportion of tanks: septic tanks: 50%, fully lined tanks: 100%, lined, open bottom tanks: 50%

System label	Pop	W4a	W5a	F3	F4	F5
System description	Proportion of population using this type of system	Proportion of wastewater in sewer system, which is delivered to centralised treatment plants	Proportion of wastewater delivered to centralised treatment plants, which is treated	Proportion of this type of system from which faecal sludge is emptied	Proportion of faecal sludge emptied, which is delivered to treatment plants	Proportion of faecal sludge delivered to treatment plants, which is treated
T1A1C2 Toilet discharges directly to a centralised foul/separate sewer	50.0	75.0	0.0			
T1A1C9 Toilet discharges directly to 'don't know where'	1.0					
T1A2C5 Septic tank connected to soak pit	29.0			90.0	90.0	5.0
T1A3C10 Fully lined tank (sealed), no outlet or overflow	7.0			90.0	90.0	5.0
T1B11 C7 TO C9 Open defecation	7.0					
T2A5C10 Lined pit with semi-permeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	4.0			90.0	90.0	5.0
T2A6C10 Unlined pit, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	2.0			90.0	90.0	5.0