

# **SFD Report**

## **Bodhgaya India**

### **Final Report**

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SFD Report Bodhgaya, India, 2017

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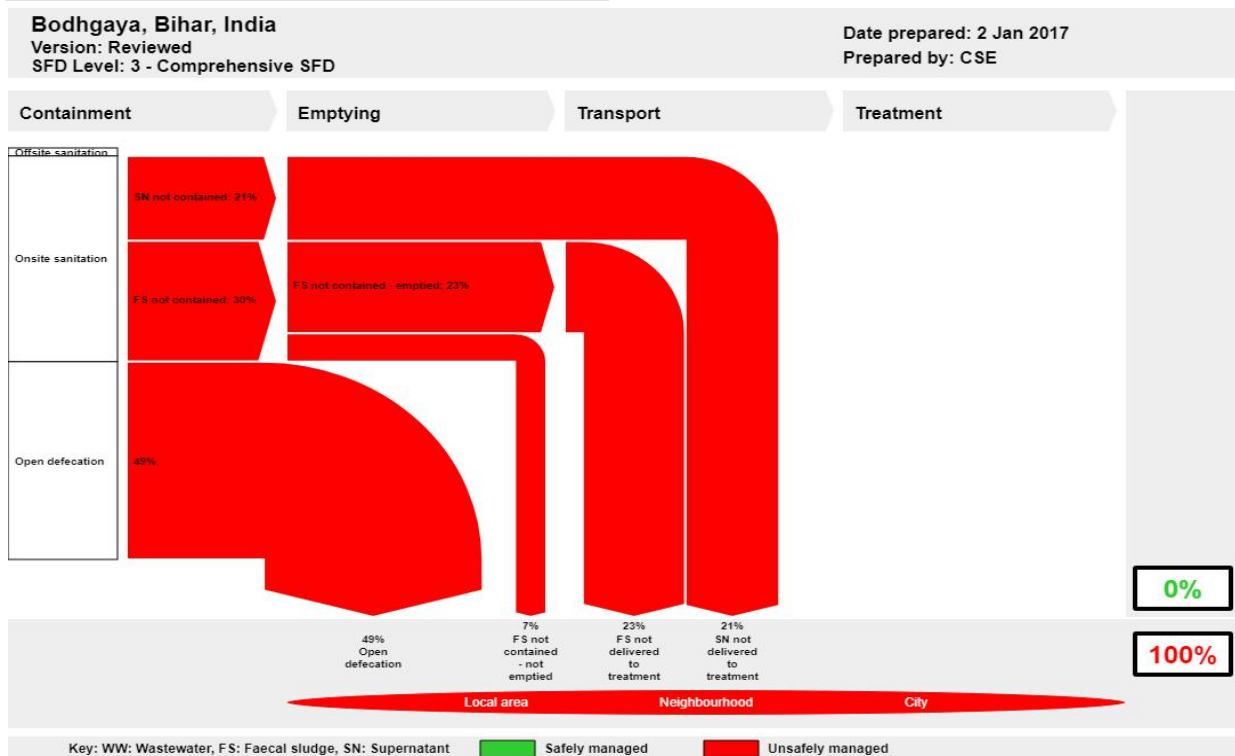
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## 1. The SFD Graphic



## 2. Diagram information

### SFD Level:

Comprehensive.

### Produced by:

Centre for Science and Environment (CSE), New Delhi with inputs from Bodhgaya Nagar Panchayat (BNP).

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The population of the city, as per Census of India, 2011 is 38,439. The population of the town as per *Saat Nischay Yojna* (Seven Resolves Scheme) survey conducted in the year 2015 is 42,862. The estimated floating population of the city is around 9,038 per day. Therefore 51,900 is the final population considered for preparation of SFD. The urban local body governing Bodhgaya is called as Bodhgaya Nagar Panchayat (BNP) which spans an area of 19.60 sq.km. The population density of Bodhgaya is 2,647 persons per sq.km which is high in comparison to the population density of Bihar state which is 1,021 persons per sq.km.

The town lies on the western bank of river Niranjana at an altitude of 113 meters above mean sea level (MSL). The temperature of Bodhgaya ranges from 48°C in summer to 4°C in winter with an average annual rainfall of 1096 mm. The humidity ranges from 36% to 90% (UDHD, 2014). Bodhgaya has a soil type of sandy loam to loam with clay (GoB, 2015).

## 3. General city information

Bodhgaya is a small town, located in the Gaya district of Bihar. It is internationally renowned for its immense religious and cultural significance. It is one of the most prominent Buddhist pilgrimage sites and houses a UNESCO World Heritage site within its boundaries. In 2002, the Mahabodhi Temple in Bodhgaya became a UNESCO World Heritage site (REEL, 2011).

## 4. Service outcomes

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

**Containment:** The city does not have a functional sewerage system. 51% of the population of Bodhgaya depends on Onsite Sanitation Systems (OSS). The following are the different types of containment systems present in the town.

Lined pit with semi-permeable walls and an open bottom is used by 9% population. It does not have an outlet. This system is prevalent in low-income settlements and at households, provided with toilets under central and state sanitation schemes.

Septic tanks connected to an open drain is used by 26% population. Out of which, 13% (assumed 50% of 26%) of the population is dependent on cylindrical shaped lined tanks, influenced by *Shankar-Balram* model, which has been recognized by Central Public Health Environment Organisation (CPHEEO). These are installed in a set of two or three tanks in series and are locally considered and called as septic tank. The total cost for installation of such tanks are INR 16,000 (245.5 USD). And the other 13% (assumed 50% of 26%) of the population is dependent on two/three chambered rectangular shape septic tanks connected to open drains which are observed in houses of middle to high-income groups, hotels, institutions and monasteries. The well-constructed standard septic tanks, rectangular in shape connected to open drains are also found in the community and public toilets. The size of the septic tank present in the public toilet at the Mahabodhi temple has a dimension of around 10.67 m x 5.33 m x 2.8 m (MBC, 2016).

Fully lined tanks connected to open drains are used by 16% of the population. In which, 8% of the population is dependent on single chambered lined tanks, rectangular in structure and another 8% of the population is dependent on cylindrical tanks.

It was observed during field visit that diurnal domestic floating population practice OD near to bus parking area and only few adults use public toilets which are available at bus stands. Hence, it is estimated that 21% of the floating population and 55% of the fixed population is practising open defecation. Hence, 49% of the total population of Bodhgaya practice open defecation.

Emptying: There are two vacuum tankers in total which are run by the BNP. Each has a capacity of 4,000 litres, out of which only one tanker is frequently used. The other tanker is used occasionally due to low demand for emptying service. The typical no. of trips covered in a day are 3 to 4.

The total no. of people involved during the emptying operation are two labourers, one driver, and one supervisor. The emptying fee charged per trip by ULB is around INR 4,000 (61.39 USD), whereas, the private emptiers charges around INR 2,000 (30 USD) per trip. At times, if the sludge in the containment becomes hard to pump out, acid and water is added to dilute the sludge in order to make the emptying process easier. Two private emptiers hail from Gaya city run their business in Bodhgaya. Manual scavengers were also

observed plying in the city during the comprehensive study.



**Figure 1: Prefabricated Septic tank (Source: Aishwarya /CSE, 2016)**

Transportation: A truck-mounted suction machine is used for emptying and transportation of faecal sludge (FS). Collected FS from containment systems are transported 3-4 km away from the city and discharged into the outskirts/ open fields of the city (BNP, 2016).



**Figure 3: Septage being discharged into open fields (Source: Aishwarya/ CSE, 2016)**

Treatment/Disposal: There is no treatment facility available for sewage and faecal sludge generated in the town. The FS collected by the vacuum tankers is discharged into open fields in a place called Katorba at the outskirts of the city (BNP, 2016).

According to Census of India, 2011, 4.2% of the city is dependent on offsite systems of which, population connected to sewer line is 4.1% and user interface discharging directly into open drain or open ground is 0.1%. But from the field survey conducted, it was observed that there is no functional sewerage in the city. The OSS is divided into two categories. The containment system in which FS is contained and one in which FS is not contained. FS is considered not contained in Bodhgaya when the FS infiltrates and pollutes the high groundwater table and also if the supernatant from the septic tank and the fully lined tank connected to open drain is discharged on the soil. 51% of the city is dependent on OSS, out of which 26% is dependent on septic tank connected to open drain, 16% on fully lined tank connected to open drain and 9% on the lined pit with semi-permeable walls and open bottom.

SN from the two systems (septic tank connected to an open drain and fully lined tank connected to an open drain) together constitutes 21%. 'FS not

contained – emptied’ comes out to be 23% (12% from septic tank connected to open drain, 7% from fully lined tank connected to open drain + 4% from the lined pit with semi-permeable walls). ‘FS not contained- not emptied’ is 7% (1% from septic tank connected to open drain + 1% from fully lined tank connected to open drain + 5% infiltrate from the lined pit with semi-permeable walls). Together they constitute 30% ‘FS not contained’.

As there is no treatment facility in Bodhgaya and since the groundwater table is high, also, the FS collected from households is indiscriminately discharged into the environment. Hence, excreta of 100% population are unsafely managed, this includes the 49% population which defecates in open.

### 5. Service delivery context

National Urban Sanitation Policy (NUSP) was issued in 2008, by the Ministry of Housing and Urban Affairs (MoHUA), formerly known as Ministry of Urban Development (MoUD). 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 state to develop state urban sanitation strategies and work with cities to develop City Sanitation Plans (CSPs).

NUSP identifies the constitution of the multi-stakeholder task force, known as city sanitation taskforce (CSTF) as one of the principal activities to be taken up to start the city sanitation planning process. CSTF has now been renamed as Swachh Bharat City Level Task Force (SBCLTF) (MoUD, 2014)

The Environment (Protection) Act, 1986 and the Water (Prevention and Control of Pollution) Act, 1974 have provisions relating to sanitation services and environmental regulations. It 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 (MoUD, 2013).

In February 2017, MoHUA issued the National Policy on Faecal Sludge and Septage Management (FSSM). The policy aims to set the context, priorities, and direction for, and to facilitate, nationwide implementation of FSSM services in all ULBs such that safe and sustainable sanitation becomes a reality for all in each and every household, street, town and city in India (MoUD, 2017).

There are various schemes launched by the central government and state government to provide basic

civic amenities including improvement of urban sanitation. Under the combined scheme of Swachh Bharath Mission (SBM) and Chief Minister’s Saat Nischay Yojna (7 resolves) to meet the same objective, a total of 530 toilets has been constructed. 170 toilets have been completed under a state scheme called Support Programme for Urban Rejuvenation (SPUR) and 360 toilets have been completed by ULB’ s fund (BNP, 2016). As per BNP a sewerage scheme (DPR) of INR 95.9 crores (15 Million USD) has been prepared under Jawaharlal Nehru National Urban Rejuvenation Mission and is currently in implementation. It has been prepared for the base year 2015 and the ultimate year 2045.

The BNP did a rapid assessment of FSM in the city to calculate the funds required for the same. It was estimated that INR 1,602.3 lakh (2.47 million USD) is required for implementation of effective FS and septage management including operation and maintenance for five years (MoUD, 2016).

