SFD Promotion Initiative

Srikakulam
India

Final Report

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On behalf of Federal Ministry for Economic Cooperation and Development

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Sandec Sanitation, Water and Solid Waste for Development

BILL & MELINDA GATES foundation

SFD Report Srikakulam, India, 2015

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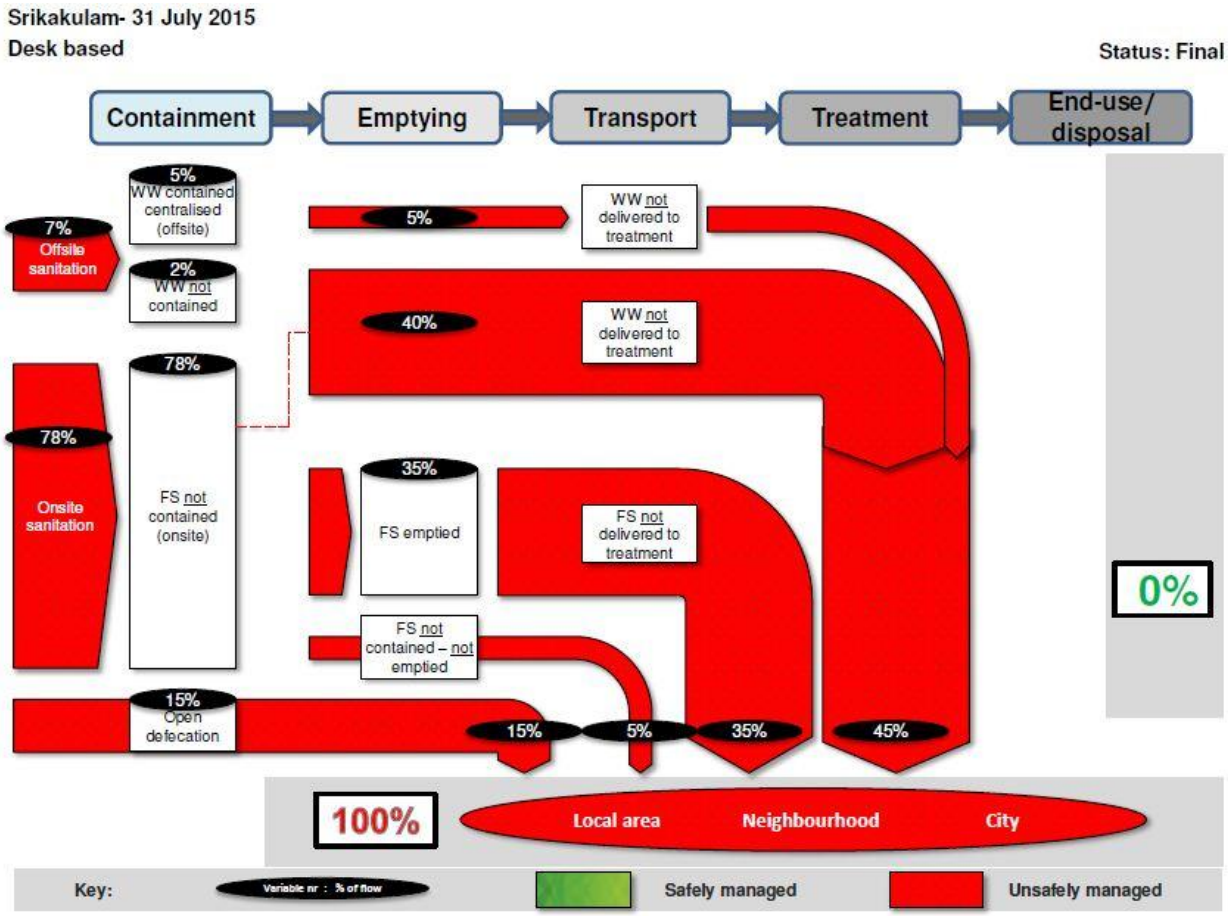
1. The Diagram



2. Diagram information

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3. General city information

Srikakulam is a coastal city located in the state of Andhra Pradesh (AP). It is the district headquarters and is an important administrative and commercial centre. It is one of the oldest municipalities of the state, established in 1856. It is located adjacent to the National Highway number 5 connecting Chennai and Kolkata. River Nagavali flows through the city. (MA&UD, 2011).

The population of city as per the 2011 Census is 133,911 persons. The density of city is 6,419 persons per sq.km which is very high when compared to state average of 308 persons per sq.km. Total slum population is 49,405 persons which constitutes 37% of the total population (MA&UD, 2011).

Municipal boundary has been chosen for the current study. It comprises of an area of 20.9 sq.km (MA&UD, 2011).

4. Service delivery context

In 2008, the Ministry of Urban Development (MoUD) issued the National Urban Sanitation Policy (NUSP). The policy aims to: raise awareness, promote behaviour change; achieve open defecation free cities; develop citywide sanitation plans; and provide 100% safe confinement, transport, treatment and disposal of human excreta and liquid wastes. The NUSP mandates states to develop state urban sanitation strategies and work with cities to develop City Sanitation Plans (CSPs). Furthermore, it explicitly states that cities and states must issue policies and technical solutions that address onsite sanitation, including the safe confinement of faecal sludge (USAID, 2010).

The objectives of NUSP are to be realized through CSPs and state sanitation strategies. As of now there are very few cities which have finalized their CSPs, and those plans are also not implemented. This remains a major drawback in implementation of NUSP.

The advisory note on septage management in urban India, issued by MoUD in 2013, recommends supplementing CSPs with Septage Management Sub-Plan (SMP). Still septage management in India is not prominent due to lack of knowledge, consideration of septage management as an interim solution, lack of sufficient funding and many other socio-political issues.

There are no specific legal provisions relating to septage management, but there are a number of provisions relating to sanitation services and environmental regulations, which majorly stems from, The Environment (Protection) Act, 1986 and the Water (Prevention and Control of Pollution) Acts. Municipal acts and regulations usually refer to management of solid and liquid wastes but may not provide detailed rules for septage management (MoUD, 2013).

5. Service outcomes

Overview on technologies and methods used for different sanitation systems through the sanitation service chain is as follows:

Containment: There is negligible sewerage network and it is not connected to any Sewage Treatment Plant (STP). The city is majorly dependent on septic tanks which are generally not adhering to design prescribed by Bureau of Indian Standards (BIS). The effluent from the septic tank flows into open drains. Some households are also connected to pits.

