Fecal Sludge Management: Diagnostics for Service Delivery in Urban Areas

Case study in Dhaka, Bangladesh

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Supporting document

Final

April 2016

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Preface / Acknowledgements

This report is a city case study of a World Bank Economic and Sector Work on *Fecal Sludge Management: Diagnostics for Service Delivery in Urban Areas* (P146128). The task team leaders were Isabel Blackett and Peter Hawkins and the task team members were Zael Sanz Uriarte, Ravikumar Joseph, Chris Heymans and Guy Hutton.

This report is based on work conducted between January 2014 and February 2016 by Oxford Policy Management (OPM) in partnership with the Water, Engineering and Development Centre (WEDC) at Loughborough University. The core research team was Ian Ross (OPM), Rebecca Scott (WEDC), Ana Mujica (OPM) and Mike Smith (WEDC). The broader team who contributed to the study included Zach White, Rashid Zaman and Simon Brook from OPM, as well as Andy Cotton and Sam Kayaga from WEDC. Andy Peal (independent consultant) also contributed to certain aspects of the methodology.

Detailed feedback on early drafts was received from Ravikumar Joseph, Isabel Blackett and Peter Hawkins and Josses Mugabi of the World Bank, as well as Elisabeth Kvarnstrom and Mark Ellery (consultants). The team benefitted from the support and facilitation of Abdul Motaleb and Nishtha Mehta of the World Bank.

Finally, helpful feedback from Dhaka WASH sector stakeholders was received at the beginning and end of the research process, through workshops at the World Bank office in May 2014 and October 2014.

Executive summary

Introduction

This report summarises the main findings of a case study on faecal sludge management in Dhaka, Bangladesh. It is part of the project entitled 'Fecal Sludge Management: Diagnostics for Service Delivery in Poor Urban Areas', funded by the World Bank Water and Sanitation Programme (WSP). There are five city case studies as part of this project (Balikpapan, Dhaka, Freetown, Lima and Santa Cruz). The specific objectives of the Dhaka study were:

- To provide quantitative and qualitative data on the sanitation situation in Dhaka from a socio-economic perspective, specifically as it relates to FSM.
- To do the above in such a way that the data is representative of the city as a whole but also providing a separate picture of the situation in slums (especially the slum areas of Mirpur and Uttara where a World Bank-supported project is underway)
- To provide initial recommendations to guide discussions around future interventions in the sanitation sector in Dhaka, by contributing credible data and analysis.
- To inform the development of analytical tools and guidelines for using them, by "road-testing" draft tools using primary data collection.

Methodology

The study followed an overall research framework developed as part of the inception period, which set out research questions and sub-questions. Data collection instruments were then developed so as to answer these questions. Six data collection instruments were used in Dhaka, four quantitative and two qualitative. The quantitative instruments were a household survey, transect walks, observation of service provider practices, and tests of fecal sludge characteristics. The qualitative instruments were key informant interviews and focus group discussions.

The OPM / WEDC team led on methodology design and data analysis, while data collection was undertaken by separately-contracted consultants under the leadership of WSP. All data collection was undertaken by Adhuna Ltd, with the exception of key informant interviews which were undertaken by WSP short-term consultants.

The household survey primarily aimed to collect data from households using on-site sanitation (particularly those living in slums) regarding their use of FSM services and preferences for future FSM services. The sampling was carefully planned so as to allow conclusions to be drawn about the city as a whole on a representative basis, and about slum areas in particular, on a purposive basis. The transect walks aimed to enable participants to make a subjective and qualitative assessment of physical and environmental conditions within a community. The observation protocol for service providers involved making visual inspections about fecal sludge (FS) from pits or tanks to final disposal, in particular watching service providers go about their business. The tests of FS characteristics were carried out at three stages: (i) during removal, (ii) after removal, and (iii) after treatment (which was not relevant for Dhaka). The key informant interviews aimed to address key questions about how both the 'enabling environment' and the operating environment affects FSM services (past, current and future). Finally, the focus group discussions with residents of informal settlements aimed to gather qualitative data that would complement, validate, or challenge conclusions drawn from the household survey data.

Sampling for most quantitative instruments was derived from the sampling for the household survey, for which there were two sub-samples. For sub-sample A, the Primary Sampling Units (PSUs) were *mohallas*, an administrative unit akin to “urban neighbourhoods”, which were selected so as to allow estimates which were representative of Dhaka city as a whole. For sub-sample B, the PSUs were slum neighbourhoods, purposively selected from larger slum areas which were defined geographically using secondary data. The focus of the purposive sample was Mirpur and Uttara, two large slum areas in the north-west of the city. There were 720 households overall, equally divided between the two sub-samples, with sub-sample A giving city-wide data, and sub-sample B giving slum-specific data.