### 6. Overview of stakeholders

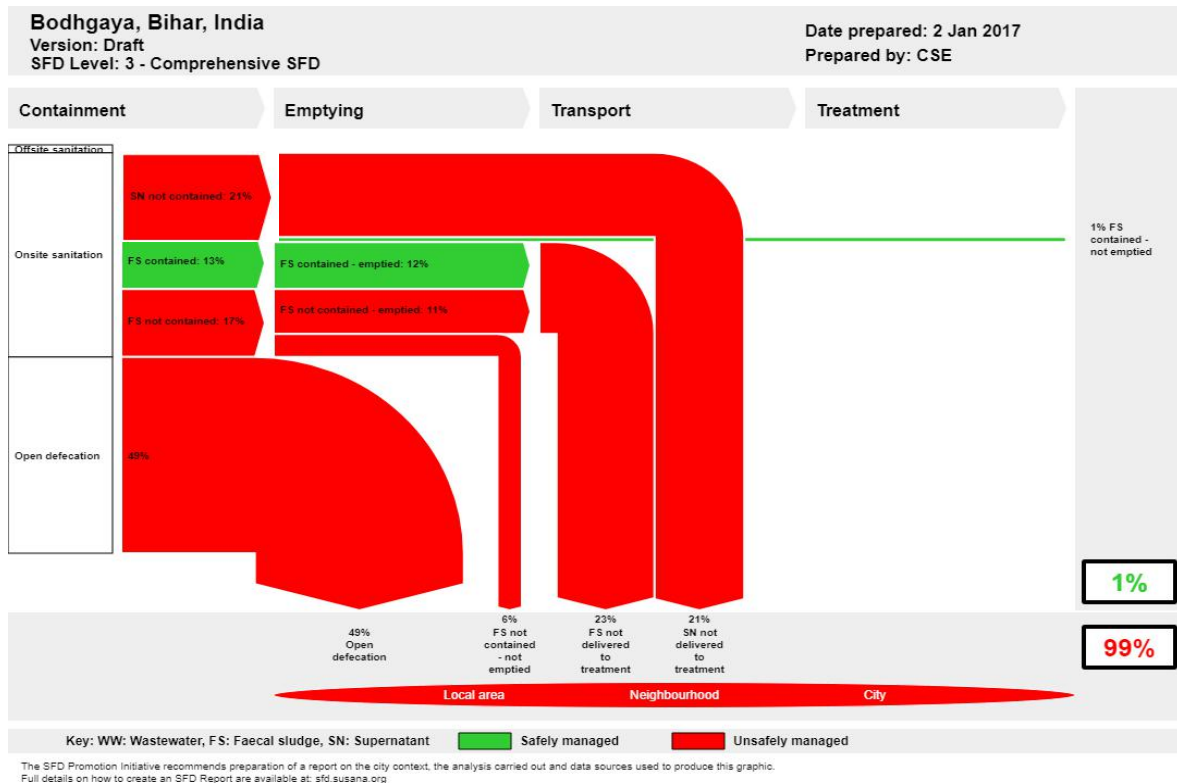
The 74<sup>th</sup> Constitutional Amendment Act of 1992 reformed the sector by transferring responsibility for domestic, industrial, and commercial water supply and sewerage (WSS) from state agencies, such as Departments of Public Health Engineering and State Water Boards, to Urban Local Bodies (ULBs).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

Public Health and Engineering Department, Bihar is responsible for ensuring access to safe water; supply of drinking water and development of sanitation facilities; constant monitoring of quality of drinking water supply; sanitation; reforming water supply and sanitation sector, UD&HD performs implementation of schemes supported by the center and state government, Reform Support Unit (RSU) implements the projects supported by DFID-SWASTH in the state of Bihar.

Key Stakeholders	Institutions / organizations
Public institutions	Public health and Engineering Department (PHED), Ministry of Housing and Urban Affairs (MoHUA), National Ganga Council (NGC), Ministry of Water Resources, River Development & Ganga Rejuvenation (MoWRDR &GR), Bihar Urban Infrastructure Development Corporation (BUIDCo), Urban Development and Housing Development (UD and HD), Support Programme for Urban Reforms (SPUR), Bihar state pollution control board (BSPCB), State Level Programme Management Group, Reform Supporting Unit (RSU)
NGOs	Centre for Science and Environment (CSE), Samuhik Vikas Samithi-community based self-help organization, Department for International Development (DFID)
Private sector	Local masons

Table 1: Key stakeholders (Source: Compiled by CSE, 2017)

## 7. Context-adapted SFD graphic



## 8. Description of context-adapted SFD

The only difference suggested in the context-adapted SFD is at containment stage for correctly designed septic tanks, though connected to open drains.

With an earlier assumption of 50% of the proportion of the content of the septic which is solid FS, generated and collected inside the septic tanks. 50% of the content is supernatant which attributes to be 21% of the population flows through open drains. The solid FS collected in the septic tank are considered to be contained and hence 13% of FS is contained (represented green in colour at containment stage). Followed by this, 12% FS contained is emptied, remaining 1% is FS remains in the tank which is contained and never emptied. The supernatant generated from the septic tank connected to open drain are not contained and hence considered to be unsafely managed (represented red in colour).

Overall, excreta of 99% population are not managed safely according to the context-adapted SFD.

## 9. Process of SFD development

Data are collected from secondary sources.

The city is visited to conduct the surveys, FGDs and KIIs with relevant stakeholders, to fill in the data gap and to cross-check the data collected.

To start with, a relationship between sanitation technologies defined in Census of India and that defined in the project is established. The survey data are quantified and cross-checked with FGDs and KIIs.

The data are fed into the SFD Graphic Generator to calculate the excreta flow in terms of percentage of the population and also produce the SFD graphic. It can be concluded that excreta of the whole population are discharged into environment untreated.

The SFD graphic of Bodhgaya city developed using the graphic generator is not able to capture the correctly designed fully functional septic tanks as a contained system, as based on feedback from SBCLTF. Hence, the city-specific context-adapted SFD graphic is manually corrected to convey the substantial picture of the excreta management in the city.

## 10. Credibility of data

Two key sources of data are used; Census of India, 2011 and published documents of relevant departments. Most of the data are then updated by KIIs. Overall three Key Informant Interviews and

five Focus Group Discussions have been conducted with different stakeholders.

There were three major challenges to develop the SFD. Published/unpublished reports were not able to provide (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 provided by secondary sources.

Published/unpublished reports mostly differentiate between systems connected to the user interface, if any, but does not give information about the design of actual containment systems on ground level or about the disposal of septage and wastewater generated.

Therefore, a random household survey was conducted in few wards of the city to identify and cross-check the data collected from the secondary sources.

The objective of the survey conducted was to obtain a more accurate measure of how excreta are managed through stages of sanitation service chain (from containment to end-use or disposal). For the validation of the SFD prepared for the city, the graphic (refer section 1) was presented in an SBCLTF meeting. Based on their feedback, a context-adapted SFD graphic is prepared.

## 11. 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
  - Groundwater Year Book, Central Groundwater Board, 2014
  - City Sanitation Plan for Bodhgaya, GoB, 2014
  - City Development Plan, (2010- 2030)
- KIIs with representatives from
  - Head representative of Samuhik Vikas Samithi (NGO)
  - Mahabodhi Temple Manager
  - Bihar State Tourism Development. Corp LTD.
- FGDs
  - BNP staff
  - BNP emptiers and transport in charge
  - Slum dweller representatives
  - SBCLTF members
  - Local masons
- Random household survey

Bodhgaya, India, 2017

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## Abbreviations

AMRUT	Atal Mission for Rejuvenation and Urban Transformation
BIS	Bureau of Indian Standard
BNP	Bodhgaya Nagar Panchayat
CAPEX	Capital Expenditure
CGWB	Central Ground Water Board
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health & Environmental Engineering Organization
CSE	Centre for Science and Environment
CSTF	City Sanitation Task Force
DFID	Department for International Development
DUDA	District Urban Development Authority
DPR	Detailed Project Report
EWS	Economically Weaker Sections
FGD	Focus Group Discussion
FS	Faecal Sludge
FSM	Faecal Sludge Management
FSSM	Faecal Sludge and Septage Management
GoI	Government of India
HFA	Housing For All
INR	Indian National Rupee (INR = 66.5 USD)
KII	Key Informant Interview
LPCD	Litres per Capita per Day
MHUPA	Ministry of Housing and Urban Poverty Alleviation
MIS	Management Information System
MLD	Million Litres per Day
MoHUA	Ministry of Housing and Urban Affairs (Formerly known as MoUD)
MoUD	Ministry of Urban Development
MWRRD &GR	Ministry of Water Resources, River Development and Ganga Rejuvenation
MSL	Mean Sea Level
NIC	National Informatics Centre
NIUA	National Institute of Urban Affairs
NITI	National Institution for Transforming India (Formerly Known as Planning Commission)
NMCG	National Mission for Clean Ganga
OD	Open Defecation
OPEX	Operational Expenditure
OSS	Onsite Sanitation System
PMAY	Pradhan Mantri AwasYojna
PPE	Personal Protective Equipment
RSU	Reform Supporting Unit
SBM	Swachh Bharat Mission
SBCLTF	Swachh Bharat City Level Task Force (Sanitation Task Force)
SFD	Shit Flow Diagram
SLB	Service Level Benchmarks



SLIP	Service Level Improvement Plans
SN	Supernatant
SPUR	Support Program for Urban Rejuvenation
Sq.km.	Square kilometre
STP	Sewage Treatment Plant
SWASTH	Sector Wide Approach to Strengthen Health
SWM	Solid Waste Management
UDHD	Urban Development & Housing Department
ULB	Urban Local Body
USAID	United States Agency for International Department
WSS	Water Supply and Sewerage
WW	Waste Water

## 1 City context

Bodhgaya is a small town, located in the Gaya district of Bihar. It is internationally renowned for its immense religious and cultural significance. It is one of the most prominent Buddhist pilgrimage sites and houses a UNESCO World Heritage site within its boundaries. In 2002, Mahabodhi Temple, located in Bodhgaya, became a UNESCO world heritage site (REEL, 2011).

The population of the city, as per Census of India, 2011 is 38,439. The population of the town as per *Saat Nischay Yojna* (Seven Resolves Mission) survey conducted in the year 2015 is 42,862. A population of 1,264,329 persons visited the city in the year 2016. During the peak season of tourists, i.e. around six months of the year on an average 9,038 persons visited per day (BSTD, 2017), please refer Table 2. Hence, for this study the floating population is assumed to be 9,038 per day. On adding the floating population (9,038) to the permanent population (42,862), as per *Saat Nischay Yojna*, final population considered for the preparation of SFD is 51,900. These figures were calculated in consensus with city officials and other relevant stakeholders.

The Urban local Body governing Bodhgaya is called as Bodhgaya Nagar Panchayat (BNP) or Bodhgaya Municipal Council spanning an area of 19.60 sq. km. There are 19 wards in the city, among which ward no.17 is the most populous ward with a population of 3,386 and ward no.4 is the least populous ward with a population of 1,229. The population density of the town is 2647 persons per sq.km which are high in comparison to the population density of Bihar which is 1,102 persons per sq.km. The total slum population of Bodhgaya is 17,704 which is 46.05 % of the total population.