Figure 1: Private vacuum tanker (Source: Rahul/CSE, 2015)

Figure 2: Wall poster of septic tank emptying service in local language (Source: Rahul/CSE, 2015)

Emptying: There are five private emptiers operating in the city, they have a fleet of seven vacuum tankers with capacity of 5000 litres each. The emptying fees ranges from INR 1500 to 2500 (23 to 39 USD) per trip. Private emptiers use innovative marketing strategies to attract customers. This actually shows extent of competition between private emptiers. There are no instances of manual scavenging reported.

Transport: Private emptiers transport septage by vacuum tankers to disposal sites. The private emptiers travel 5-10 km outskirts of city to discharge septage into agricultural lands.

Treatment: There is no treatment facility for waste water and septage.

End-use/Disposal: All the waste water generated is disposed in to Nagavali River, which is also a source of potable water. As there is no dedicated disposal site, private emptiers dispose outside the town in dry lands. Sometimes dried septage is used as compost in farms. It is generally used for cultivating Eucalyptus trees.

According to Census of India, 2011, only 7% of city is dependent on offsite systems, population connected to sewer line is 5% and user interface directly discharging in open drain is only 2%, but since there's no treatment it is considered as unsafe.

Rest of the 78% of the city is dependent on onsite sanitation systems (OSS), out of which 76% is dependent on septic tanks and 2% on pits. The public latrines are connected to septic tanks and hence are incorporated in onsite systems. Faecal sludge (FS) from OSS is not contained as the septic tanks are connected to open drains and pits are polluting the ground water.

There is no clear differentiation between percentage of effluent and septage generated from septic tanks, hence it's assumed to be 50% each. Therefore, 38% of FS, which is effluent, goes into open drain and rest is emptied from tanks whenever full. Some FS is always left in the tanks and is assumed to be 5%.

There is no treatment of wastewater and septage, therefore the whole system is unsafely managed, which also includes 15% of city that defecates in open.

6. Overview of stakeholders

The 74th Constitutional Amendment Act of 1992 reformed the sector by transferring responsibility for domestic, industrial, and commercial water supply and sewerage (WSS) from state agencies, such as Departments of Public Health Engineering and State Water Boards, to Urban Local Bodies (ULBs). This transfer has resulted in a variety of implementation models, as well as lack of clarity in allocation of roles and responsibilities between state and local agencies, which sometimes results in large gaps in implementation (USAID, 2010).

The following stakeholders are responsible for sanitation service delivery in Srikakulam:

Key Stakeholders	Institutions / Organizations
Public Institutions	Public Health and Municipal Engineering Department (PHMED), Urban Local Body(ULB)- Srikakulam Municipality, State Pollution Control Board (SPCB)
Private Sector	Private emptiers

Table 1: Key stakeholders (Source: Compiled by CSE, 2015)

PHMED is responsible for planning and executing sewerage schemes. After completion, operation and maintenance is handed over to ULB.

Srikakulam Municipality is responsible for operation and maintenance of open drains, sewerage, construction and maintenance of public toilets. Municipality don't do any activity related to septage management. There is absolutely no regulation of private emptiers. Even though sanitation is an obligatory responsibility of a ULB, septage management is often neglected.

SPCB is responsible for monitoring and evaluation of STPs.

Private emptiers are solely responsible for septage management. They are providing services within and around the city.

7. Credibility of data

Two key sources of data are used; Census of India, 2011 and draft CSP, 2011. The data is crosschecked and updated by Key informant interviews (KIIs). Eight KIIs have been conducted with different stakeholders.

Data on containment is available in Census. Data on emptying and transport is collected by KIIs. However most of the data is qualitative.

Some of the issues and challenges are listed below:

- Data insufficiency and non availability: No data available on how many septic tanks are connected to open drains/soak pits
- Accuracy: Discrepancy observed between Census data and actual ground situation
- Data available at different time lines
- Limited data available on reuse (formal / informal)

Assumptions followed for preparing SFDs:

- Data provided by Census, 2011 is correct
- Septic tanks and sewer connections on ground are as per septic tanks & sewer connections defined in Census
- Volume of waste water produced is 80 % of water supplied
- All septic tanks are connected to open drains
- 90% of the people get their tanks emptied when full

8. Process of SFD development

Data is collected through secondary sources, and then a visit to the city is done to conduct KIIs with relevant stakeholders, to fill in the gaps in data and to crosscheck the data collected.

To start with, a relationship between sanitation technologies defined in Census of India and the ones defined in project is established.

The data is fed into the calculation tool to calculate the excreta flow in terms of percentage of the population.

FS and waste water are not contained in their respective sanitation systems and there is no treatment as well; hence all the arrows shown in SFD are depicting the faecal waste of the city is not handled safely.

Limitations of SFD:
It's dependent on secondary data and true picture of the city may differ.

The data available is at different timelines, for example data on containment is from census 2011, and data on emptying and transportation is collected through KIIs conducted in 2015.

Whether excreta is safely managed or not is dependent on whether the system is contained or not, and not on whether waste is safely handled.

9. List of data sources

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

- Published reports and books:
  - Census of India 2011, House listing and Housing data, Government of India
- Un–published documents:
  - Draft CSP of Srikakulam, MA&UDD, Government of Andhra Pradesh, 2011
- KIIs with representatives from
  - Government agencies:
    Srikakulam Municipality, Ground Water Department (GWD)
  - Service providers:
    Private emptiers

Srikakulam, India, 2015

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Abbreviations

APPCB	Andhra Pradesh Pollution Control Board APPCB
APUFIDC	Andhra Pradesh Urban Finance and Infrastructure Development Corporation
BIS	Bureau of Indian Standard
CAA	Constitutional Amendment Act
CSP	City Sanitation Plan
CPHEEO	Central Public Health & Environmental Engineering Organization
CD&MA	Commissioner & Director of Municipal Administration
CSE	Centre for Science and Environment
CGWB	Central Ground Water Board
CPCB	Central Pollution Control Board
FS	Faecal Sludge
HUDCO	Housing and Urban Development Corporation
GOAP	Government of Andhra Pradesh
MA&UD	Municipal Administration & Urban Development Department
MoUD	Ministry of Urban Development
NIUA	National Institute of Urban Affairs
NUSP	National Urban Sanitation Policy
OSS	Onsite Sanitation System
PHMED	Public Health and Municipal Engineering Department
SLB	Service Level Benchmarks
SMP	Septage Management Plan
SWM	Solid Waste Management
ULB	Urban Local Body
USAID	United States Agency for International Department
WSS	Water Supply and Sewerage
WW	Waste water

1 City context

Srikakulam is a coastal city located in the state of Andhra Pradesh (AP). It is the district headquarters and is an important administrative and commercial centre. It lies in the extreme north-east of Andhra Pradesh, situated within the geographic coordinates of 18.3^0N and 83.9^0E. In the year 1836, it was first constituted into a municipality under the Madras (presently Chennai) Town Improvement Act of 1865. With its history of about a century and a quarter, it is one of the oldest municipalities of the state. The municipality was upgraded and classified as first-grade municipality in the year 1965 (MA&UDD, 2011).