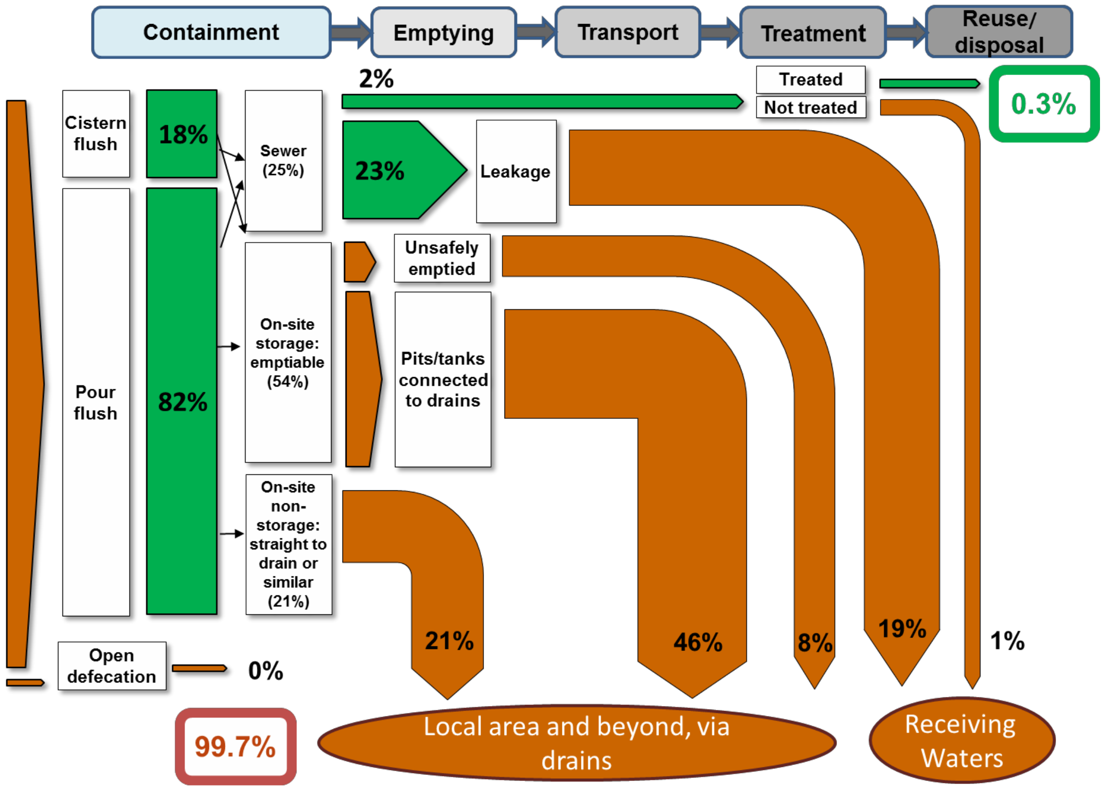
Results

The table below summarises some key indicators from the household survey:

Indicator	City-wide sample	Slum sample
Use of sanitation		
Households using improved sanitation (excluding ‘shared improved’)	78%	17%
Households using improved sanitation (including ‘shared improved’)	100%	82%
Type of containment		
a) Households using a toilet discharging to a septic tank or pit which is connected to a drain	50%	17%
b) Households using a toilet discharging directly to a drain or ditch with no intermediate containment	21%	71%
Households using a toilet discharging directly or indirectly to a drain or ditch: a) + b)	**71%**	**88%**
Households using a toilet discharging to a septic tank or pit which has never filled up / needed emptying	87%	87%
Emptying		
Households who experienced a pit/tank filling up, who emptied that pit/tank and then reused it	94%	97%
Households who emptied their pit/tank who used an informal manual emptier	97%	81%

These key data are reflected in then fecal waste flow diagrams (SFDs) in the body of the report. The Dhaka city-wide SFD is reproduced below.

Faecal Waste Flow Diagram for Dhaka – city-wide sample



The data in the table above paints a picture of almost all FS ending up in the drains or environment one way or another. It is therefore not surprising that a functioning market for FSM services barely exists.

Analysis of demand and supply for FSM services finds that demand is very low and supply is weak. That is not surprising in the context of the SFD above, and particularly the household survey finding that only 13% of households city-wide who had a toilet with a pit or septic tank had ever experienced it filling up. The drains are effectively running as sewers. Various other facts affecting demand for FSM services (type of building, accessibility of facility, fill rate and the extent of sharing) are also considered. On the supply side, there are very few mechanical emptiers in operation. The bulk of service provision, when demanded, is carried out by manual emptiers. Of those households who had emptied a pit tank city-wide, 97% had used a manual emptier last time. This is also reflected in reported intentions next time the pit or tank filled up.

Findings from the transect walks emphasise that all of Dhaka is affected by poor FSM – it is not only a problem for slum-dwellers. Latrines empty into drains throughout the city, and drains run through all areas – slums and non-slums. Having large amounts of FS in the drains and environment is an externality which affects everyone in Dhaka. Therefore, poor FSM is not only a private household matter – it is a public health and environmental hazard.

The Service Delivery Assessment shows that there is a severe shortage of public policy, capital investment and operational oversight of FSM services throughout Dhaka. This allows the current practice of latrines emptying into drains, in place of safe emptying practices, to continue. This in turn removes many of the efforts and financial costs required to achieve effective construction, management and maintenance of appropriate infrastructure. The result is significant challenges for finding solutions, which will only come about when an FSM Framework translates into clearly defined, capacitated and financed action. The overall aim of the Framework and actions must therefore be to provide a fully-functioning service chain for all of Dhaka's fecal waste flows. This requires recognition of the scale of the problem, dialogue and engagement of public, private and civil society bodies to ensure appropriate infrastructure and services can be systematically developed and adapted to respond to the various contextual challenges of the city (space, tenancy, flooding, poverty, etc.).

All of this suggests that bringing change to fecal sludge management practices in Dhaka will demand significant reform of the regulatory systems that currently govern all stages of the service chain. In the context of the general failure of existing regulatory systems, clearly segregating the roles for regulation of failure by central government, from that of licensing of compliance by local governments, from that of service management by providers, may improve the incentives for overall compliance and investment.

Economic analysis of four hypothetical intervention options is undertaken, three of which are non-conventional sewer models and one of which was full fecal sludge management. This aims to illustrate the types of costs which might be incurred for different interventions. In each case, the sanitation chain was modelled for the whole population of Uttara and Mirpur, where an intervention financed by the World Bank is to take place. Since the analysis is hypothetical, its value is in drawing together the costs data relevant to Dhaka in a comparable form using standardized units. There is a risk that the comparison of costs using data from different sources is inaccurate at best, or invalid at worst. Due to these limitations it is difficult to develop any implications for FSM in Dhaka; primary data collection on costs is required before the technology costing can be taken to be reflective of the costs of implementing different sanitation interventions.