Table 1: Population growth rate

Census year	Population	Decadal growth rate (%)
1961	6,299	0
1971	6,968	10.62
1981	15,724	125.66
1991	21,692	37.95
2001	30,857	42.25
2011	38,439	24.56

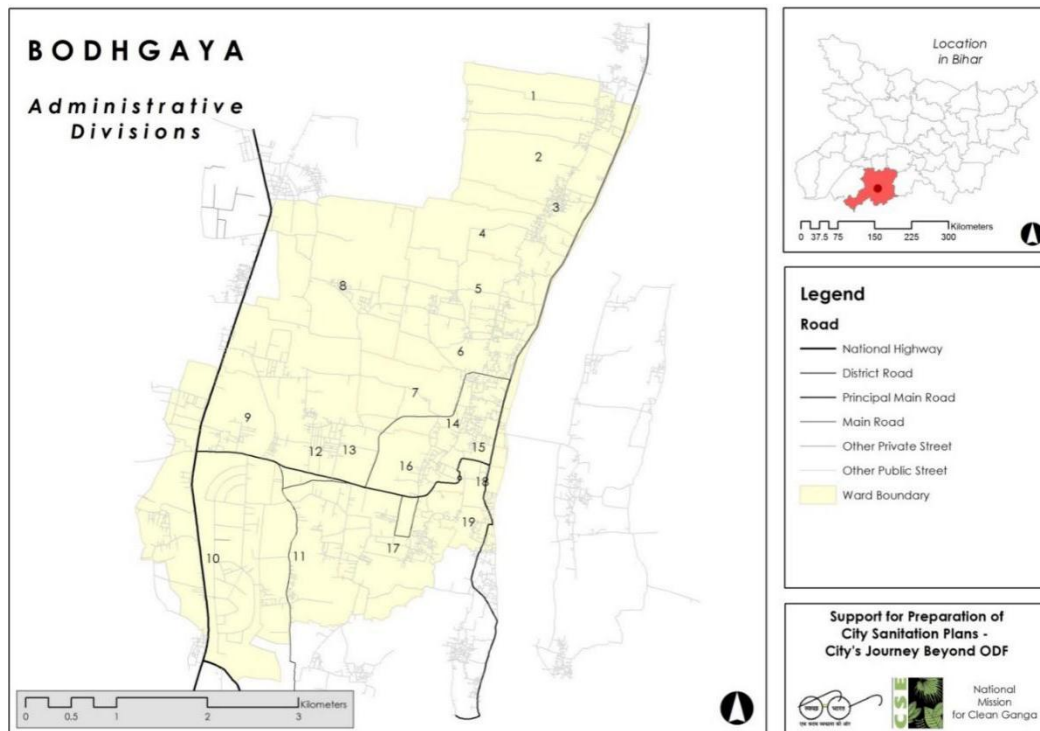
Source: Census, 2011

Its geographical location is 24° 41' 45" N. latitude and 85° 2' 22" E longitude. It is located in the transit region between the Chota Nagpur plateau and the alluvial Gangetic plains of South Bihar. Topographically, Bodhgaya lies on the western bank of river Niranjana at an average altitude of 113 meters above the Mean Sea Level (MSL). The high lands are generally in the south and the low lands in the north (UDHD, 2014). The temperature of Bodhgaya ranges from 48°C in summer to 4°C in winter with an average annual rainfall of 1096 mm. The humidity ranges from 36% to 90% with an average of 70%. Bihar is divided into three agroclimatic zones and Bodhgaya lies in Zone III. Therefore it is characterized by a soil type of sandy loam to loam with clay (GoB, 2015).

**Table 2: Floating population**

Floating population in the Year 2016		
Floating population	1,264,329	
International tourist	162,952	
Peak floating months		
Months	Domestic tourist	International tourist
January	186723	14283
February	67664	22638
September	219212	10514
October	68576	16913
November	59661	17077
December	113473	21219
<b>Total</b>	715309	102644
<b>Gross</b>	817,953	
Average daily floating population	<b>9038</b>	

Source: Ministry of Tourism, 2018



**Figure 1: Ward map of Bodhgaya Nagar Panchayat** (Source: CSE, 2016)

## 2 Service outcomes

The analysis is based on data available from Census, 2011, *Saat Nischay Yojna*, published reports of government, non-profit organizations and random household survey. Data collected from secondary sources are triangulated in the field-based study. Data on the containment are available in Census of India, 2011. Data have 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 wards are examined through random household survey (Table 4). Data on emptying, transport, treatment and disposal of faecal sludge are collected through KIIs with ULB, private emptiers and parastatal body. However, most of the data are qualitative.

### 2.1 Overview

To start with, a relationship between sanitation technologies defined in Census of India and the variables defined in the project is established. Then the population dependent on those systems is represented in terms of percentage of the population, as shown in Table 3 below:

**Table 3: Sanitation technologies and corresponding percentages of population from Census**

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 a centralized foul/separate sewer.	T1A1C2	4.1
2	Septic tank	Septic tank connected to open drain or storm sewer	T1A2C6	28.8
3	Other Systems	User interface discharges directly to open ground	T1A2C8	1.4
4	Pit latrine with slab	Lined pit with semi-permeable walls and an open bottom, no outlet or overflow, the general situation	T1A5C10	2.2
5	Pit latrine without slab	Unlined pit no outlet or overflow, the general situation	T1A6C10	3.6
6	Night soil disposed into open drain	User interface discharges directly to open drain or storm drain	T1A1C6	0.1
7	Service latrine	User interface discharges directly to 'don't know where'	T1A1C9	0.1
8	Public latrine	Septic tank connected to open drain or storm sewer	T1A2C6	4.9
9	Open defecation	Open defecation	T1B11C7 TO C9	54.7

Source: Census of India, 2011

Sanitation technologies and corresponding percentages of the population obtained from Census of India is triangulated with household surveys and key informant interviews. The study revealed the type of containment systems with the corresponding population and is depicted in Table 4.



**Table 4: Triangulation of Census data (fixed population only) with data from random HHs survey**

S. No.	Sanitation technologies and systems as defined by:	Percentage of Population	Clubbing of containment systems after field-based study	Percentages of containment system
	Census of India			
1	Piped sewer system	4.1	Lined pits with semi-permeable walls and open bottom	11
2	Other Systems	1.4		
3	Pit latrine with slab	2.2		
4	Pit latrine without slab	3.6		
5	Night soil disposed into open drain	0.1		
6	Service latrine	0.1		
7	Public latrine	4.9	Septic tank connected to an open drain	5
8	Septic tank	28.8	Fully lined tank connected to an open drain + Septic tank connected to an open drain	29
9	Open defecation	54.7	Open defecation	55

Source: Compiled by CSE, 2016

For SFD preparation, the total population considered is 51,900. Due to lack of enumeration on actual type of containment system present on ground hereof systems are clubbed in the table 4; 11% of the population is estimated to be connected with lined pits semi permeable walls and open bottom, this assumption is taken based on the KII and focus group discussion with emptiers, masons and BNP.

**Table 5: Type of systems assumed for floating population**

Floating population	Description of assumptions made	System assumed	Relative population
Out of total floating population, 13% is International population:	This population is considered to be stay in hotels, monasteries and guest houses who have toilets connected to septic tanks.	Septic tank	13%
Remaining 87% of the population is domestic population	50% of the domestic floating population ie. 44% of the population is substantially assumed to stay in hotels and guest houses who have toilets connected to septic tanks/fully lined tanks.	Septic tank	22%
		Fully lined tanks	22%
	Rest, it is assumed that 43% is diurnal floating population who are either dependent on public/community toilets or practising open defecation. Hence, it is further assumed that 50% of 43% of population i.e 22% is catered by public and community toilets.	Septic tank	22%
	And 21% of the floating population practice open defecation at river side and in proximity of bus stand area.	Open defecation	21%

Source: Compiled by CSE, 2018

**Table 6: Final percentages of the population dependent on different types of sanitation systems**

Containment system	Fixed population (42862)		Floating population (9,038)		Final Population (51,900)	
	%	Population	%	Population	%	Population
Lined pits with semipermeable walls and open bottom	11	4,715	0	0	9	4,715
Fully lined tank connected to an open drain	14	6,000	22	1,988	16	7,988
Septic tank connected to an open drain	20	8,572	57	5,152	26	13,724
Open defecation	55	2,3575	21	1,898	49	25,473

Source: Compiled by CSE, 2018

Furtherance, the final percentages obtained from Table 6 are used for preparation of SFD graphic and context-adapted SFD graphic.

### 2.1.1 Sanitation facilities

This section presents on existing sanitation facilities in institutions, commercial establishments, slums and facilities for tourists.

*Community/public toilets:* There are five public toilets and twenty two community toilets in Bodhgaya which have the containment system of a septic tank connected to an open drain.

One of the public toilets is present at the main temple of Bodhgaya. The septic tank installed is of size 30ft (9m) \* 15ft (4.5m)\* 9ft (2.7m). There is no user fee charged for the toilet (BNP,2016).

*School sanitation:* There is a total of 33 schools in Bodhgaya, out of which, 30 are government schools and 3 are privately owned. 90% of govt. schools have toilet facilities both boys and girls. The 10% which do not have access to toilets practice open defecation in and around the school premises or use toilets at home or neighbour’s house (UDHD, 2014).

*Commercial areas:* The commercial and market areas are generally in ward nos.11,12,13,15,16 and 18. The Bodhgaya *bazaar* is the biggest market which is located around the Mahabodhi temple. Around 65-70 % of the commercial area does not have toilet facilities and most of the toilets in the commercial premises are not properly maintained (UDHD, 2014).

*Industrial areas:* Bodhgaya has a few industries which are agro-based, such as flour mills. While there is no established household industrial sector, activities such as blanket making and weaving are local crafts that are practised (UDHD, 2014).

### 2.1.2 Containment

Currently, there is no functional sewerage network in Bodhgaya which caters to the households. From the comprehensive level of study conducted in the city and percentages of population dependent on the types of system explained in section 2.1, 51% of the population of Bodhgaya is dependent on OSS. The following are the different types of containment systems present in the city.

Lined pit with semi-permeable walls and an open bottom is used by 9% population. It does not have an outlet. This system is mainly present in low-income settlements and households provided with toilets under central and state sanitation schemes.

Septic tanks connected to an open drain is used by 26% population. Out of which, 13% (assumed 50% of 26%) of the population is dependent on cylindrical shaped lined tanks, influenced by Shankar-Balram septic tank which has been recognized by Central Public Health Environment Organisation (CPHEEO). These are installed in a set of three tanks in series and are locally considered and called as septic tank. The total cost for installation of such tanks is INR 16,000 (245.5 USD). And 13% of the population is dependent on two-three chambered rectangular shape septic tanks connected to open drains which are observed in houses of middle to high-income groups, hotels, institutions and monasteries. The well-constructed standard septic tanks, rectangular in shape connected to open drains are also found in the community and public toilets. The size of the septic tank present in the public toilet at the Mahabodhi temple has a dimension of around 10.67 m x 5.33 m x 2.8 m (MBC, 2016). Hence, 26% population of the city is attributed to be dependent on septic tanks.

Fully lined tanks connected to open drains are used by 16% of the population. In which, 8% of the population is dependent on single chambered lined tanks, rectangular in structure and another 8% of the population is dependent on cylindrical tanks.

It was observed during field visit that diurnal domestic floating population practice OD near to bus parking area and few adults uses public toilets which are available at bus stands. Hence, it is estimated (refer Table 5) that 21% of the floating population and 55% of households are practising open defecation. Overall, the percentage of the population practising open defecation is 49%.

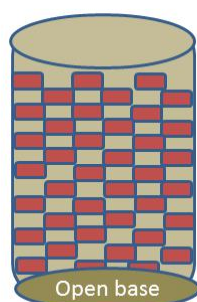


Figure 2: Representation of lined pit with semi-permeable walls (Source: CSE, 2016)



Figure 3: Prefabricated tank - locally known as septic tank (Source: Aishwarya /CSE, 2016)

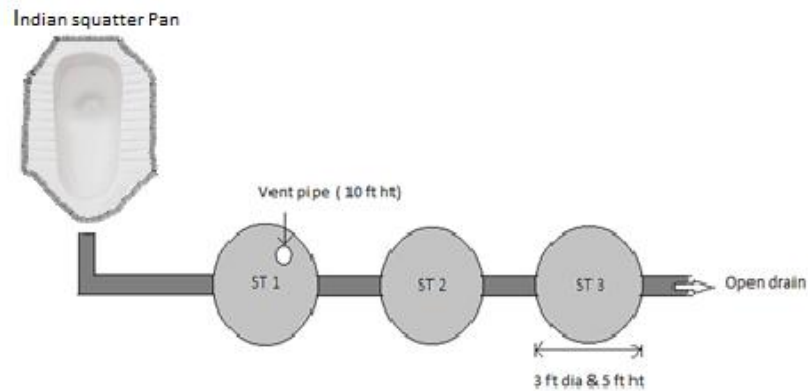


Figure 4: Top sectional view of septic tank (Shankar & Balram Model) (Source: CSE, 2016)

### 2.1.3 Emptying

There are two vacuum tankers in total which are run by the ULB each having a capacity of 4,000 litres, out of which only one tanker is frequently used. The other tanker is used occasionally due to low demand for emptying services. The typical no. of trips covered in a day are 3 to 4. The total no. of people involved during the emptying operation are two labourers, one driver, and one supervisor. The emptying fee is charged on the basis of the number of trips taken to empty a containment system. The fee to empty a containment system is INR 4,000 (61.39 USD) per trip whereas, the private emptiers charges around INR 2,000 (30 USD) per trip. At times, if the sludge in the containment becomes hard to pump out, acid and water is added to dilute the sludge in order to make the emptying process easy. As the tankers are old and lack maintenance, proper pressure is not maintained at times. This issue is dealt by flexible approach to problem-solving by using local resources like cycle rubber tubes in an innovative way. The emptiers reported that they are largely able to meet all the emptying service request on daily basis from the households and establishments (BNP, 2016). Other than that, there are two private emptiers that hail from Gaya city, operating in the city and each of them owns tractor-mounted tankers of 5,000 litres capacity.