The population of the city, as per the Census of India, 2011 is 133,911. The actual municipal corporation area is about 20.9 sq.km. The current gross population density of the city is 6,419 persons per sq.km. Total slum population is 49,405 which is 37% of the total population (MA&UDD, 2011). Municipal boundary has been chosen for the current study. Srikakulam Municipality is divided into 36 wards (SM, 2015). The population growth rate of the city is given in the following table.

Table 1: Population growth rate

Census Year	Population	Growth Rate (%)
1971	45,179	-
1981	67, 865	50.2
1991	88,883	30.9
2001	1,09,905	23.6
2011	1,33,911	21.8

Srikakulam has various tourist attractions. The temple of Sun God is located at Arasavalli, 2 kilometers away from the city, constructed by a Kalinga dynasty king. Kurmanatha temple dedicated to Kurma Avatar (Tortoise) of Vishnu is in village Sri Kurmam. It is approximately 13 kilometers east of Srikakulam. It is estimated that the floating population is approximately 10,000 persons per day (MA&UDD, 2011).

The town is located along the river bank of Nagavali with gentle slopes towards the river. The average ground level of the town is 16.55 above the mean sea level. The nature of the soils generally mixed with red earth and clay. The area is underlined by sand strata, which is fine to medium grained and groundwater occurs in confined conditions from 3 to 10 meters. The climate of Srikakulam city is humid. The highest temperature record in Srikakulam is 38.5°C (110°F) and in the winter is 19.6°C. Rainfall is owing to south-west and north–east monsoon winds. The annual rainfall is 198.50 mm which mainly occurs during the months of June-September due to the south-west monsoon (MA&UDD, 2011).

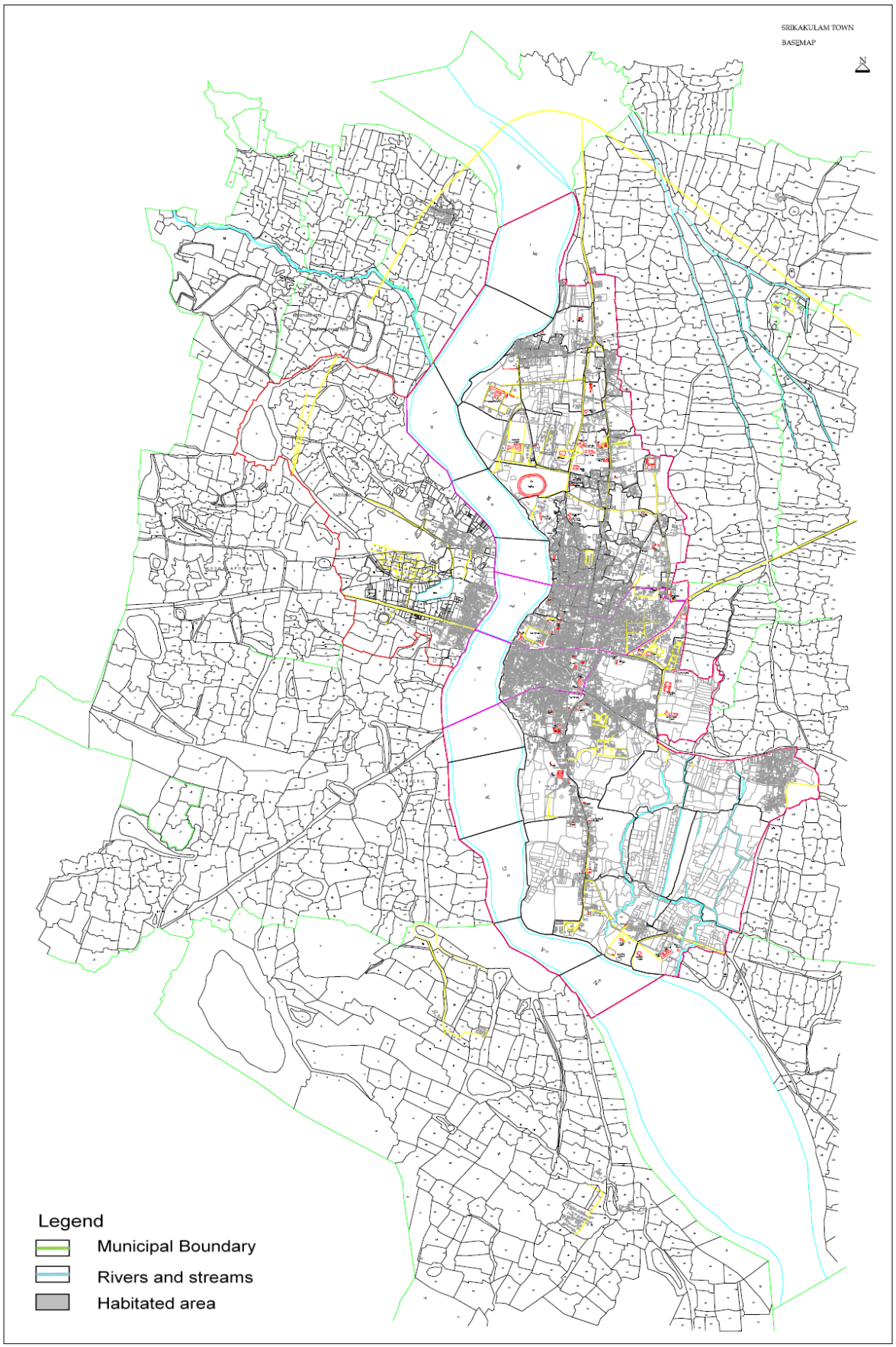

Figure 1: Base map of Srikakulam

2 Service delivery context description/analysis

2.1 Policy, legislation and regulation

2.1.1 Policies, legislations and regulations at national level

In 2008, the Ministry of Urban Development (MoUD) issued the National Urban Sanitation Policy (NUSP). The policy aims to: raise awareness, promote behaviour change; achieve open defecation free cities; develop citywide sanitation plans; and provide 100% safe confinement, transport, treatment and disposal of human excreta and liquid wastes. The NUSP mandates states to develop state urban sanitation strategies and work with cities to develop City Sanitation Plans (CSPs). NUSP specifically highlights the importance of safe and hygienic facilities with proper disposal and treatment of sludge from on-site installations (septic tanks, pit latrines, etc.) and proper operation and maintenance (O&M) of all sanitary facilities. Furthermore, it explicitly states that cities and states must issue policies and technical solutions that address onsite sanitation, including the safe confinement of faecal sludge (FS) (USAID, 2010). The objectives of NUSP are to be realized through CSPs and state sanitation strategies. As of now there are very few cities, which have finalized their CSPs, and those plans are also not implemented. This remains a major drawback in implementation of NUSP.