A 'Prognosis for Change' assessment surmises that the externalities of poor FSM are both public and dispersed, whereas addressing the lack of proper containment would involve private costs (from households and property developers). A credible threat of enforcement, which would raise the cost of inaction on the part of these stakeholders, is therefore critical. Proper containment will require the enforcement of ensuring existing emptiable systems (pit/tank) are disconnected from drains, that existing non-emptiable systems are upgraded, and that newly-constructed buildings have an appropriate containment system. Change is achievable on this front, but interventions will not be successful unless they address the incentives which deliver the current outcome, which is the drains running as sewers.

Recommended intervention options from the study are identified, grouped according to the key stages of the sanitation service chain. These relate to the following areas, and are discussed in detail in section 10.

- Formalised and operational *transport, treatment and end-use* stages of the fecal sludge service chain need to be identified and put in place, enabling fecal sludge to be safely received, treated and managed as upstream arrangements are improved. Effective business and financial models will be needed for each stage.

- Systematic and progressive steps to improve existing *containment infrastructure* must include disconnecting latrine outlets from drains as alternative 'outlets' are introduced. Newly-constructed buildings should not be permitted to discharge fecal materials to drains. For on-site systems, the aim must be to introduce correctly built containment that enables systematic and safe emptying services to function.

- A range of affordable mechanical, or improved manual, *emptying* services are needed that can respond quickly to demand, especially for shared sanitation facilities and for the urban poor. Licencing, service agreements and contracts can help service providers to invest in improved business operations, as well as improve regulation to achieve service standards.

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1 Introduction and Research Framework

1.1 About this report

This report summarises the main findings of a case study on faecal sludge management in Dhaka, Bangladesh. It is part of the project entitled 'Fecal Sludge Management: Diagnostics for Service Delivery in Poor Urban Areas', hereafter "the FSM research project". This work is funded by the World Bank Water and Sanitation Programme (WSP). There are five city case studies as part of this project (Balikpapan, Dhaka, Freetown, Lima and Santa Cruz).

This project is led by Oxford Policy Management (OPM) in partnership with the Water, Engineering and Development Centre (WEDC) at Loughborough University. The overall objective of this assignment is : "to work with the WSP urban sanitation team to develop the methodology, design, develop survey instruments and undertake analysis of data collected from five field case studies (linked to World Bank operations projects), refine the diagnostic tools and develop decision-making tools and guidelines for the development of improved FSM services." Specific objectives of the Dhaka case study are listed in the next section. The scope includes the need for city-wide septage services with a focus on poor urban communities.

This document is part of a project deliverable designed to be internal at this stage. Therefore, it does not contain much background information and the assumed audience is the WSP project team and others familiar with the Dhaka FSM context.

The report's structure is detailed below. It begins with background to the research and the city, moving into several sections analysing the urban sanitation context which are not specific to FSM. Thereafter, the report's focus is FSM services in particular.

1.2 Study rationale and objectives

It is very common for poor people living in urban areas of most low-income countries either use on-site sanitation facilities, or defecate in the open. Even when improved on-site options are used to contain feces, in many cities there exist few services for collection, transport and disposal or treatment of the resulting fecal sludge. Few opportunities for resource recovery through end-use of fecal sludge exist. The service delivery gaps within and between stages of the sanitation service chain become more apparent as sanitation coverage increases in poor urban areas. Failure to ensure strong links throughout the fecal sludge management (FSM) service chain results in untreated fecal sludge (FS) contaminating the environment, with serious implications for human health.

Despite this, there are few tools and guidelines to help city planners navigate complex FSM situations, despite increasing demand for this. This study aims to build on existing frameworks and tools, in particular the Service Delivery Assessment scorecard, Fecal Waste Flow Diagram, and the Economics of Sanitation Initiative toolkit. The aim is to produce diagnostic and decision-making tools that are based in tried-and-tested strategic planning approaches and frameworks, with a focus on practicality. Critically, updates to the tools and guidelines have been updated based on primary data collection in five cities. In most of the cities, this is supported by interaction with city stakeholders involved in ongoing World Bank lending. Acknowledging the difficulty of reforming FSM services in cities, political economy questions around FSM are explicitly included as part of the overall analysis.

In addition, the specific objectives of the study are:

- To provide quantitative and qualitative data on the sanitation situation in Dhaka from a socio-economic perspective, specifically as it relates to FSM.
- To do the above in such a way that the data is representative of the city as a whole but also providing a separate picture of the situation in slums (especially the slum areas of Mirpur and Uttara where a World Bank-supported project is underway)
- To provide initial recommendations to guide discussions around future interventions in the sanitation sector in Dhaka, by contributing credible data and analysis.
- To inform the development of analytical tools and guidelines, by "road-testing" draft tools using primary data collection.

The study was therefore primarily socio-economic rather than technical. It did not aim to carry out technical inspections of infrastructure or produce detailed maps with neighbourhood-level analysis and recommendations. For those who have worked on sanitation in Dhaka for some time, there may be few surprises, but the report does offer representative data to back up what has previously been reported in smaller or more general studies.

1.3 Research framework

During the inception stage, the OPM/WEDC team developed a Research Framework (RF), based on the overarching research questions implicit in the TOR and draft research protocol. From these questions a logical set of project components was developed. These became the basis for the data collection instruments that would enable the data to be collected for the indicators making up each component.

The approach is to place all components – as well as ensuing results – of the study within the context of the FSM service chain, to optimise its relevance and effectiveness. This is clear from the full version of the RF in the inception report, with all components and questions arranged along the service chain. There is not space here to go through the research questions. The research framework can be downloaded from a link available in Annex D

The structure of components from the inception report is reflected in Table 1 below, some of which were adapted during the course of the study. The study methodology is then described in the next section.