Manual emptiers, though existing in Bodhgaya, could not be quantified, as manual cleaning/manual scavenging is a punishable act as per Manual Scavenging Act 2013 and thus shunned by the administrative agencies. However, the practice of manual cleaning, de facto, exists and is practised mainly in areas having inaccessible narrow roads which cannot be served by the mechanical emptiers. During random survey, it was also recorded that many proponents in Bodhgaya prefer manual cleaning of containment systems as the systems look “completely whitewashed”, this can be attributed to lack of awareness and warrants rigorous campaigns aiming at behaviour change. There are eight families, that are involved in the emptying business. Emptying equipment involves a 2 Hp pump, spade, shovel, hosepipe and a cycle driven cart (Manual emptier, 2017).



Figure 5: Emptying of a septic tank at the temple (Source: Shantanu/CSE, 2016)

#### 2.1.4 Transportation

A truck-mounted suction machine is used for emptying and transportation of FS. Collected FS from containment systems is transported 3-4 km away from the city and disposed into the outskirts/open fields of the city (BNP, 2016).



Figure 6: Truck mounted vacuum tanker (Source: Aishwarya/CSE, 2016)

#### 2.1.5 Treatment and disposal/end use

No treatment facility for faecal sludge and wastewater is present in Bodhgaya. Collected FS from the containment systems is discharged into open fields, 2-3 km away from the city boundary. During the comprehensive study, it was observed that many children work and play in the fields at a small distance from the site of disposal (BNP, 2016). Faecal sludge collected by manual emptiers is discharged at nearby open fields or open drains.



Figure 7: Septage getting emptied into open field (Source: Aishwarya /CSE, 2016)

## 2.2 SFD matrix

The SFD matrix is shown in Appendix 7.7 and the final SFD for Bodhgaya is presented in Appendix 7.3.

### 2.2.1 SFD matrix explanation

Definition and estimation of different variables (used to make SFD) are explained below in table 7 and 8.

**Table 7: Description of variables used for defining containment systems**

S. No.	Variables	Description (city context)	Percentage of population
1	T1A2C6	Septic tank connected to open drain or storm sewer	26
2	T1A3C6	Fully lined tank connected to an open drain or storm sewer	16
3	T2A5C10	Lined pit with semi-permeable walls and open bottom, no outlet	9
4	T1B11C7 TO C9	Open defecation	49

Source: CSE, 2016

**Table 8: Description of variables used in SFD**

System type	Variables	Description (city context)	Percentage of population
Offsite	Not applicable (Since the town does not have an offsite sanitation system)		
Onsite	SN not contained	SN from OSS (T1A2C6 & T1A3C6) that is conveyed in the open drains	21
	SN not delivered to treatment	SN in open drains that gets discharged into the river/open field	21
	FS not contained	FS from the OSS (T1A2C6, T1A3C6 and T2A5C10) where the depth of groundwater is low and there is 'significant risk' of groundwater contamination or the OSS is connected to open drain	30
	FS not contained – emptied	FS is emptied from the OSS (T1A2C6, T1A3C6 and T2A5C10) where FS is not contained, which is emptied, using either motorized or manual emptying equipment.	23
	FS not delivered to treatment	FS that is dumped in the city and it either: <ul style="list-style-type: none"> <li>• Gets discharged in to the Ganga River</li> <li>• Or is applied to land as soil conditioner</li> </ul>	23
	FS not contained not emptied	FS not contained not emptied from OSS (T1A2C6, T2A5C10 and T1A1C6) represents the OSS that doesn't get emptied.	7
Open defecation	Open defecation	With no user interface, users defecate in water bodies or on open ground or to 'don't know where'; consequently the excreta are NOT contained.	49

Source: (CSE, 2016)

### Offsite systems

According to Census of India 2011, 4.2% of the city is dependent on offsite systems of which, population connected to sewer line is 4.1% and user interface discharging directly into open

drain or open ground is 0.1%. But from the field-based study, it was observed that there is no operational functioning sewer system present in the city.

#### *Onsite sanitation systems*

The OSS is divided into two categories. The containment system in which FS is contained and one in which FS is not contained. FS is considered not contained in Bodhgaya when the FS infiltrate pollutes the high ground water table and also if the septic tank and fully lined tanks are connected to open drain.

51% of the city is dependent on OSS, out of which 26% is dependent on septic tank connected to open drain, 16% on fully lined tank connected to open drain and 9% on lined pit with semi-permeable walls and open bottom. There is no clear differentiation between the volume of SN and solid FS generated from septic tank and fully lined tank connected to open drain, hence to reduce maximum error it is assumed to be 50% in each of the systems. It is also assumed that 90 % of FS is emptied during the emptying process thereby leaving 10% of systems not getting emptied in time.

SN from the two systems (septic tank connected to an open drain and fully lined tank connected to an open drain) together constitutes 21%. 'FS not contained – emptied' comes out to be 23% (12% from septic tank connected to open drain, 7% from fully lined tank connected to open drain + 4% from the lined pit with semi-permeable walls). 'FS not contained- not emptied' is 7% (1% from septic tank connected to open drain + 1% from fully lined tank connected to open drain + 5% infiltrate from the lined pit with semi-permeable walls). Together they constitute 30% 'FS not contained'.

#### *Open Defecation*

On triangulation of data from *Saat Nischay Yojna* and on considering floating population, it was observed that around 49% population practice open defecation.

As there is no treatment facility in Bodhgaya and since the groundwater table is high, the FS disposed from containment systems is not treated and in turn, pollutes the environment. The excreta of 100% population are unsafely managed which includes the 49% of the population that still practice open defecation.

### **2.2.2 Risk of groundwater contamination**

The SFD assessment includes the risk of groundwater pollution as an important factor in determining whether excreta are contained or not contained. If the risk of contamination to groundwater is low then FS is considered "contained". The type of OSS in use also has an influence on the infiltration of liquid into the groundwater and therefore on the potential risk of groundwater pollution. Risk of groundwater contamination is estimated through graphic generator and overall risk estimated is 'Significant Risk'.

The Groundwater in the phreatic aquifers in Gaya district is slightly alkaline in nature. Based on the survey with households and KII in Bodhgaya, it was decided to characterize all existing sanitation containment systems as having "significant risk" of groundwater pollution as the pre-monsoon groundwater table depth in Bodhgaya ranges from 5-10 mbgl and the post-monsoon groundwater table depth ranges from 2-5 mbgl (CGWB, 2013).

According to the Census, 67.5% of the population were dependent on hand pumps for water supply, 14% population dependent on tap water from a treated source and 8.4% on a private well, tube well or bore well. According to the random sample survey and KIIs conducted, it was reported that around 85% of the population is dependent on piped water supply, the source of which is ground water from deep tube wells while the remaining 15% rely on hand pumps. Despite having 85% coverage, most of the households and other establishments had dug private borewells to supplement the unreliable municipal water supply.

### 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 or between septic tanks and pit latrines but not about the design of the actual containment systems on ground. Therefore, a random household survey was conducted in each ward of the city to identify and cross check the data collected from the Census, 2011. The census data are 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.

The three key sources of data used are; (i) Census of India, 2011 as base data (ii) *Saat Nischay Yojna* for the population in Bodhgaya as it is a recent survey. (iii) The final population constitutes the population considered under *Saat Nischay Yojna* and the floating population of Bodhgaya. Published documents of relevant departments, KII and FGD are further used for data triangulation. Overall one KII and five FGDs have been conducted with different stakeholders.

The Census mostly differentiate between systems connected to the user interface, if any, but does not give information about the design of actual containment systems on ground level or about the disposal of septage and WW generated. Therefore, a random household sample survey was conducted in few wards of the city to identify and cross check the data collected from secondary sources. The census data are solely derived from the responses of the head of the household. 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.

Although the number of households considered per ward was less to represent the whole city, the random households surveyed were carefully selected so that different typology of settlements and different socio-economic backgrounds are well represented.

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 is assumed to be 50% each. Based on the random survey, it is assumed that respondents getting their OSS emptied within 10 years are using their systems with emptying and respondents getting their OSS emptied after 10 years are using their system without emptying. In the matrix, it is assumed that 90% of the population gets their containment systems emptied when full.

The objective of the survey conducted was to obtain a more accurate measure of how excreta are managed through stages of sanitation service chain (from containment to end-use or disposal). Please refer appendix 7.11 for questionnaire used for random household sample survey. To reduce the uncertainty around the data collected, the draft SFD graphic was prepared and presented to the SBCLTF, based on their feedback a context-adapted SFD was prepared.

### 2.3 Context-adapted SFD

According to the SBCLTF, SFD generated by graphic generator is not sufficiently visualizing the actual situation at containment stage of sanitation chain. According to the stakeholders the properly designed septic tanks, which are regularly emptied, should be considered contained even if the supernatant is discharged into open drains. Hence, a context-adapted city specific SFD graphic is manually corrected to convey the true picture of the excreta management in the city.

Please refer Appendix 7.5 for the context-adapted SFD graphic. There is no major change done in the graphic. The only difference suggested in this context is at containment stage, i.e. for correctly designed septic tanks. Out of 51% of the population, dependent on onsite sanitation system, 26% of the population is dependent on septic tanks connected to open drain or storm sewer. 16% of the population is dependent on fully lined tanks connected to open drain or storm sewer. 9% of the population, dependent on lined pit with semi-permeable walls and open bottom, is attributed to be FS not contained.

With an earlier assumption of 50% of the proportion of the content of the septic tank is solid FS, rest of the 50% is assumed to be supernatant. According to SBCLTF, the solid FS collected in the septic tank (attributed to 13% population) should be considered contained as it is neither polluting the ground water nor the solid excreta are overflowing in the open drain. Hence 13% of FS is considered contained at containment stage (represented green in colour). 12% FS contained is emptied and rest 1% FS remains in the tank which is contained and never emptied. Nevertheless, the supernatant generated from septic tank connected to open drain is not contained and hence considered to be unsafely managed (represented red in colour).

Overall excreta of 99% population are not managed safely according to the context-adapted SFD. The graphic is well received by the stakeholder's group and city's authority has agreed that the context-adapted SFD graphic is representing much closer picture to the ground conditions.

### 3 Service delivery context description

#### 3.1 Policy, legislation and regulation

##### 3.1.1 *Policies, legislations and regulations at national level*

In 2008, the Ministry of Housing and Urban Affairs (MoHUA), formerly known as 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 state 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. NUSP identifies the constitution of the multi-stakeholder task force as one of the principal activities to be taken up to start the city sanitation planning process. As per the requirement of CSP, a major role is to be played by the members of institutions, organizations, individuals, NGOs, academicians, local councillors, industry owners, consultants, media representatives of private sector, etc. Constitution of Swachh Bharat City Level Task Force (SBCLTF) formerly known as City Sanitation Task Force (CSTF) is facilitated by drawing members from these groups in consensus with citizens who will be constantly supporting the CSP preparation by analysing the strengths and competencies required to overcome the current situation and to improve sanitation facilities (MoUD, 2014).