The advisory note on septage management in urban India, issued by MoUD in 2013, recommends supplementing CSPs with Septage Management Sub-Plan (SMP) as a part of CSP, being prepared and implemented by cities. Septage here broadly refers to not only FS removed from septic tanks but also that removed from pit latrines and similar on-site toilets. This advisory provides references to Central Public Health & Environmental Engineering Organisation (CPHEEO) guidelines, Bureau of Indian Standard (BIS) standards, and other resources that users of this advisory may refer for details while preparing their SMP (MoUD, 2013). It clearly discusses on techno- managerial and socio- economic aspects of septage management in India and provides guidelines for Urban Local Bodies (ULBs) to plan and implement SMP.

There are no specific legal provisions relating to septage management, but there are a number of provisions relating to sanitation services and environmental regulations, which majorly stems from, The Environment (Protection) Act, 1986 and the Water (Prevention and Control of Pollution) Act, 1974. It also applies to households and cities with regard to disposing wastes into the environment. ULBs/ utilities also have to comply with discharge norms for effluent released from sewage treatment plants and to pay water cess under the Water Cess Act, 1977. The ULB is responsible for ensuring the safe handling and disposal of septage generated within its boundaries, for complying with the Water Act for meeting all state permit requirements and regulations (CSE, 2010). Municipal acts and regulations usually refer to management of solid and liquid wastes but may not provide detailed rules for septage management (MoUD, 2013).

The Prohibition of Employment as Manual Scavengers and their Rehabilitation Act is enacted in 2013. This act prohibits employment of manual scavengers and installation of insanitary latrines. It has laid strong emphasis on rehabilitation of manual scavengers. This act has become instrumental in eradicating manual scavenging from India.

2.1.2 Policies, legislations and regulations at state level and ULB level

According to Constitution of India, water and sanitation is a state subject. Statutory powers are conferred to the state for making laws on water and sanitation.

There is no specific state sanitation policy for Andhra Pradesh, but the state follows the approaches advocated in the NUSP. State sanitation strategy is being developed. There are no specific laws and regulations on septage management at state level. However municipal laws have partly addressed aspects of septage management. Some of them are listed below:

a. Andhra Pradesh Municipalities Act, 1965
The act governs the structure and management of municipalities in Andhra Pradesh. Provisions for sanitation have been listed here.

Part V, Chapter 1 of Andhra Pradesh Municipalities Act, 1965 states the following:
"*All house drains whether within or outside the premises to which they belong and all private latrines and cess pools within the municipality shall be under the control of the council but shall be altered, repaired, cleaned and kept in proper order at the expense of the owner of the premises to which the same belong or for the use of which those were constructed and in conformity with by-laws and regulations framed by the council in this behalf "* (GoAP,1965) .

Act clearly recommends constructing septic tanks and cesspools in accordance with the by-laws and regulations.

b. Andhra Pradesh Building Rules, 2012
Andhra Pradesh Government have issued comprehensive building rules and other related rules which are applicable to Municipal Corporations, Municipalities, Nagar Panchayats and areas covered by urban development authorities in the State. These building rules are regulating the building activities in above areas.

The by-law states that the work of other building services like sanitation, plumbing, lifts, electrical installations, and other utility services shall be as per National Building Code standards and shall be executed under the planning, design and supervision of qualified and competent technical personnel.

2.1.3 Institutional roles

The MoUD is the nodal ministry for policy formulation and guidance for the urban water supply and sewerage sector. The ministry's responsibilities include broad policy formulation, institutional and legal frameworks, setting standards and norms, monitoring, promotion of new strategies, coordination and support to state programmes through institutional expertise and finance. The ministry is also responsible for managing international sources of finance. The Central Public Health and Environmental Engineering Organisation (CPHEEO), created in 1953, is the technical wing of the MoUD, which advises the ministry in all technical matters and collaborates with the State Agencies about water supply and sanitation activities. CPHEEO plays a critical role in externally funded and special programmes. CPHEEO also plays a central role in setting design standards and norms for urban water supply and sanitation (Planning Commission, 2002).

Table 2: Institutional roles and responsibilities

Institution	Roles and responsibilities
Municipal Administration & Urban Development (MA&UDD)	It is responsible for policy formulation, preparation of municipal laws, monitoring and evaluation of programmes, supervision of municipal administration, coordination with related state government departments, liaison with the central government and external funding agencies etc.
Commissioner & Director of Municipal Administration (CD&MA)	It is the executive arm of MA&UDD and is responsible for the implementation of laws, policies and programmes relating to the urban sector. It is responsible for administrative and financial management of municipalities, implementation of development programmes like Integrated Development of Small and Medium Towns (IDSMT), Swarna Jayanti Shahari Rozgar Yojana (SJSRY), Urban infrastructure Development Scheme for Small & Medium Towns (UIDSSMT), Integrated Housing and Slum Development Programme (IHSDP), Integrated Low Cost Sanitation (ILCS) etc. The CD&MA acts as a conduit between the municipalities and the government and provide guidance, help and assistance to all local bodies.
Public Health and Municipal Engineering Department (PHMED)	It provides technical support to local bodies in execution of engineering works like water supply schemes, drainage and sewerage works, major roads, etc. Apart from executing capital projects, the department also provides technical guidance to ULBs in preparation and execution of similar schemes.
Andhra Pradesh Pollution Control Board (APPCB)	Advises state on pollution related standards and policies. Monitoring of treatment plants. Key regulator for pollution related issues.
Andhra Pradesh Urban Finance and Infrastructure Development Corporation (APUFIDC)	It extends technical assistance to the local bodies in the preparation and implementation of development schemes and is designated the State Level Nodal Agency for JNNURM. It acts as a conduit between the ULBs, the Government of India and financing agencies like Housing and Urban Development Corporation (HUDCO). The corporation, on behalf of the municipalities borrows loans from financial institutions and acts as a financial intermediary.
Directorate of Town and Country Planning (DTCP)	It is responsible for the planning orderly growth of cities and towns, preparation of master plans, its review and revision, preparation of regional development plans, etc.
Srikakulam Municipality	Responsible for operation and maintenance (O&M) of urban infrastructure. Development control. Overall management of the civic services in the city. Responsible for septage emptying and transportation and disposal.