Table 1 FSM project components

	Assessment	Objective		Component
1	Service delivery assessment	To understand the status of service delivery building blocks, and the prognosis for change in FSM services overall	1a	SDA scorecard
			1b	Stakeholder analysis
2	FS situation assessment	To understand current FS management patterns, risks and future scenarios	2a	Fecal Waste Flow Diagram
			2b	FS characteristics and end-use potential
			2c	Public health risk analysis
3	Existing demand & supply assessment	To understand customer demand for FSM services and the current status of service providers	3a	Demand - mapping customer demand and preferences
			3b	Supply - mapping service provider supply and capacity
4	Intervention assessment	To identify a hierarchy of FSM intervention options and models for implementing and financing them	4a	Intervention options
			4b	Implementation and financing models
5	Appraisal	To appraise different interventions against the "business as usual" scenario	5a	Economic appraisal of intervention options

1.4 Report structure

This report is structured sub-divided into three groups of chapters. The initial chapters describe the city background and methodology. There are three chapters which cover the urban sanitation context without a specific focus on FSM. The rest of the report considers FSM services and service delivery.

- Background
  - Section 2 summarises the study methodology
  - Section 3 provides background to the city
- Urban sanitation context
  - Section 4 shows a Fecal Waste Flow Diagram
  - Section 5 contains a Public Health Risk Assessment
- Analysis of FSM services
  - Section 6 contains the potential FSM service demand and supply assessment
  - Section 7 discusses reuse options
  - Section 8 contains a Service Delivery Assessment
  - Section 9 provides a Prognosis for Change based on the current situation
  - Section 10 discusses intervention options
  - Section 11 provides economic analysis of the intervention options
  - Section 12 concludes
- Annexes
  - Annex A contains a map of sampled areas
  - Annex B contains the detailed Faecal Waste Flow matrices
  - Annex C provides the full SDA scoring table
  - Annex D provides more information on the public health risk assessment
  - Annex E contains further tables on the economic analysis.

2 Methodology

2.1 Overall design

A key component of this study was primary data collection, since it aimed to build on an earlier 12-city FSM study based only on secondary data collection (Peal et al. 2013). The study had six different data collection instruments, four quantitative and two qualitative, each of which contribute to various project components shown in Table 1 above. These instruments are summarised in Table 2 below.

Table 2 Summary table of data collection instruments

	Instrument	Data source	n per city
Quantitative	1. Household survey	Survey of households (i) across the city, (ii) in slums / informal settlements	720 (= 360 + 360)
	2. Observation of service provider practices	Observation of containment, collection, transport/disposal and treatment/disposal	5
	3. Testing fecal sludge characteristics	Samples from (i) pits/tanks during emptying, (ii) truck/vessel outflow, (iii) final drying bed or outflow	5
	4. Transect walk	Observation of environmental and public health risks through transect walk Drinking water supply samples, tested for fecal contamination and chlorine residual Drain water samples, tested for fecal contamination	40 (= 30 + 10) 60 (= 30 + 30) 60 (= 30 + 30)
Qualitative	5. Key informant interviews	(a) government (e.g. council / utility, ministries) (b) service providers along the sanitation chain (c) other key FSM agencies	As required
	6. Focus group discussions	FGDs with slum, low-income and informal communities	10

The overall design decided by WSP was that team OPM/WEDC should lead on methodology and analysis, while actual data collection would be managed by two types of consultants contracted separately. A local firm, Adhuna Ltd, was contracted by WSP to conduct primary data collection under all of the above instruments, except for the Key Informant Interviews. In addition, short-term consultants (Mark Ellery and Elisabeth Kvarnstrom) were contracted to conduct the Key Informant Interviews and produce the draft SDA and PEA.

Detailed research protocols for the instruments in the table above are available in a separate instruments report here. This section briefly summarises each instrument, and the ensuing section describes the sampling approach.

Household survey

The household survey aimed to collect data from and about households using on-site sanitation (particularly those living in slums, informal or low-income settlements) regarding their use of FSM services and preferences for future FSM services. The household survey informs multiple components of this research. The sampling was carefully planned so as to allow conclusions to be drawn about the city as a whole on a representative basis, and about slum areas in particular, on a purposive basis. Questionnaire sections included household members and characteristics, use of water and sanitation infrastructure, usability and observation of latrines, satisfaction and planning on sanitation, filling up and emptying, and last time emptying.

Observation of service provider practices

The observation protocol involved making visual inspections about fecal sludge (FS) from pits or tanks to final disposal, in particular watching service providers (SPs) go about their business. It required the identification of hazards, hazardous events, and an assessment of possible risks at each stage (containment, emptying, transport, treatment and end-use or disposal) of the fecal sludge management chain.

Testing fecal sludge characteristics

The characteristics of faecal sludge will vary, depending on many factors including but not limited to the length of time for which it has been stored, the season, and the storage conditions (e.g. whether the sludge was in a lined or unlined pit). Assessment of the characteristics was required at three stages: (i) during removal, as this will influence the removal methods that could be used, (ii) after removal, as this will influence how the faecal sludge can be transported and treated, and possible resource recovery options, and (iii) after treatment, as this will determine the resource value of the end product derived from the faecal sludge.

Transect walk

The Transect Walk enabled participants to make a subjective and qualitative assessment of physical and environmental conditions within a community. During the walk, participants make systematic observations, discuss their observations and record their findings using a standard reporting format. The information collected complements information collected from household questionnaires, observations, and sample collection and analysis. For this study, a transect walk provides information about the broad environmental risks to public health, in particular with respect to the presence of fecal material and solid waste, and the likelihood that these enter drainage channels and water sources. When all observations are complete, participants ask community members a few short questions to gain information about typical behaviours in the community that could be a source of risk (latrines discharging to drains, overflowing latrines, illegal dumping of fecal sludge, etc.) and the frequency of those behaviours throughout the year (daily, weekly, seasonal, etc.). These walks were designed to give an overall picture of conditions in a neighbourhood, with the aim of this being built into a city-wide picture. They did not aim to allow detailed maps to be drawn with FS flows to be physically tracked, nor did they aim to make operational recommendations at the neighbourhood level. Further discussion of this issue is in Section 5.