The advisory note on septage management in urban India, issued by MoUD in 2013, recommends supplementing CSPs with a Septage Management Sub-Plan (SMP), 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 systems. This advisory provides a reference to Central Public Health & Environmental Engineering Organisation (CPHEEO) guidelines, Bureau of Indian Standard (BIS), and other resources that users of this advisory may refer, for details while preparing their SMP (MoUD, 2013). The advisory clearly discusses the techno-managerial and socio-economic aspects of septage management in India and provides guidelines for Urban Local Bodies (ULBs) to plan and implement SMP.

The Environment (Protection) Act, 1986 and the Water (Prevention and Control of Pollution) Act, 1974 have provisions relating to sanitation services and environmental regulations. It 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 and for meeting all state permit requirements and regulations (CSE, 2010). Municipal acts and regulations usually refer to the

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 insanitary latrines - Laying strong emphasis on rehabilitation of manual scavengers. The broad objectives of the act are to eliminate insanitary latrines, prohibit the employment of manual scavengers and the hazardous manual cleaning of sewer and septic tanks, and to maintain a survey of manual scavengers and their rehabilitation (MoSJE, 2014).

In February 2017, MoHUA issued the National Policy on Faecal Sludge and Septage Management (FSSM). The policy aims to set the context, priorities, and direction for, and to facilitate, nationwide implementation of FSSM services in all ULBs such that safe and sustainable sanitation becomes a reality for all in each and every household, street, town and city in India (MoUD, 2017).

The Fourteenth Finance Commission (FC-XIV) was constituted by the President of India under Article 280 of the Constitution on 2 January 2013 to make recommendations for the period 2015-20. Its assignments include distribution of revenue between union and state; devising a formula for the grant; suggesting a method to augment resources for local bodies; and taking care of any matter referred to it (NIUA, 2015).

Model Municipal Building Bye-laws 2016 prepared by Town and Country Planning Organization (TCPO). Building Byelaws 2016 is used to regulate coverage, height, building bulk, and architectural design and construction aspects of buildings so as to achieve orderly development of an area. They are mandatory in nature and serve to protect buildings against fire, earthquake, noise, structural failures and other hazards. It includes chapters on green buildings and sustainability provisions, rainwater harvesting, Waste Water (WW) reuse and recycle, installation of solar roof top photo voltaic norms, revised norms for adequate toilet facilities for women and public conveniences in public buildings and mandatory provisions for segregated toilet facilities for visitors in public buildings (TCPO, 2016).

### 3.1.2 *Policies, legislations and regulations at state level and ULB level*

According to the Constitution of India, water and sanitation are state subjects. Statutory powers are conferred to the state for making laws on water and sanitation. Some of the policies, laws and regulations are listed below:

#### *Draft Urban Sanitation Strategy, 2010*

The state has prepared a Draft Urban Sanitation strategy which construes upon the overall framework of NUSP. The objective of the strategy is to encourage cities to prevent open defecation, provide potable water in adequate quantity and safely manage waste water thereby prioritizing sanitation and developing individual action plans suited to local conditions. The strategy aims at motivating the ULB for planning, execution and operation and maintenance of all works related to water supply, sewerage, solid waste management and sanitation works; henceforth promoting a healthy competition amongst the ULB by awarding the best performing ULB. The strategy's regards to water management promotes ULB to ensure effective discharge of waste water from all toilets by aiming for 100% sewerage system with treatment of sludge before discharge. The state intends to consolidate all plans under the City Sanitation Plan (CSP).

### *Bihar Municipal Act, 2007*

The Bihar municipal Act, 2007 and section – 81 (2)(w) of the Bihar Urban Planning and Development Act, 2012, the Government of Bihar notified the Bihar Building Bye Laws 2014, which is enforced to all the municipal areas of the state. As per the bye-laws, the building plan will only be approved if the plan includes a septic tank in the design. If anyone is found to have approved building plan in deviation of building bye-laws shall be liable to be prosecuted and shall be liable to pay fine of rupees fifty thousand or sentence to imprisonment for a period which may extend to one year or both (GoB, 2014).

### *Bihar Building Bye-Laws, 2014*

The Bihar Building bye-laws highlight the specifications to be followed by the passing of building plans and during construction of septic tanks only. The document refers to volume 1, chapter 5 of the National Building Codes (BIS, 2005).

The Fifth State Finance Commission (FC-V), Bihar was constituted by Governor of Bihar in January 2016. The commission is set up under the Article 243 Sec I of the Indian Constitution, which orders that the Governor of the state would, at the end of every fifth year establish a Finance Commission for the purpose of reviewing, within the introduction of the 73rd Amendment of the Constitution Act, 1992. The Bihar Finance Commission is a committee pertaining to the state of Bihar, established with a purpose of reviewing the financial implementations of the state. The main purpose of this committee is to formulate implementation of financial policies pertaining to the state of Bihar (DPD, 2016).

### *3.1.3 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 Organization (CPHEEO), created in 1953, is the technical wing of the MoUD, which advises the ministry on 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 norm setting for urban water supply and sanitation (Planning Commission, 2002).

National Council for Rejuvenation, Protection and Management of River Ganga referred as National Ganga Council formerly known as National Ganga River Basin Authority (NGRBA) is the implementation wing of National Mission for Clean Ganga (NMCG), which was constituted under the provisions of the Environment (Protection) Act (EPA), 1986. The council aims at ensuring effective abatement of pollution and rejuvenation of the river Ganga by adopting a river basin approach to promote inter-sectorial co-ordination for comprehensive planning and management, maintenance of minimum ecological flows in the river Ganga with the aim of ensuring water quality and environmentally sustainable development (NMCG, 2011).

The 74<sup>th</sup> 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 a lack of clarity in roles and responsibilities of state and local agencies, resulting in large gaps in implementation (USAID, 2010).

Management and delivery of urban basic services in Bodhgaya is governed by various institutions. Table 7 summarizes the institutions responsible for policy making, service provision and regulation of urban services:

**Table 9: Roles and responsibilities**

Institutions	Roles and responsibilities
Public health and Engineering Department (PHED), Bihar	Ensuring access to safe water supply, development of sanitation facilities; monitoring of quality of drinking water supply; ensuring participation of communities in schemes involving drinking water supply and sanitation; reforming water supply and sanitation sector.
Urban Development & Housing Department, Bihar	Implementation of schemes supported by the centre and state government respectively, such as the National Ganga Mission, Atal Mission for Rejuvenation Urban Transformation (AMRUT), Swacch Bharat Mission (SBM), and <i>Saat NischayYojna</i> .
Bihar State Pollution Control Board	Regulatory measures for domestic and industrial, licensing for environmental check etc. Monitor the compliance standards regarding ground water, ambient air, leachate quality and the compost quality including incineration standards as specified in Schedule II, III & IV of 'The Water (Prevention and Control of Pollution) Act 1974'.
Reform Support Unit (RSU)	Execution of projects related to water and sanitation supported by DFID-SWASTH in the state of Bihar.
Bodhgaya Nagar Panchayat	Overall management of the civic services in the city. Public sanitation, solid waste management, public health and education.
BUIDCO	Bihar Urban Infrastructure Development Corporation Ltd

Source: Compiled by CSE, 2016

### 3.1.4 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 largest cities have created municipal water and sanitation utilities that are legally and financially separate 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 subsidize operating costs (Planning Commission, 2002).

Furthermore, when no separate utility exists, there is no separate allocation 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 Bodhgaya, public health, sanitation, conservancy, and solid waste management services are delivered by BNP. No official has been appointed in particular to look into matters pertaining to sanitation (BNP, 2016).

### 3.1.5 *Service standards*

1. Service Level Benchmarks (SLB), 2008: Issued by the Ministry of Urban Development (MoUD) in 2008, the SLB seek 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. The SLB refers to improving service through better provision and delivery. It evaluates the performance of urban services provided by different ULBs throughout the country.
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 organization constituted in September 1974 under the Water(Prevention and Control of Pollution) Act, 1974. General standards are notified in respect of parameters for safe discharge to inland surface water/public sewers/land for irrigation/marine coastal areas shall be applicable for the effluent quality.
3. Manual on Sewerage & Sewage Treatment, Second Edition, 2013: This manual was developed by Central Public Health and Environmental Engineering Organization (CPHEEO). It provides detailed designs and guidelines for various technologies of wastewater management.
4. Code of Practice for Installation of Septic Tanks, 1985: Issued by, Bureau of Indian Standards. The code specifies standards and design consideration for installation of septic tanks.

## 3.2 Planning

### 3.2.1 *Service targets*

A draft city sanitation plan has been prepared under Support Programme for Urban Reforms (SPUR) in 2014. SPUR is a six year old technical assistance programme designed to enhance the ability of major towns and cities through their ULBs to provide services such as clean water supply, improved sanitation, sewage treatment and solid waste management (IMC, 2015).

The Swachh Bharat Mission (SBM), one of the flagship programmes of the government of India, launched on October 2<sup>nd</sup> 2014 by the MoUD. SBM-Urban aims to eliminate open defecation, eradicate manual scavenging, capacity augmentation of ULBs and generate awareness about sanitation and its linkage with public health during the mission period till 2019. The SBM (urban) aims to ensure that no new insanitary toilets are constructed during the mission period and that pit latrine should be converted into sanitary latrines. The target group for construction of household units of toilets thus is (i) 80% of urban households engaging in open defecation, remaining 20% of households practising open defecation are assumed to be catered by community toilets due to constraints of space (ii) all households

with insanitary latrines (iii) all households with single-pit latrines (MoUD, 2014). Table 8 provides an overview of service delivery progress in accordance with SBM.

**Table 10: Service delivery targets in accordance with SLBs**

Sanitation service chain	Parameter	National benchmark	Time frame to achieve benchmark
Containment	Coverage of toilets	100%	2019
Transport	Coverage of sewer network services	100%	2031
	Collection efficiency of the sewerage network	100%	2031
Treatment	Adequacy of sewage treatment capacity	100%	2031
	Quality of sewage treatment	100%	2031
End-use/disposal	Reuse and recycling	20%	2031
Other	Cost recovery	100%	2031
	Efficiency of collection of charges	100%	2031
	Redressal of customer complaints	80%	2031

Source: Adapted from (MoUD, 2008), (MoUD, 2010)

SBM is complimented by the state mission of *Saat Nischay Yojna's- "Har Ghar Shauchalaya"* (Toilet in each house) of Government of Bihar. Under the combined scheme of SBM and *Saat Nischay Yojna*, a total of 170 toilets have been completed under SPUR and 360 toilets have been completed under the ULB in order to meet the same objective (BNP, 2016).

**Table 11: Service delivery progress in accordance with SBM and Saat Nischay Yojna (28.02.2017)**

No. of HH as per Saat Nischay Yojna	No. of HH without toilet as per Saat Nischay Yojna	Targets as per survey up to March 2017	Total allotment (lakhs)	Targets fixed up to March 2017 (SPUR)	Toilets completed		Total no. of wards	No. of ODF wards	Community toilets	
			Amount spent (lakhs)		Toilets in progress				Completed	In progress
					Under SPUR	Under ULB				
6883	4727	1788	136.82	534	170	360	19	4	5	12
			39.26		-	148				

Source: BNP, 2016

According to rapid assessment of FSM in the city done by BNP, they would need one additional emptying truck which will improve the emptying service. Each vehicle is expected to complete two trips per day with an average distance of round trip being 20 km (MoUD, 2016).

### 3.2.2 Investments

As per BNP, a DPR of sewerage scheme of INR 95.9 crores has been prepared for Bodhgaya and is currently under implementation. The sewerage scheme has been prepared for the base year 2015 and the ultimate year 2045. Table 12: Investment requirement for sanitation services provided in BNP from 2015 to 2045 (UDHD, 2014).