The 74th Constitutional Amendment Act of 1992 reformed the sector by transferring responsibility for domestic, industrial, and commercial water supply and sewerage (WSS) from state agencies, such as Departments of Public Health Engineering and State Water Boards, to Urban Local Bodies (ULBs). This transfer has resulted in a variety of implementation models, as well as lack of clarity in allocation of roles and responsibilities between state and local agencies, which sometimes leave large gaps in implementation (USAID, 2010).

Management and delivery of urban basic services in Andhra Pradesh is governed by various institutions. Table-2 provides roles and responsibilities of various institutions responsible for policy making, service provision and regulation of urban services.

A host of institutions are involved in management of sanitation activities with varying roles. While most of the state level institutions are responsible for policy setting, oversight and monitoring, PHMED and municipality are responsible for actual implementation. The municipal acts place most of the responsibilities in the area of sanitation to the municipality.

2.1.4 Service provision

Institutional arrangements for water supply and sanitation in Indian cities vary greatly. Typically, a state-level agency is in charge of planning and investment, while the local government (Urban Local Bodies) is in charge of operation and maintenance (NIUA, 2005). Some of the larger cities have developed municipal water and sanitation utilities that are legally and financially separated from the local government. However, these utilities remain weak in terms of financial capacity. In spite of decentralization, ULBs remain dependent on capital subsidies from state governments. Tariffs are also set by state governments, which often even subsidize operating costs (Planning Commission, 2002a).

Furthermore, when no separate utility exists, there is no separation of accounts for different activities within a municipality. Some states and cities have non-typical institutional arrangements. For example, in Rajasthan the sector is more centralized and the state government is also in charge of operation and maintenance, while in Mumbai the sector is more decentralized and local government is also in charge of planning and investment (NIUA, 2005).

In Srikakulam, PHMED is responsible for planning, designing, construction of sewerage network. Municipality is responsible for operation and maintenance of sewerage network. Public health and sanitation is delivered by the municipality through the environmental engineering and health department of the municipality. Municipality don't do any activity related to septage management. There is absolutely no regulation of private emptiers. Even though sanitation is an obligatory responsibility of a ULB, septage management is often neglected.

2.1.5 Service standards

1. Service Level Benchmarks (SLB), 2008: Issued by the Ministry of Urban Development in 2008, which seeks to (i) identify a minimum set of standard performance parameters for the water and sanitation sector that are commonly understood and used by all stakeholders across the country; (ii) define a common minimum framework for monitoring and reporting on these indicators and (iii) set out guidelines on how to operationalize this framework in a phased manner.SLB refers to improving service through better provision and delivery. It evaluates the performance of ULBs in providing urban services.

2. General Standards for Discharge of Environmental Pollutants Part-A: Effluents-The Environment (Protection) Rules, 1986 (Schedule VI): Issued by Central Pollution Control Board (CPCB), a statutory organisation constituted in September, 1974 under the Water (Prevention and Control of Pollution) Act, 1974.

3. Manual on Sewerage & Sewage Treatment, Second Edition, 2013: This manual has been developed by Central Public Health and Environmental Engineering Organization (CPHEEO).It provides detailed design and guidelines for various technologies of wastewater management.

4. Code of Practice for Installation of Septic Tanks, 1985: Issued by Bureau of Indian standards. It is a national standards setting body of India. The code specifies standards and design consideration for installation of septic tanks.

3 Service outcomes

Service outcome analysis is based on secondary sources. Two key sources of data are; Census of India, 2011 and draft CSP, 2014. The data is crosschecked and updated by Key Informant Interviews (KIIs). Data on containment is available in the Census. Data on emptying, transport and treatment is collected by KIIs. However, most of the data is qualitative. Draft report of City Sanitation Plan helped to understand the current situation of service delivery chain. No/negligible sewerage system exists; hence, majority of the population of Srikakulam is dependent on-site sanitation system.

3.1 Overview

This section presents the range of sanitation technologies/infrastructure, methods and services designed to support the management of FS and/or wastewater (WW) through sanitation service chain in Srikakulam. The details on quantitative estimations are presented in table below and following sections:

Table 3: Sanitation technologies and contribution of excreta in terms of percentage of population

S. No.	Sanitation technologies and systems as defined by:		SFD reference variable	Percentage of population
	Census of India	SFD promotion initiative		
1	Piped sewer system	User interface discharges directly to centralized separate sewer	T1A1C2	5%
2	Septic tank	Septic tank connected to open drain or storm sewer	T1A2C6	73.6%
3	Other systems	User interface discharges directly to open ground	T1A1C8	0.6%
4	Pit latrine with slab	Lined pit with semi-permeable walls and open bottom, no outlet or overflow, significant risk	T2A5C10	2.6%
5	Pit latrine without slab	Unlined pit no outlet or overflow, significant risk	T2A6C10	0.1%
6	Night soil disposed into open drain	User interface discharges directly to open drain or storm drain	T1A1C6	0.7%
7	Service latrine	User interface discharges directly to ‘don’t know where’	T1A1C9	0.6%
8	Public latrine	Septic tank connected to open drain or storm sewer	T1A2C6	2.2%
9	Open defecation	Open Defecation	T1B11C7 TO C9	14.7%

3.1.1 Sanitation facilities

This section presents existing sanitation facilities apart from household toilets.

Community toilets and Public toilets:
In Srikakulam, 2.2 % of population is dependent on community/public toilets. According to CSP there are 16 community/public toilets with 132 seats. All the toilets are connected to septic tanks (MA&UDD, 2011).

Institutional sanitation:
There are total 38 schools, 7 high schools, and 31 elementary schools. It is reported that there are no sanitary facilities available for students and staff. The ones which are available are damaged or are in bad condition (MA&UDD, 2011). Data on sanitation of these institutions is not available and hence not considered in making the SFDs.

Industrial areas/ Commercial areas:
It is observed that sanitation situation in market, commercial and public areas is quite poor. One of the community toilets is located at Rythubazar lane and managed by the marketing and horticulture department of the state government. The market area has a community toilet with 4 seats along with 8 bathrooms and 1 restroom. Open spaces around the market area are used for urination (MA&UDD, 2011).

Hospitals:
There is only one government hospital and 31 private hospitals in the town. There are three urban health centers. And there are no dispensaries in the town (MA&UDD, 2011). Data on sanitation of these institutions is not available and hence not considered in making the SFDs.