Testing water supply and drain water quality

During transect walks, samples of drinking water supplies and water flowing in drains (drain water) were taken from a selection of PSUs in the city and tested for levels of *E. coli.* The results can help to identify the extent to which there is an association between poor FSM services and resulting levels of fecal contamination in the local environment (i.e. in water supplies and surface water drains). This information, together with results from transect walk observations, reported behaviours and practices associated with sanitation in the community and other data sources, helps build-up a picture of the public health risks associated with poor FSM services, associated with contamination levels (hazard), exposure and vulnerability.

Key informant interviews

Key informant interviews (KIIs) are the way in which primary information was sought to address key questions about how both the ‘enabling environment’ and the operating environment affects FSM services (past, current and future). KIIs were held with stakeholders having responsibility or interest in FSM services at city-level and beyond, allowing the enabling and operating environments to be better understood in relation to their influence within the city.

Focus group discussions

The objective of Focus Group Discussions (FGDs) with residents of informal settlements was to gather qualitative data that would complement, validate, or perhaps challenge responses made during the household survey. Questions focused on obtaining information relating to household sanitation and FSM practices (particularly identifying the practices of “others” as individuals are reluctant to talk honestly about their own, or their family’s, practices), service levels, past interventions, risks and other issues associated with FSM services that affect their community.

2.2 Sampling

2.2.1 Sampling for the household survey

The key sampling method was for the household survey, with the sampling approaches used for other instruments using the selected clusters as a basis for their own sampling. Therefore, the household survey is discussed first, and the remaining instruments are covered afterwards. Overall it is crucial to understand that in the sampling, two pictures were being sought: the first to give a representative understanding of the city-wide situation, and the second to give a specific understanding of the situation in slums on a purposive level.

The study population were people living in Dhaka, Bangladesh. Hence, the sampling frame for the household survey contains all urban areas within the boundaries of the Dhaka City Corporations (different definitions of Dhaka’s boundaries are discussed in section 3.1). Some non-residential areas were excluded from the sampling frame, which is discussed below.

There were two sub-sample areas (denoted A and B). Sub-sample A was representative of the city as a whole, while sub-sample B focused on poor urban areas (identified as ‘slums’ in Dhaka) without any attempt to be statistically representative. The aim of sub-sample A was to get city-representative estimates at minimum cost and minimum administrative burden. Therefore, it has a relatively small sample size, for example compared to what would be necessary for studies with different objectives (e.g. an evaluation aiming to attribute impact to an intervention).

Sub-samples and sampling units

For sub-sample A, the Primary Sampling Units (PSUs) were *mohallas*, which are an administrative unit akin to “urban neighbourhoods”. Mohallas are the lowest administrative unit in formal city arrangement, and sit below the ward level.[1] Lists of wards and mohallas were collected from both Dhaka North City Corporation (DNCC) and Dhaka South City Corporation (DSCC).

For sub-sample B, the PSUs were slum neighbourhoods, purposively selected from larger slum areas which were defined geographically using secondary data. The focus of the purposive sample was Mirpur and Uttara, two large slum areas in the north-west of the city which each received one third of the sub-sample B PSUs. This is because a World Bank-supported project is currently underway in those localities, as well as them being some of the largest slum areas in Dhaka (see Figure 3 in section 3.2 below).

The Secondary Sampling Units (SSUs) were households, in both cases. A list of slums in Mirpur was collected from the UPPR (Urban Partnerships for Poverty Reduction) project data for 2014. A list of slums in Uttara was collected from the Centre for Urban Studies (2005) study team, and was updated by Adhuna based on visits to these areas. Finally, a map of all Dhaka’s slums, based on remote sensing of Google Earth images in 2014, was collected from the World Bank. All three sources were used to build the list of potential sub-sample B PSUs to be purposively selected.

A map showing the location of sampled PSUs within wards is shown in Annex A.

Sample sizes

To estimate the sample size for sub-sample A, the statistical software EpiInfo was used. The sample size needed to generate city-representative estimates with a confidence level of 90% was predicted to be 360 households, given other variables in the power calculation.[2] Surveys placing a premium on representativeness would aim for 95% confidence, but it was decided that 90% was enough to give us a good idea of FSM services used in the city. It was decided to use the same sample size for sub-sample B, for ease of comparison and understanding. The power calculation would be identical for sub-sample B, but since the sampling is purposive rather than random, there is no specific level of confidence. The total number of households surveyed across both sub-samples was therefore 720.

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[1] In a household survey, households are the sampling unit we are interested in, but it is difficult and expensive to sample 1000 households from across a city completely randomly, as you would potentially have to go to 1000 different localities. Therefore, most surveys take an intermediary approach using clusters of households. This approach has two sampling units. The community/neighbourhood is the primary sampling unit (PSU) and the household is the secondary sampling unit (SSU). The reason we say PSU instead of community/neighbourhood is the former can be clearly defined geographically, whereas the latter means different things to different people. The size of a PSU will differ across cluster surveys. The gold standard is to use census enumeration areas (usually between 200-400 households), but this is not always possible.

[2] This is based on an expected frequency of 80%, a design effect of 2, a PSU/cluster size of 12, a total number of 30 PSUs, and a margin of error of 5%. For the city-wide sample, our indicator of interest is the proportion of households using on-site sanitation (OSS), which for Dhaka was estimated to be around 80%.

Sampling methodology

Sub-sample A – city-wide

A cluster random sampling method was used to sample the mohallas/PSUs to be surveyed. First, any mohallas which were outside the sampling frame were excluded, due to the study's focus on residential areas. These were any which were predominantly characterised by university areas, business districts, government administrative areas, military cantonments and diplomatic areas. The rationale for this was that, which the sanitation arrangements of such institutions are an important part of the whole picture, a socio-economic household survey can only interview residential households. Of the remaining mohallas, 15 mohallas from DNCC and 15 from DSCC were randomly sampled using a programme in Stata (a statistical software package), so as to account for the relative population size of wards and mohallas across the two This gave 30 mohallas out of 690 in the list. This can legitimately be called a city-wide sample of mohallas, with the caveats that non-residential areas are excluded and Dhaka is defined as the city corporation jurisdiction.