**Table 12: Investment requirement for sanitation services provided in BNP**

S.L No.	Description	Investment requirement (INR in lakhs)	Year of meeting 100% benchmark
1.	Provision for toilets and urinal	1,080.30	2018
2.	Sewerage and sewage treatment plant	5,086.7	2023
3	Storm water drainage	1,936.71	2025
4.	Water supply	2,305.1	2023

Source: UDHD, 2014

Table 11: Capital and O&M Investment requirements for services in BNP from 2015 - 2045 depicts the capital investment and the operation and maintenance investment requirements for sanitation services from 2015 – 2045 (UDHD, 2014).

**Table 13: Capital and O&M Investment requirements for services in BNP from 2015 - 2045**

SL. No.	Description	Total capital Investment (Lakhs in INR)	O&M expenditure plan						
			2015	2020	2025	2030	2035	2040	2045
1.	Provision for toilets and urinals	896.34 (\$ 5.84 Million)	14.79	19.97	25.14	30.32	35.5	40.67	45.85
2.	Sewerage and sewage treatment plant	4238.92 (\$ 27.6 Million)	93.26	125.9	158.54	191.18	223.81	256.45	289.09

Source: UDHD, 2014

As per the rapid assessment of FSM in city done by BMC, the budgetary provision required for capital expenditure for FSM is around 1412.81 lakh (2.16 million USD). Whereas, the operation and maintenance (O&M) cost associated with the emptying services and treatment operations is estimated to be INR 189.49 lakh (0.29 million USD) for 5 years (MoUD, 2016). Further details of CAPEX and OPEX have been provided in Table 12: Status of CAPEX& OPEX for FSSM.

**Table 14: Status of CAPEX& OPEX for FSSM.**

S. No.	Component	CAPEX (INR lakhs)	OPEX (INR lakhs)	Total (INR lakhs)
1	Faecal sludge management	10	39.26	49.26
2	Liquid waste management	1,402.81	150.22	1,553.03
3	FSSM Total	1,412.81	189.49	1,602.30

Source: MoUD, 2016



### 3.3 Reducing inequity

#### 3.3.1 Current choice of services for the urban poor

The total slum population of Bodhgaya is 17,704 which is 46.05% of the total population (Census, 2011). There are 18 slums with a total of 3,109 households in Bodhgaya (BNP, 2016). The most common type of containment system present in the slums is lined pit with semi-permeable walls. Despite the presence of toilets in many households, most slum dwellers practice open defecation (UDHD, 2014).

*Samvardhan* is a state level Support Program for Urban Reforms (SPUR) which works with the UDHD of Bihar in developing the infrastructure of the town. It was a 6-year partnership programme (2010 -2016) between the govt. of Bihar & United Kingdom’s Department for International Development. The goal of *Samvardhan* was “Economic growth and poverty reduction to be significantly accelerated in Bihar by 2016”. The program aimed at significantly enhancing the ability of identified ULB’s to provide urban services and attract private investment in the state (UDHD, 2014).

Currently, under SPUR, 534 individual toilets have been constructed. The individual household toilets to slum dwellers are commissioned by the women of the *Samuhik Vikas Samithi* in Bodhgaya. Sixteen hand pumps under SPUR have also been installed (BNP, 2016).



Figure 8: Slums in ward no. 10 (Source: Aishwarya /CSE, 2016) Figure 9: Overhead tank on CT at Janpur slum (Source: Aishwarya /CSE, 2016)

#### 3.3.2 Plans and measures to reduce inequity

Pradhan Mantri Aawas Yojna (PMAY), Housing for All (Urban) project is aimed for urban areas with following components: (i) Slum rehabilitation of slum dwellers with participation of private developers using land as a resource; (ii) Promotion of affordable housing for weaker sections through credit linked subsidy; (iii) Affordable housing in partnership with public & private sectors; and (iv) Subsidy for beneficiary-led individual house construction or enhancement.

Under Housing for All (HFA) scheme, 110 houses for the economically weaker section have been sanctioned out of which, the construction of 93 houses is in progress and the first instalment of 43 houses has been completed. The project cost for construction of 110 EWS houses at the BNP is INR 462.66 lakhs. The total funds available within the ULB for the

construction of these houses is INR 78.98 lakhs, out of which, the total fund utilized is INR 21.5 lakhs for the year 2016.

The *Samuhik Vikas Samithi* community-based self-help organizations in the slums formed under SPUR facilitate the provision of toilets to the slum households. Apart from this, it helps the residents by providing them money as credit with the marginal interest rate for opening a bank account and for starting their own business. The self-help organization is run by women. It is recognized by the local government and is established in all the notified slums of the city (BNP, 2016).

### 3.4 Outputs

#### 3.4.1 *Capacity to meet service needs, demands and targets*

Municipal expenditures in India account for 1.1% of the country's GDP, compared to 6.9% in South Africa and 9.7% in Switzerland. ULBs, therefore, rely mainly on national or state grants (AFD, 2014). In the context of Bodhgaya, the major source of income (both revenue and capital) is through grants from Finance Commission and the remaining is generated through taxes and user charges. At present, Bodhgaya Nagar Panchayat (BNP) has no guidelines that would cite the regulated emptying and disposal of faecal sludge. BNP also receives funds for sanitation infrastructure development which comes through SBM and *Saat Nischay Yojana*.

Shortage of human resource can be witnessed in the BNP. It largely relies on staff hired on a contractual basis to provide the daily service needs to the public. At present, there are 4 permanent employees and 16 employees on contract. The staff also lack the basic know-how and technical skills (BNP, 2016).

#### 3.4.2 *Monitoring and reporting access to services*

Data on service levels should be collected, documented and reported to MoUD according to the format prescribed by SLB framework.

The progress of toilet coverage gets reflected on mission progress dashboard in the SBM-Urban website. Of 4,041+ Municipalities in 650+ districts, 3,802 ULBs are active. 75 million plus cities are being monitored separately. Under SBM, which is complemented by *Saat Nischay Yojna* 170 toilets have been constructed under SPUR and 360 toilets have been constructed by ULB's fund.

Data on service levels should be collected, documented and reported to MoUD according to the format prescribed by SLB framework. Service level improvement plans (SLIPs) are prepared with yearly targets. It has to be reviewed each year and progress has to be monitored. Until now, there has been no monitoring of septic tanks or pits done. The planning documents like City Development Plan (CDP) and CSP have to be reviewed once in 5 years. This gives an opportunity to monitor the progress of service level improvement. The city has prepared CSP under SPUR program.

BNP is yet to digitize the billing of emptying services and does not maintain any register on the number of tanks emptied on the weekly or monthly basis. Such data, if recorded can be used to quantify septage emptied. Currently, there is no regular inspection being carried out to check the quality of the emptying services which are provided in the city. There has been

no sanitary inspector assigned, to inspect the design of septic tanks and their adherence to standards at the time of construction (BNP, 2016).

### 3.5 Expansion

In 2016, MoUD initiated a rapid assessment of 131 flagship cities to estimate the budgetary requirement for implementing Faecal Sludge and Septage Management (FSSM) in selected cities across the country, supported by the National Alliance for Faecal Sludge and Septage Management (NFSSM). The flagship cities include 100 smart cities, 12 cities in Ganga basin and others across India. A declaration was signed – for cities journey beyond Open Defecation Free (ODF) - mainstreaming effective faecal sludge and septage management by key decision makers and NFSSM alliance members.

AMRUT, a mission to provide basic services (e.g. water supply, sewerage, urban transport) to households and build amenities in cities to improve the quality of life for all. The cities are required to submit Service Level Improvement Plan (SLIP) documents (includes details on funding of specified projects by ULB) to the state. SLIP is prepared based on a target for each year. The state will then prepare State Annual Action Plan (SAAP) document compiling all the details given in SLIPs. SAAP is then forwarded to the MoUD to approve and sanction funds. It has been decided to divide the projects into two phases (MoUD, 2015). Upon the initiation of the mission, states were mandated to prepare yearly SAAP documents, but as per the current amendments in the guidelines of the mission, states have been mandated to prepare an action plan for remaining mission period.

In 2016, Chief Minister of Bihar launched a *Saat Nischay Yojna (CM's Seven Resolves)*, a campaign which delves towards holistic development of the state on 7 main issues. Two of the seven issues focused on sanitation service: 1. Coverage of access to toilets to improve sanitation facilities and be open defecation free. The scheme provides an outlay of INR 28,700 crore (USD 4.315 billion) to construct 1.72 lakh crore (1.72 billion) toilets in the state. 2. Provision of lined drains to the households and roads with an outlay of INR 78,000 crore (USD 11.73 billion)

National Heritage City Development and Augmentation Yojana (HRIDAY) was launched on 21 January 2015 with the aim of bringing together urban planning, economic growth and heritage conservation in an inclusive manner to preserve the heritage character of each Heritage City. The scheme shall support the development of core heritage infrastructure projects including the revitalization of linked urban infrastructure for heritage assets such as monuments, Ghats, temples etc. along with reviving certain intangible assets. These initiatives shall include the development of sanitation facilities, roads, public transportation & parking, citizen services, information kiosks etc. Gaya city has been granted a total of INR 40.04 crore (63 million USD) fund, based on its population and size (MoUD, 2015). But under this scheme, no work has been done for sanitation in the city (BNP, 2016).

#### 3.5.1 Stimulating demand for services

The following activities may stimulate demand for services:

- Awareness generation on septic tank construction, regular emptying of septic tanks through awareness campaigns

- Awareness campaigns on ill effects of environmental degradation because of disposal of untreated septage into the local environment
- Capacity building of ULB staff on septage management
- Skill development for local masons and plumbers
- Monitoring and regulation of private emptiers

It is recognized that the end objectives and corresponding benefits of SBM cannot be achieved without proper management of faecal sludge and septage across the sanitation service chain. Further, it is well understood that sewerage coverage will not meet the complete sanitation needs in all areas, and a strategy which is a combination of OSS and off-site (decentralised and centralised) must coexist in all cities and must be given equal attention. However, the current policies are not explicit enough and also do not provide an outcome-focused direction on this issue (MoUD, 2017).

### 3.5.2 *Strengthening service provider roles*

Currently, the emptying services have been provided by both BNP as well as a few private operators. Safety gears could be provided to the workers to avoid contact with pathogens and accordingly, proper training should be given to the emptiers.

SBM majorly provides funds for access to toilets but thereafter lacks funds for treatment and disposal of sewage and faecal sludge throughout the service chain. The service delivery of sewage and faecal sludge treatment and disposal can be met through converging the two national flagship programmes – SBM and NMCG. The ULB can take the benefit of the programmes and strengthen the services along the value chain and achieve the goals of both programmes.

## 4 Stakeholder engagement

### 4.1 Key informant interviews

The KIIs were 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, letter, and call to visit the concerned departments. The purpose of the SFD study and depth of data required was conveyed through an introductory letter to respective departments. One KII was conducted with the head of the *Samuhik Vikas Samithi* - a community-based self-help organization in the slums which is formed under SPUR. Apart from KIIs, a survey was also conducted, which included interviews with a representative from NGO, institutions and other commercial establishments. Indeterminate information was available prior to the field-based research about the type of containment, emptying service, transportation and disposal of sewage generated by the city. The visit enabled in enhancing data collection through gathering progress details of SBM, *Saat Nischay Yojna*, published and unpublished reports like CDP, City Sanitation Plan (CSP) etc. Interview with BNP emptiers and other stakeholders provided additional insight into the service delivery context.

### 4.2 Field observations

In order to get a better picture of variety/typology of OSS, primary surveys were conducted. A random sample was carefully chosen to get a good spatial representation from each ward of OSS dependence based on Census, 2011. A few households were surveyed in the city as well as in the slums to get an overall picture of the sanitation scenario of the city. It was made sure that respondents from slums are surveyed as well. The surveyor also recorded the field observations related to sanitation. Such surveys, observations and KIIs helps to produce a more credible and accurate SFD, provides qualitative data and perhaps more precise quantitative data relating to the service delivery. Some of the observations are listed below.