Due to the lack of data on excreta generated from institutions, industrial areas, restaurants and hotels. These establishments have not been taken into consideration for production of SFD. The excreta from public toilets and residential areas are considered for this study.

3.1.2 Containment

There is limited sewerage network, which conveys wastewater to open drains flowing through the city. The city is majorly dependent on septic tanks (75%) (SM, 2015a). The effluent from the septic tank flows into open drains. Some households are also connected to the pits. Wastewater generated from the households discharge into open drains. It was observed during the visit to the city that, size, location, and design of on-site systems are majorly dependent on the space available, the practice followed in the particular area from a long time and prerogative of local masons (SM, 2015b). The septic tanks constructed are generally not adhering to design prescribed by Bureau of Indian Standards (BIS) (SM, 2015a).

The commonly found pit toilets are made of concrete rings placed one above the other. These are a kind of prefabricated tanks. People prefer using concrete rings over constructing tanks, as rings are inexpensive and easily replaceable (Brahmaiah, 2015).

Figure 2: Prefabricated pits (Source Rahul/CSE 2015)

3.1.3 Emptying

Septage from septic tanks and pit latrines is emptied by the private emptiers using vacuum tankers. Private emptiers are solely responsible for emptying services (SM, 2015a).There are five private emptiers in the city operating with a fleet of seven vacuum tankers of 5000 litres capacity each. The emptying fees range from INR 1500 to 2500 (23 to 39 USD) per trip (Nagesh, 2015). During a visit to the city, it was observed that private emptiers use innovative marketing strategies to attract customers. Eye catchy wall paint advertisements of various private emptiers contacts are found on house's exterior walls. This actually shows extent of competition between private emptiers. There are no instances of manual scavenging reported.

Emptying work is done mechanically. Generally, there are 2-3 persons; one driver, one operator and the rest are helpers. There is no provision/usage of gloves, boots or masks or any other safety gears (Madhu, 2015). Though more than 70% of city's population is dependent on onsite sanitation systems (OSS), septage management has not got due attention by the municipality (SM, 2015a).

Figure 3: Wall poster of septic tank emptying service in local language

(Source: Rahul/CSE, 2015)

3.1.4 Transportation

Septage is transported by truck mounted vacuum tankers. The private emptiers travel 5-10 km outskirt of city to discharge septage into agricultural lands. Sewage is coneveyed through open drains.

Figure 4: Private vacuum tanker (Source: Rahul/CSE, 2015)

3.1.5 Treatment and Disposal

As there is no treatment facility for wastewater all the wastewater generated is disposed into Nagavali River, which is also a source of potable water (SM, 2015a). There is no disposal or treatment facility for septage as well. Private emptiers dispose septage outside the town on dry lands. Dried septage is used as compost (soil conditioner) in farms. It is generally used for cultivating paddy and eucalyptus trees (Rayudu, 2015).

3.2 SFD matrix

The final SFD for Srikakulam is presented in appendix 7.3.

3.2.1 SFD matrix explanation

According to Census of India, 2011, only 7% of city is dependent on offsite systems, population connected to sewer line is 5% and user interface directly discharging in open drain or open ground is only 2%, but since there's no treatment it is considered as unsafe. Around 78% of the city is dependent on OSS, out of which 76% are dependent on septic tanks and 2% on pits. The public latrines are connected to septic tanks and hence are incorporated in onsite systems. FS from OSS is not contained as the septic tanks are connected to open drains and pits are polluting the ground water.

It is difficult to determine the percentage of effluent and septage produced from septic tanks, hence it's assumed to be 50% each to reduce error in estimation. Therefore, 38% of FS, which is effluent, goes into open drain and rest is emptied from tanks whenever full. Some FS is always left in the tanks and is assumed to be 5%.There is no treatment of wastewater and septage, therefore the whole system is unsafely managed, which also includes 15% of city that defecates in open.Definition and estimation of different variables (used to make SFD) is explained below.

Table 4: Description of variables used in SFD

Variable	Description
W2	WW contained centralized (offsite)
W15	WW not contained (offsite)
W11	WW not delivered to treatment
W11a	WW not delivered to centralized treatment plant
W11c	WW not contained not delivered to treatment plant
F10	FS not contained (onsite)
F3	FS emptied
F3b	FS not contained- emptied
F15	FS not contained- not emptied
F11	FS not delivered to treatment
OD9	Open Defecation

Assuming Census figures are correct; W2 is estimated to be around 5%. W15 is rounded off as 2%, as it includes WW discharged in open drains i.e. 0.7%, WW discharged on open ground (defined as other systems in Census) i.e. 0.6% and WW from service latrines i.e. 0.6%. 38% of FS, that is effluent from septic tanks, is discharged into open drains, hence WW which is not contained and not delivered to treatment plant comes out to be 40%, therefore W11c=40%. Total WW not delivered to treatment plant, i.e. W11 comes out to be 45% (W11=W11a+W11c).

F10 is estimated to be around 78% which constitutes of 76 % population dependent on septic tanks, 2.6% dependent on Lined pits with semi-permeable walls and open bottom and 0.1% dependent on unlined pits. Since there is no clear demarcation in quantity of solid FS generated and effluent/infiltration generated from an onsite system, it is assumed to be 50% each. It is also assumed that 90% of population (dependent on onsite systems) gets their system emptied when full. Therefore out of 78% OSS dependent population, FS of 35% population gets emptied, therefore F3b=35%. Since there is no FS treatment, the emptied FS is discharged untreated in environment therefore F11 comes out to be 35%. Since there's some sludge always left in the tanks and pits, F15 is estimated to be 5%. Around 15% of population practice open defecation and hence OD9 is computed to be 15%.

It can be concluded that excreta of 100% of population is not managed safely in Srikakulam city. The following table summarizes the percentages of the population using each sanitation technology and method along the service chain.