Households (SSUs) were sampled using systematic random sampling. Adhuna produced Google Earth images with the border of each sampled mohalla indicated. Next, they drew the largest possible rectangle that fits within the border of the mohalla, and divided it into twelve equally-sized blocks. Upon arrival in the block, the supervisor sent the enumerator to the centre of each block, and took them to a randomly selected household closest to the centre of that block, by spinning a pen and visiting the nearest household to which it was pointing, taking care to not be influenced by households which were easier to access. Where the nearest household was a building of more than one floor containing more than one household, a floor of the building was randomly selected.

Sub-sample B – slums

A purposive sampling method was used. First, collected lists of slums in Mirpur, Uttara and elsewhere from different sources (see above). Next, for Mirpur and Uttara, any slums were excluded which contained fewer than 200 households from the slum lists, then randomly sampled 10 slums from each of Uttara and Mirpur. For the rest of the city's slums, 10 slums were purposively sampled from other parts of the city, based on the World Bank map and aiming to balance a variety of geographical areas with a variety of slum sizes. Adhuna visited those 10 slums in advance to verify that they were slums as per the national definition.

For sampling households/SSUs, the same process was followed as in sub-sample A.

2.2.2 Sampling in the other instruments

Observation of service provider practices and testing FS characteristics

Fully recorded observations were made at 5 different locations, through all stages (where possible) of the sanitation service chain. The chosen observations reflected existing fecal sludge management practices as much as possible, considering both manual and mechanical, formal and informal emptying methods. Arrangements for observation were driven by the schedules of the service providers with whom Adhuna collaborated.

Tests for FS characteristics were carried out on FS collected during the observations, so the sampling method is identical.

Transect Walks

Transect walks were conducted in 40 PSUs in total: all 30 PSUs of sub-sample A and 10 randomly selected PSUs from the full list of sub-sample B PSUs. Annex D includes an explanation of the format and scoring used during the Transect Walks.

Testing water supply and drain water quality

Samples of drinking water supplies and drain water (water freely flowing in drains) were taken in 20 PSUs; 10 PSUs from sub-sample A and sub-sample B were randomly selected for transect walks. Water samples were taken from the three most common drinking water supplies identified in the PSU (through asking community members) namely piped water into the community, from groundwater sources within the community, or from surface water sources. Samples were taken at the source of the supply and tested for levels of *E. coli*, to identify contamination in the supply itself and avoid measuring contamination resulting from poor water storage or handling practices. Drain water samples were taken from locations to represent the three most common types and characteristics of drains in the community (identified during the transect walks) and also tested for levels of *E. coli*, to identify contamination from poor sanitation and fecal sludge handling within the PSU. A standard procedure for collecting samples was followed, with samples sent to registered laboratories for testing.

Key informant interviews (KIIs)

The total number of interviews required, as well as the range and extent of questioning, was influenced by the availability of current and reliable data from other sources, as well as constraints on time and resources. Selection of interviewees was purposive, based on advice received from stakeholders and existing knowledge of the World Bank consultant.

Focus group discussions (FGDs)

10 FGDs were held with households from 10 sub-sample B PSUs, which were randomly selected from the total of 30 sub-sample B PSUs in slum areas.

2.3 Fieldwork implementation

Pretesting, training and piloting

Initial pre-testing was carried out by Adhuna to refine the instruments before a week of enumerator training. During the training, all data collection instruments were piloted in urban communities in both higher-income and lower-income areas, as part of field practice for the enumerators. The team then joined a debriefing session before starting data collection.

Field team composition

For the quantitative survey, four field teams were deployed for data collection. Each team was composed by one Supervisor and two Household Enumerators. In addition to that there was one qualitative team composed of one supervisor and two qualitative researchers. An experienced Field Manager was responsible for ensuring overall management, field implementation and quality assurance.

Data collection

The field teams collected the majority of the data from the 60 sampled PSUs in 4 weeks during September-October 2014. On average, each team spent one day in a PSU. Each household interviewer conducted the survey in 6 households per day, and thus each team with 2 interviewers completed 12 households in a cluster in one day. For the transect walks (TWs), five teams of two participants conducted all 40 TWs over 7 days (5 consecutive days in late September / early October for 37 TWs and a further 2 days in late October to complete the remaining 3 TWs). Teams conducted between 2 and 10 TWs each. Observations of service providers were conducted over a 1 week period in mid-November, with 2 observations carried out on the first day and the remaining 3 on the subsequent days. The delay to data collection was waiting for the pit emptiers that Adhuna was in contact with to be called to carry out emptying services.

Data entry, cleaning and analysis

The quantitative survey data were entered into SPSS at Adhuna’s offices in Dhaka, using various data quality checks, including range checks, skips and internal consistency checks. After data cleaning checks, data were then transferred into the statistical software Stata. Data were analysed using Stata in OPM’s offices in Oxford.

2.4 Limitations

This study has various limitations which are important to explain, so that readers understand the strengths and weaknesses of the data and what conclusions can and cannot be drawn from the analysis. These should be considered in the context of the objectives of the study (see section 1.2 above). These are:

- Socio-economic survey – household surveys with enumerators skilled in social research can only really ask question of householders. Such individuals cannot make technical inspections of infrastructure which would require a different skillset. Therefore, it is necessary to take the household’s responses at face value (e.g. about the destination of their blackwater). Furthermore, it was not possible to physically establish the pathways of FS once it has left then household (e.g. which kind of drain, or its ultimate destination).

- Sampling method – sample surveys are designed to estimate indicators for a broader population. Therefore, they cannot produce detailed data for specific neighbourhoods without dramatically increasing the sample size and appropriate stratification. The sample size is relatively small, compared to what would be necessary for an impact evaluation, for example. In a similar vein, transect walks aimed to build up a broad picture rather than specific maps or explanations for individual neighbourhoods. In addition, the study only focuses on residential areas and households, not institutions.