During field visit, it was observed that there were four main drains in Bodhgaya. The Amwan Pyne drain in Peepar Pati was loaded with solid waste from the city as well as wastewater from ward no.1, 2, 3, 4, 5, 6, 7, 15, 16 and 17. Children were seen catching catfish from the open drains. The second drain, Rajpura Pyne, which is in Rajpura carries the wastewater discharged from ward no. 1, 2,3,4,5 & 6. The third drain is Mocharim Pyne which carries the wastewater from ward no. 17, 18 & 19. It was seen that many households directly released their wastewater from an outlet into the drain. The drain leads to a low-lying open field and eventually joins river Niranjana. The fourth drain flows through a place called Baapu nagar which is ward No. 10. This drain carries wastewater only from ward no.10.

It was also observed that FS is disposed off from the vacuum tanker into the open fields at a place called Katorwa. The FS which flows through the fields is used as manure for agriculture. It was seen that many young children work and play in the fields at a small distance from the site of disposal.

During field survey, it was seen that many houses in the slums, despite having toilets did not use them and preferred to open defecate in the fields. Also, many toilets in the slums were not constructed properly. Some of the issues faced by residents were a lack of proper doors. Some doors were built in a way such that there was a gap between the door hinge and the wall thereby making the toilets unusable. Also, the outlet from the toilet was connected to a

pit with an opening in between. The opening was not covered completely thereby giving out a foul smell.

During the field observation, four main drains which carry the wastewater generated in Bodhgaya were identified. The drain Amwan Pyne in Peepar Pati carries the wastewater which is discharged from ward no.1,2,3,4,5,6,7,15,16,17 and its length is around 4.5 km. Wastewater as well as solid waste were observed being discharged into this drain.

#### 4.3 Focus group discussion

The FGDs were conducted to complement, validate and challenge data collected during literature review and interviews. In total, five FGD sessions were conducted. FGDs were held with the BNP staff, BNP emptiers and transportation in charge, slum dweller representatives, local masons and SBCLTF members. The questionnaires for FGDs were prepared in English, but the interviewer asked the questions, translating them into Hindi language.

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

Stakeholders were identified and task force was formulated and notified under the mandate by NUSP(refer appendix 7.8 for more details). An FGD was conducted with the SBCLTF's members and the draft SFD was presented and analysed. SBCLTF's members validated the collected data and the final SFD graphic (SBCLTF, 2017).



## 5 Acknowledgement

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## 7 Appendix

### 7.1 Stakeholder identification

**Table 15: Stakeholder identification**

S. No.	Stakeholder group	In Bodhgaya context
1	City council / Municipal authority / Utility	Bodhgaya Nagar Panchayat
2	Ministry in charge of urban sanitation and sewerage	UD & HD, Government of Bihar
3	Ministry in charge of urban solid waste	UD & HD, Government of Bihar
4	Ministries in charge of urban planning finance and economic development	UD & HD, Government of Bihar
	Ministries in charge of environmental protection	Forest department, Government of Bihar
	Ministries in charge of health	Health department, Government of Bihar
5	Service provider for construction of OSS	Local masons
6	Service provider for emptying and transport of faecal sludge	Bodhgaya Nagar Panchayat, Private emptiers and manual emptiers
7	Service provider for operation and maintenance of treatment infrastructure	N/A
8	Market participants practising end-use of faecal sludge end products	N/A
9	Service provider for disposal of faecal sludge (sanitary landfill management)	Bodhgaya Nagar Panchayat
10	External agencies associated with FSM services: e.g. NGOs, academic institutions, donors.	Centre for Science and Environment, New Delhi

Source: CSE, 2016

## 7.2 Tracking of engagement

**Table 16: Tracking of engagement**

S. No.	Name of Organisation	Designation	Date of engagement	Purpose of engagement
1	Bodhagay Nagar Panchayat	BNP staff	07/11/2016	Introduction of SFD and permission to conduct FGDs in the offices and municipal wards.
2	Bodhagay Nagar Panchayat	Emptiers and transportation in charge	08/11/2016	FGD
3	Bodhagay Nagar Panchayat	Slum dweller representatives	09/11/2016	FGD
4	Private	Local masons	09/11/2016	FGD
5	Samuhik Vikas Samithi	Head Representative of	09/11/2016	KII
6	Mahabodhi Temple	Temple Manager	08/11/2016	KII
7	SBCLTF	16 members of SBCLTF	17/03/2017	FGD
8	Bihar State Tourism Development. Corp LTD.	Manager Cum Controlling officer	13/10/2017	KII
9	Manual emptier	Emptier	16/10/2017	KII

Source: CSE, 2017

7.3 SFD Graphic

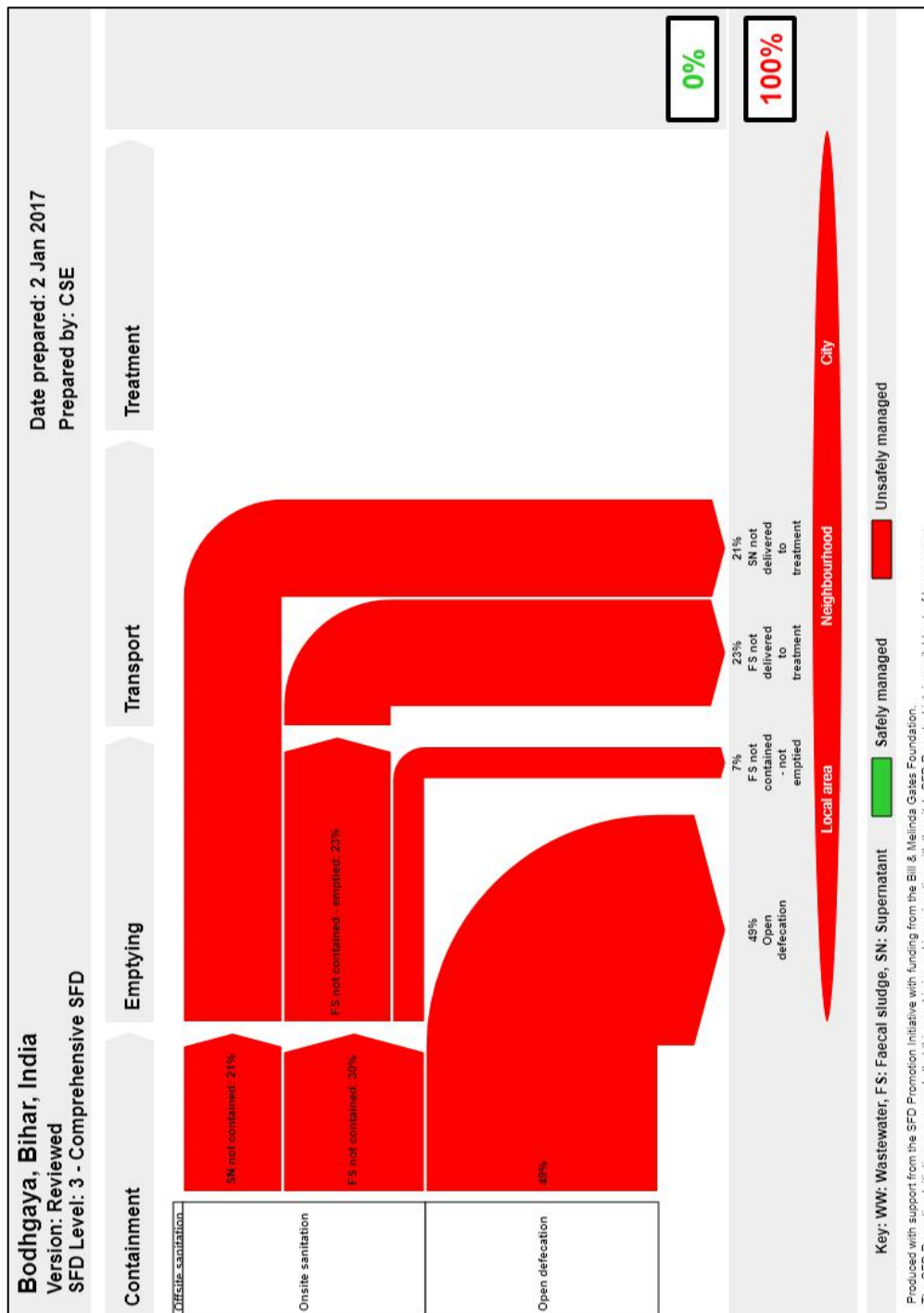


Figure 10: SFD graphic (Source: SFD graphic generator)

### 7.4 SFD brief explanation

**Table 17: Percentage of the population using each system technology and method**

System Type	Containment	Emptying	Transport	Treatment	End-use/ disposal
Offsite	No functional offsite system present				
Onsite	<p>T1A2C6: 26% of the population is dependent on septic tank connected to open drain or storm sewer.</p> <p>T1A3C6: 16% of the population dependent on fully lined tank connected to open drain or storm sewer</p> <p>T2A5C10: 9% of population is dependent on lined pit with semi-permeable walls and open bottom with no outlet or overflow.</p>	<p>Not applicable.</p> <p>It is assumed that 90% of population has their OSS emptied.</p> <p>Since there is no clear differentiation between % of septage and supernatant, it is assumed to be 50% each.</p> <p>Based on the above observation, SN from the two systems (T1A2C6 + T1A3C6) together constitute 21%. FS not contained - emptied comes out to be 23% (13% from septic tank connected to open drain +7% from fully lined tank connected to open drain + 3% from lined pit with semi-permeable walls. FS not contained- not emptied is 7% (2% from septic tank connected to open drain + 1% from fully lined tank connected to open drain + 5% infiltrate from lined pit with semi-permeable walls). Together they constitute 7% FS not contained.</p>	<p>Since there is no treatment facility present, the 21% SN which is generated and the 30% FS which is not contained is transported from the respective containment systems and discharged into the environment.</p>	<p>No treatment facility exists hence no FS is treated;</p>	<p>All the FS emptied gets discharged into open fields where it is used for agricultural purposes.</p> <p>The SN discharged through open drain is released into bigger drains or fields.</p>
Open defecation	T1B11C7 to C9: 49% of population is dependent on open defecation.				