Table 5: Percentage of the population using each system technology and method

System type	Containment	Emptying	Transport	Treatment	End-use/ disposal
Offsite	T1A1C2 (Reference L1): 5% of the population is connected to centralised sewer, hence W2 is 5%. T1A1C6 (Reference L4): 0.7 % of the population is discharging their excreta directly to open drain. T1A1C8 & T1A1C9 (Reference L5): 0.6% of the population is discharging their excreta directly to open ground and 0.6% discharging-don't know where. Total WW not contained (offsite), i.e.W15, adds up to 2%.	Not Applicable.	All the WW via sewers would be eventually discharged to open drain, hence W11a=5% WW not contained, delivered to centralised treatment plant, i.e. W4c is zero WW not contained not delivered to centralised treatment plants, i.e. W11c, is 40% which includes 35% of effluent from OSS. Total WW not delivered to treatment plant, i.e. W11, is 45%.	No WW treatment plant hence no treatment	Untreated WW is disposed in river and also used for irrigation sometimes. WW, which is not contained, and disposed untreated in local area comes out to be 45%
Onsite	78% of population is dependent on onsite sanitation systems, since none of the systems are contained, F10, FS not contained is 78% T1A2C6 (Reference L8): 76% of population is dependent on septic tanks connected to open drain T2A5C10 (Reference S4):2.6% of population is dependent on lined pit with semi permeable walls and open bottom T2A6C10 (Reference S4):0.1% of population is dependent on unlined pit	Since most of the population is getting their systems emptied, it is assumed 90% of population has their onsite technology emptied. Since there is no clear differentiation between % of septage and effluent, it is assumed to be 50% each. FS not contained-emptied, i.e. F3b comes out to be 35% and FS not contained-not emptied, i.e. F15 becomes 5%.	FS not delivered to treatment plant, i.e.F11, comes out to be 35%.	No FS treatment facility exists	All the FS along with WW without treatment ends up in river.
Open Defecation	15% of population practice open defecation and hence OD9 is computed to be 15%.				

3.2.2 Risk of groundwater contamination

The town is located along the river bank of Nagavali on a fairly sloping ground with gentle slope towards the river. The average ground level of the town is about 16.5 m above the mean sea level. The soil is generally mixed with red earth and clay (MA&UDD, 2011).

The area is underlined by sand strata, and groundwater occurs in confined conditions from 3 to 10 mbgl. The ground water level is recorded as 4.52 mbgl in May, 2015(GWD, 2015). However, the ground water available in the area is not potable, rendering the water unfit for human consumption. Therefore, protected water is being supplied through piped system from infiltration wells with Nagavali River as the source (SM, 2015c).

As the ground water table is high and the pit latrines are prevalent. There may be chances of contamination .But there is no data available to quantify the level of contamination.

4 Stakeholder engagement

4.1 Key informant interviews

The relevant departments were contacted through e-mail, letter, call and fax prior to visit to the city. The purpose of the SFD study and depth of data required was conveyed through introductory letter to respective departments. Overall, 8 KIIs were conducted with different stakeholders like government functionaries, private emptiers, (see appendix 7.2). The GoAP operate through its MA&UD department. MA&UDD is supported by C&DMA and PHMED, DTCP etc.

Limited documents were available on web hence the visit to city also helped in collecting data, including unpublished reports. The KIIs and data collected helped in understanding the existing situation and upcoming development plans in the sanitation sector. Due to limitation of desk-based study all the key stakeholders engaged in sanitation services could not be interviewed in person.

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7 Appendix

7.1 Stakeholder identification

Table 6: Stakeholder identification

No.	Stakeholders group	In Srikakulam context
1	City council / Municipal authority / Utility	Srikakulam Municipality
2	Ministry in charge of urban sanitation and sewerage	Municipal Administration and Urban Development Department, GoAP.
3	Ministry in charge of urban solid waste	Municipal Administration and Urban Development Department, GoAP.
4	Ministries in charge of urban planning finance and economic development.	Municipal Administration and Urban Development Department, GoAP.
	Ministries in charge of environmental protection/	Ministry of Environment, Forest, Science & Technology, GoAP.
	Ministries in charge of health	Ministry of Health, Medical & Family Welfare, GoAP.
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	NA
8	Market participants practising end-use of faecal sludge end products	Farmers
9	Service provider for disposal of faecal sludge (sanitary landfill management)	NA
10	External agencies associated with FSM services: e.g. NGOs, academic institutions, donors,	Private emptiers

7.2 Tracking of engagement (Tab 3: Stakeholder tracking tool)

Table 7: Tracking of engagement

Name of organisation	Name of contact person	Position	Date of engagement	Purpose of engagement
Srikakulam Municipality	Mr D.Manohar Rao	Assistant Engineer (Water supply)	06.02.2015	Information/ data collection
Srikakulam Municipality	Mr Murali Krishna	Environmental Engineer	06.02.2015	KII
Srikakulam Municipality	Mr Satyanarayana	Building Inspector	06.02.2015	KII
Srikakulam Municipality	Mr Ch.V.V.Bapi Raju	Commissioner	07.02.2015	Introduction of SFD
Srikakulam Municipality	A. Satya Murthy	Town planning officer	07.02.2015	KII
Srikakulam Municipality	P. Balaji Prasad	Sanitary Inspector	07.02.2015	KII
Ground water Department	Mr Kishore Babu	Geologist	07.02.2015	KII
National Institute of Urban Management (NIUM)	Mr S.R.S.Ratnam	Team Leader	07.02.2015	Information/ data collection
Nagesh septic cleaning	Mr Nagesh	Private emptier	07.02.2015	KII
Madhu septic cleaning	Mr Madhu	Private emptier	07.02.2015	KII
Super septic cleaning	Mr Rayudu	Private emptier	07.02.2015	Information/ data collection
NA	Mr Brahmaiah	Mason	07.02.2015	KII