- Definition of Dhaka – as explained in section 3.1, the definition of Dhaka used is the area under the jurisdiction of the two Dhaka City Corporations (covering about 7 million people), rather than any other definition in use.

- Seasonality – The data collection took place at the end of, or just after, the monsoon season in Bangladesh, which runs from May to September. The timing of a survey will always influence its results, which is true for several of the instruments used in this study. In this case the most likely influence is that drains were running fuller than normal, which could have diluted the fecal load and made the *E. coli* counts lower than would be expected, particularly at the height of the dry season. Other influences may also have been taking place, such as changes in water usage patterns and latrine emptying rates.

3 Background to Dhaka city

3.1 Dhaka overview

Bangladesh is one of the most densely populated countries in the world with approximately 160 million people living in a land area of around 150,000 km^2. The country is moving convincingly towards achieving most of the Millennium Development Goal targets and in particular has made remarkable progress in the reduction of open defecation to just 3% nationwide (WHO/UNICEF, 2014). While the majority of the population still lives in rural areas, the urban population has been growing rapidly from just 5% of the total population in 1971 to 27% in 2008.

Dhaka is reportedly the fastest growing city in the world, with a growth rate of around 3% per annum. This adds an estimated half a million people per year to the 14 million people already residing in Dhaka mega-city. An associated trend is the vertical expansion of the city, which has seen houses making way for multi-storey apartment blocks, which then in turn have made way for high-rise buildings. Expansion of the sewerage network has not kept up with population growth.[3] . Anecdotally, from key informant interviews with sweepers, there has also been a decrease in demand for the emptying of septic tanks. Given the near absence of a mechanical emptying market in Dhaka, this suggests an overall increase (both in relative and absolute terms) in households connecting pits and septic tanks to drains of various kinds. Regardless of the trend in recent years, it is clear that a large fecal load is ending up in the storm water drainage system. Further details are provided in section 6.

Defining the boundaries of Dhaka is not straightforward – different definitions and jurisdictions are shown in Table 3. For this study, “Dhaka” was defined as being the areas under the jurisdiction of the Dhaka City Corporations, commonly referred to as “Dhaka City”. This is due to this being the most commonly-understood term and it being administrated by a clear authority. Ultimately, one definition had to be selected and the one most appropriate for both city planning was selected, so it is justified to call this a city-wide sample. It should also be noted that the boundaries of Dhaka City do not fully align with DWASA’s service area.

Table 3 Differing definitions of Dhaka

	Area (km^2)	Households	Population	Notes
Dhaka mega-city (Dhaka Action Plan area)	767	3,337,130	14,171,567	commonly called Dhaka Action Plan (DAP) area:(including adjoining urban areas, some of which are outside Dhaka district)
Greater Dhaka	316	2,034,146	8,906,039	DCCs + 17 rural unions, not often referred to
Dhaka City	126	1,576,746	6,970,105	98 Wards of DCCs + 1 Cantonment & Birman Bandar, commonly called Dhaka City

BBS Population & Housing Census, 2011

[3] DWASA’s 2013 Sewerage Master Plan for Dhaka City (see section 3.2) refers to

While average incomes in Dhaka are relatively high as compared to the rest of Bangladesh, the absolute number of poor people in Dhaka is also very high. Over one-third of all Dhaka residents live in slum areas with densities 7-8 times greater than the city average.

The topography is extremely flat and close to sea level. Much of the city sits on a layer of Madhupur clay that extends to a depth of about 10m. Other areas sit on a variety of soil types, including loose and soft silty clay, clayey silt or organic clay. It is widely recognised that, as these soil types have low infiltration capacity they are not suited to the infiltration requirements of on-site sanitation systems needing to 'drain away' effluent, such as correctly installed septic tanks.. Dhaka experiences a hot, wet and humid tropical climate. The monsoon between the months of May and October is responsible for over 85% of the annual average rainfall of over 2,000mm. This combined with the urban density and destruction of water bodies leaves Dhaka highly susceptible to seasonal flooding.

Until November 2011, the task of running the affairs of the city of Dhaka was undertaken by the Dhaka City Corporation (DCC), comprising 92 wards. At that time, it was split into two parts – Dhaka North City Corporation (DNCC) with 36 wards, and Dhaka South City Corporation (DSCC), with 56 wards. Each is headed by a government-appointed administrator. The DCCs are designated as autonomous bodies responsible for municipal services (i.e. public health, water supply and drainage, roads, etc.) and given fund-raising power including levying of rates, fees and rents. However, the Government reserves the right to intervene in their affairs, e.g. by appointing the Chief Executive Officer, or transferring functions.

According to the population census 2011, 78% of the population of Dhaka city live in rented housing. In 2005 it was estimated that there were over 3 million slum dwellers residing in 5,000 slums, comprising 35% of the population of Dhaka city at that time (Centre for Urban Studies, 2005).[4] Slums and squatter settlements are increasingly concentrated on the fringes of the city, due to an acute demand for land and high land prices, especially in the central zones and upper class residential areas.