Source: CSE, 2016

7.5 Context-adapted SFD Graphic

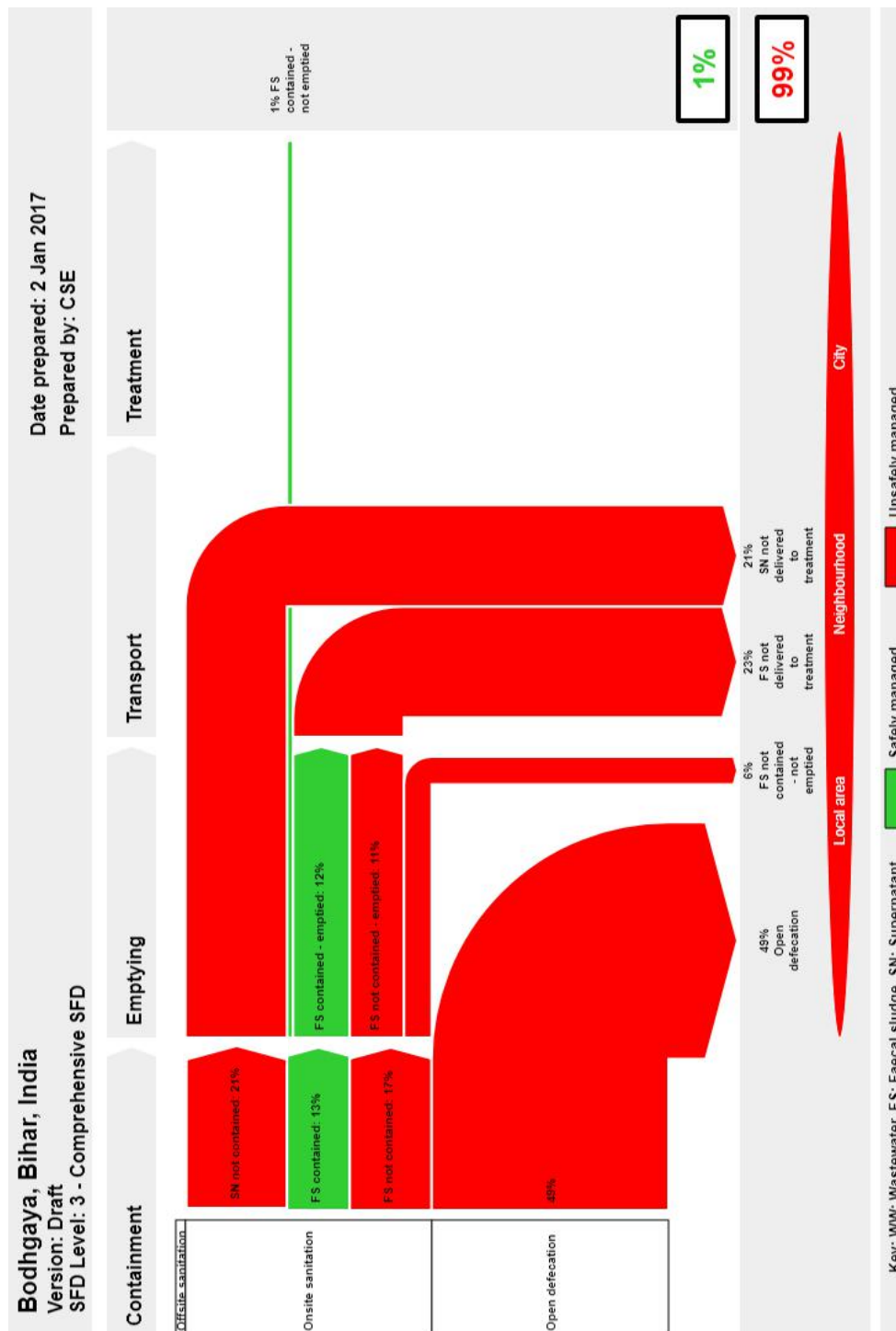


Figure 11: Context-adapted SFD graphic

### 7.6 SFD selection grid

List A: Where does the toilet discharge to? (i.e. what type of containment technology, if any?)	List B: What is the containment technology connected to? (i.e. where does the outlet or overflow discharge to, if anything?)									
	to centralised combined sewer	to centralised foul/separate sewer	to decentralised combined sewer	to decentralised foul/separate sewer	to soakpit	to open drain or storm sewer	to water body	to open ground	to 'don't know where'	no outlet or overflow
No onsite container. Toilet discharges directly to destination given in List B					Significant risk of GW pollution Low risk of GW pollution					Not Applicable
Septic tank					Significant risk of GW pollution Low risk of GW pollution	T1A2C6				
Fully lined tank (sealed)					Significant risk of GW pollution Low risk of GW pollution	T1A3C6				
Lined tank with impermeable walls and open bottom	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution					
Lined pit with semi-permeable walls and open bottom	Not Applicable									T2A5C10 Low risk of GW pollution
Unlined pit	Not Applicable									Significant risk of GW pollution Low risk of GW pollution
Pit (all types), never emptied but abandoned when full and covered with soil	Not Applicable									Significant risk of GW pollution Low risk of GW pollution
Pit (all types), never emptied, abandoned when full but NOT adequately covered with soil	Not Applicable									Significant risk of GW pollution Low risk of GW pollution
Toilet failed, damaged, collapsed or flooded										
Containment (septic tank or tank or pit latrine) failed, damaged, collapsed or flooded										
No toilet. Open defecation	Not Applicable						T1B11 C7 TO C9			Not Applicable

Figure 12: SFD selection grid (Source: SFD graphic generator, 2016)

### 7.7 SFD calculation grid

Table 18: SFD matrix

Bodhgaya, Bihar, India, 2 Jan 2017. SFD Level: 3 - Comprehensive SFD  
 Population: 51900  
 Proportion of tanks: septic tanks: 50%, fully lined tanks: 50%, lined, open bottom tanks: 50%

System label	Pop	F3	F4	F5	S4e	S5e
<b>System description</b>	Proportion of population using this type of system	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	Proportion of supernatant in open drain or storm sewer system, which is delivered to treatment plants	Proportion of supernatant in open drain or storm sewer system that is delivered to treatment plants, which is treated
<b>T1A2C6</b> Septic tank connected to open drain or storm sewer	26.0	90.0	0.0	0.0	0.0	0.0
<b>T1A3C6</b> Fully lined tank (sealed) connected to an open drain or storm sewer	16.0	90.0	0.0	0.0	0.0	0.0
<b>T1B11 C7 TO C9</b> Open defecation	49.0					
<b>T2A5C10</b> Lined pit with semi-permeable walls and open bottom, no outlet or overflow, where there is a "significant risk" of groundwater pollution	9.0	90.0	0.0	0.0		

Source: SFD graphic generator

## 7.8 Community/public toilets

**Table 19: Details of community/public toilets**

S.L No	Community Toilet/ Public Toilet	Location/Address	Ward No.	Zone(East, West, North, South)
1.	Belwatand	Suryapura	1	North
2.	Amwa road	Amwaa	2	North
3.	Near water tank	Amwaa	4	North
4.	Petrol pump amwaa	Amwaa	4	North
5.	Newtapur	Dahariyabigha	5	North
6.	Mauniya	Mauniya	5	North
7.	Upadhayaybigha	Rajapur	6	North
8.	Rajapur more	Rajapur	6	North
9.	Mahadalittola	Janpur	8	West
10.	Bapunagar	Bapunagar	10	West
11.	Bapunagar	Bapunagar	10	West
12.	Rampur road	Rampur	11	North
13.	Near vietnam temple	Bhagalpur	13	North
14.	Maharani road	Pachhati	14	North
15.	Project kanya high school	Pachhati	14	North
16.	Amwan Pyne , miyanbigaha	Miyanbigaha	16	West
17.	Anandvidyapith	Miyanbigaha	16	West
18.	Piparpanti mahadalittola	Piparpanti	17	South
19.	Mastipur	Mastipur	17	South
20.	Sidhiya ghat	Bodhgaya bazar	18	East



21.	Tikabigaha	Tikabigaha	19	South
22.	Urail	Tikabigaha	19	South

Source: BNP, 2016

**Table 20: Public Toilets constructed by Bodhgaya Nagar Panchayat**

Sl. No.	Location	Zone (East, West, North, South)	Ward No.	Landmark
1	Node-1	South	17	Node-1
2	Birla dharamsala bus stand	West	16	Miya Bigha
3	Karma temple	West	17	80 Feet Road
4	Primary health center	East	18	Near Verma More
5	Kalchakra tempo stand	North	18	Near Kalchakra Maidan

Source: BNP, 2016

## 7.9 Swachh Bharat City Level Task Force – Bodhgaya

**Table 21: SBCLTF list of members**

S.L. No	List of Members	Designation/ Department
1.	Mr. Sushil Kumar	Executive Officer
2.	Mr. Sanjay Kumar	Public Awareness Department.
3.	Ms. Asha Kumari	Project Officer
4.	Mr. Naveen Kumar	Representative of CSE
5.	Mr. Gulab Chandra Prasad	Cleaning staff
6.	Mr. Rajiv Kumar	Reporter
7.	Mr. Amarender Kumar	Sludge Inspector
8.	Mr. Mithilesh Kumar	City Manager
9.	Mr. Manoj Kumar	Reporter
10.	Mr. Jay Singh	Director
11.	Mr. Sushil Singh	Magadh University
12.	Mr. Suresh Singh	Chairman
13.	Mr. Sanjay Singh	Secretary
14.	Mr. Rajesh Kumar Singh	Assistant Engineer
15.	Mr. Surya Mohan Kumar	Accountant
16.	Mr. Ravishankar Kumar	Reporter

Source : CSE,2011



**Figure 13: SBCLTF meeting** (Source: Shantanu/CSE)

## 7.10 Photographs captured during field visit



Figure 14: Amwan Pyne drain (Source: Aishwarya/CSE, 2016)



Figure 15: Boys fishing from the drain (Source: Shantanu/CSE, 2016)



Figure 16: Direct release of sewage into Mocharim Pyne drain (Source: Aishwarya/CSE, 2016)



Figure 17: KII with local mason

7.11 Questionnaires for random household survey and emptiers



CENTRE FOR SCIENCE AND ENVIRONMENT, NEW DELHI  
Focus Group Discussion (FGD)  
QUESTIONNAIRE

Date: \_\_\_/\_\_\_/\_\_\_, Area Name: \_\_\_\_\_, Ward: \_\_\_\_\_,

Co-ordinates: \_\_\_\_\_, No. of Participants (4-10) \_\_\_\_\_

*Group Profile*

No. of Male: \_\_\_\_\_ No. of Female: \_\_\_\_\_

Respondents	1	2	3	4	5	6	7	8	9	10
Gender										
Age										
Marital Status ((U/M)										
Household size										
Social category (G, OBC, SC, ST)										
House Structure (P,K, SP)										
Latrine facility (IT, ST, CT, PT, ODF)										
IT: Individual Toilet, ST: Shared toilet, CT: Community Toilet, PT: Public Toilet, ODF: Open Defecation										
Who constructed toilet (SF, Govt.,Pvt.,NGO)										

1

Respondents	1	2	3	4	5	6	7	8	9	10
Single/Double chamber (S/D)										
Effluent connected to :Sewer/Covered Drain/Open drain/Soak pit (S/CD/OD/SP)										
Lining of tank: side wall and bottom :Mortar/cement (M/C)										
Connected with bathroom (Y/N)										
Connected with kitchen (Y/N)										
Connected with room floor wash water and laundry (Y/N)										
Who desludges the tank (Govt./Pvt.)										
Frequency of desludging										
Cost of desludging										
Willing to pay										

Figure 18: Questionnaire for random house hold survey

**For emptiers**



CENTRE FOR SCIENCE AND ENVIRONMENT, NEW DELHI  
Septic tank Cleaner Survey

Date: ...../Nov/2016      Time: .....      Place: .....

1. Owner name & Mob. No. ....
2. De-sludging process (Manual/Mechanical/Semi M.M) .....
3. Reasons for adopting the process.....
4. Type of vehicle used for transportation (Tractor/Truck/trolley/others) .....
5. Price of vehicle.....
6. Type of ownership (Own vehicle /hire from others) .....
7. Number of vehicles (total in your area) . . . . .
8. Capacity of vehicles .....
9. Typical age of Vehicles .....
10. Vehicle Assembling point.....

11. Vehicle Details.

New or second hand	
Mileage	
Durability of vehicle (Max.)	
Capacity of pump (in HP)	
Location of pump on vehicle	
Tank maintenance details (if any rupture etc.)	
Tank durability (max.)	

12. Typical No of trips per day .....
13. Average distance per trip.....
14. Area of responsibility.....

15. Fees charge/trip.....
16. Time taken for desludging activity.....
17. Where is sludge dumped .....
18. Where should be disposal site to be located? .....
19. Official dumping site for city.....
20. Reuse for sludge .....
21. Total Quantity of faecal sludge received per day per trip (Approx.).....
22. Septic tank location (top place used for any activity or unused).....
23. Septic Tanks details (Capacity, dimension, materials used for construction, Inlet and outlet baffle etc.....
24. Areas having highest demand for sludge clearing .....
25. Frequency of desludging per household.....
26. Fees Charges /Trip (Competitors) .....
27. NO. Of private Operators in your area .....
28. Are you maintaining any register/produce any bill for payment? .....
29. Is the current practice suitable for the you (Suggest any changes) .....
30. Major issue running in the business .....
31. Safety Measures if any during desludging process .....
32. Marketing Strategy.....
33. Why you are doing this work? .....

Figure 19: Questionnaire for emptiers