7.3 SFD matrix

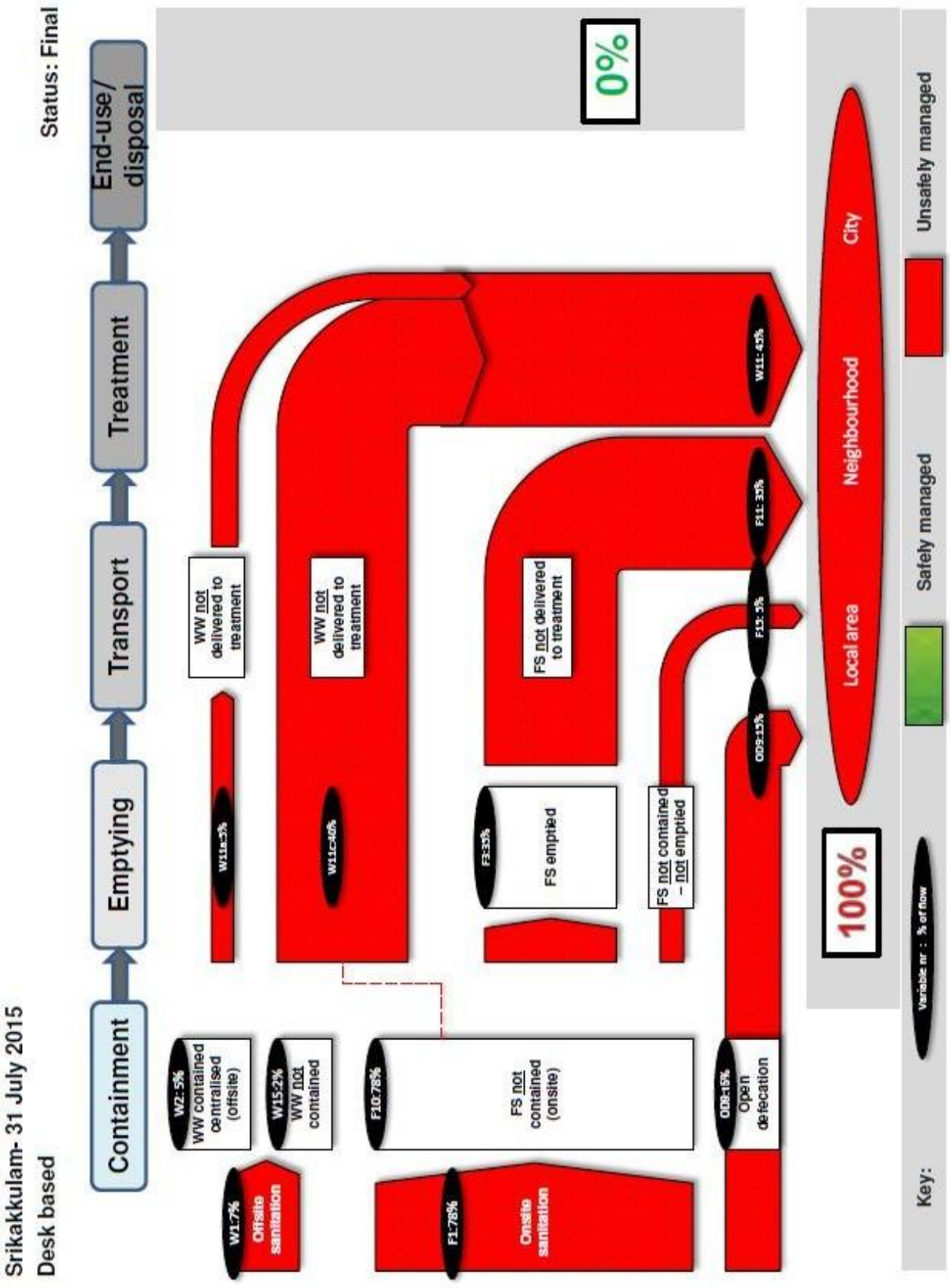

Figure 5: SFD matrix

7.4 Organogram of Srikakulam Municipality

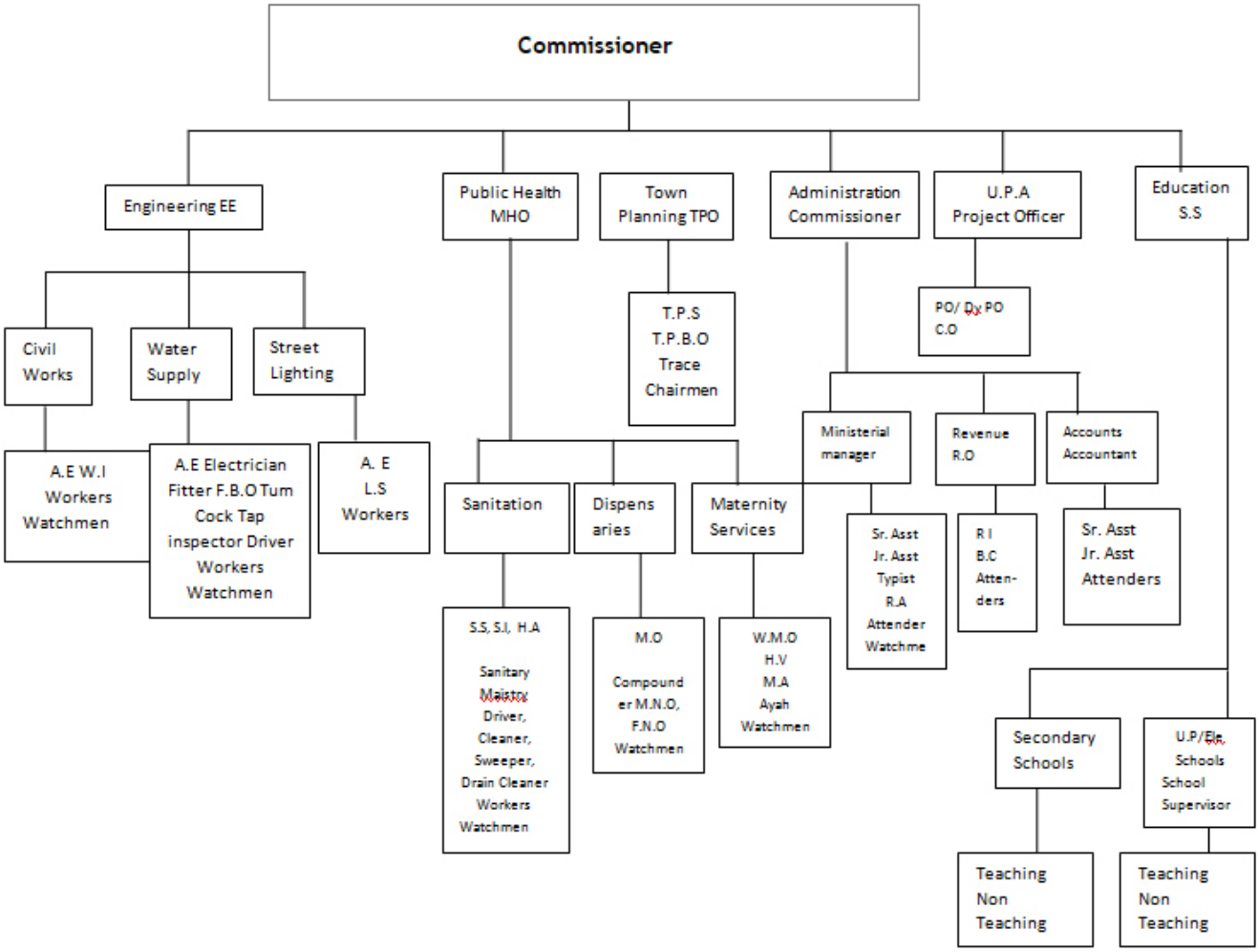

Figure 6: Organogram of Srikakulam Municipality