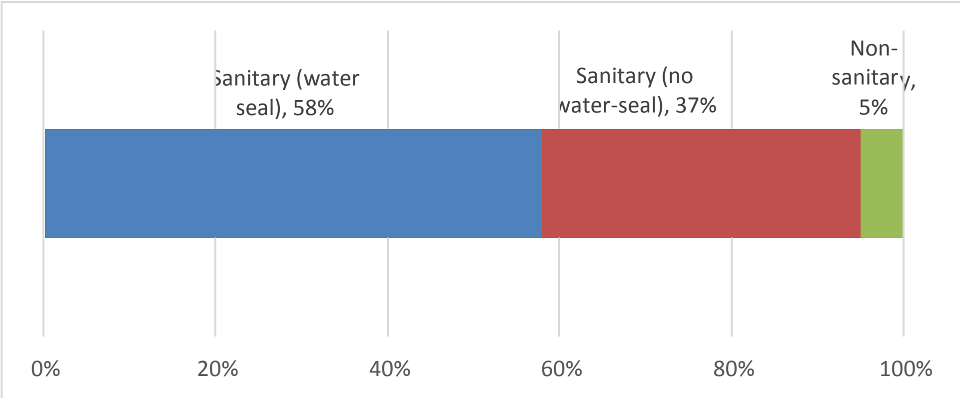
3.2 Dhaka's sanitation context

According to the 2011 census, access to "sanitary" latrines within the Dhaka City Corporation area is 94%. The Bangladesh Bureau of Statistics (BBS) definition of a sanitary latrine comprises of two arrangements: either a sanitary latrine with a water seal, where feces are covered by the water that remains in the water seal (or pan) after use; or a sanitary latrine without water seal, or where the water seal is broken, such that water does not remain in the pan after use. Data are shown in Figure 1 below. The census identified extremely low rates of open defecation within the city (0.3%, not shown in the chart), and relatively low use of non-sanitary latrines (5%).[5]

[4] Updated data from a slum census conducted by BBS in 2014 should be available by mid-2015.

[5] Ideally we would also show the census data re-categorised by JMP definitions, but this is not possible without access to the raw census data. Shared sanitation is particularly important in Dhaka, as is shown in our data in section 4 below. The definitions of sanitary and non-sanitary latrines are from the National Sanitation Strategy 2005, with the key difference being whether the passage between then squat hole and pit is sealed (either by a lid or a water seal).

Figure 1 Use of sanitation in Dhaka, by type of facility (Census, 2011)



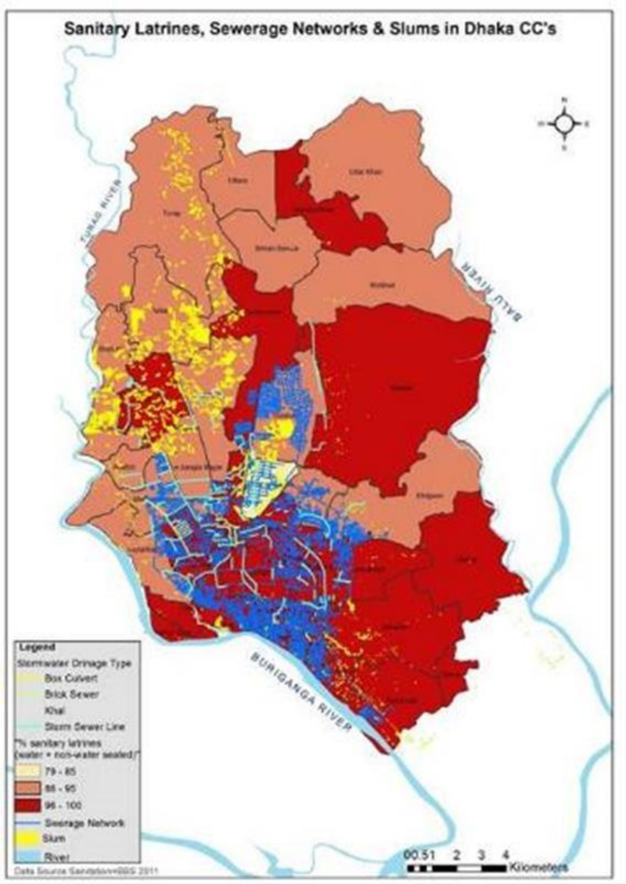
Definitions used by the Bangladesh Bureau of Statistics (as well as the Millennium Development Goal for sanitation) relate to the type of user-interface (i.e. the latrine itself), without reference to how or where the latrine discharges fecal waste beyond this containment stage, through to further stages of the sanitation service chain. However, for the purposes of this study, the focus is primarily the management of fecal sludge from latrines (i.e. the containment stage) and to an extent all forms of fecal waste flows, including sewerage, through to end-use/disposal (see Figure 2 below).

Figure 2 The sanitation service chain

The study is not focusing on the structural conditions or the latrine itself, so much as the extent to which it contains / does not contain fecal sludge and what happens to the fecal sludge from this stage onwards. For this reason, the household survey and later sections of this report refer to different categories for household sanitation facilities and assesses fecal sludge management in relation to the service chain above.

In addition, the spatial dimension of access to sanitary latrines and sewerage networks is also important. This is shown in Figure 3 below, which overlays spatial data on use of sanitary latrines (red/pink shading) with sewer network (blue lines) and slums (yellow shaded). As can be seen, the sewerage network only covers a small proportion of Dhaka geographically, and is by no means used by all residents in the areas nominally “covered”. Slums are dotted around the city, but there is a significant concentration in Uttara and Mirpur in the north-west of Dhaka.

Figure 3 Indicative map of sanitation in Dhaka City, overlaid with slum locations and the sewerage network



It is beyond the scope of this report to undertake a detailed literature review of the sanitation context in Dhaka or summarise the history of urban sanitation sector development. It is however necessary to highlight a few key documents and studies which are directly relevant to the objectives of this study. In terms of sector context, two key documents should be mentioned, which are DWASA's 2013 Sewerage Master Plan for Dhaka City (prepared by Grontmij), and the 2014 Draft Institutional and Regulatory Framework for Fecal Sludge Management in Dhaka City (prepared by ITN-BUET). The former sets out DWASA's stall in terms of planning for the wastewater management and sanitation systems in Dhaka city with a planning horizon of 2035. The latter has sets out a proposed framework for FSM which was welcomed by DWASA.

In terms of studies, the key reference is the 2011 study of FSM in three cities of Bangladesh, including Dhaka, by WaterAid Bangladesh (funded by BMGF). It provides some of the only detailed household survey data on pit/tank emptying available prior to the present study. In terms of sampling, it is not representative of the city, since households were drawn from pockets in the fringe of the city which require emptying. It is therefore most comparable to sub-sample B in the present study.

3.3 Dhaka's FSM context

Later sections of this report will identify the scale of FSM services and its implications, based on extensive qualitative and quantitative data during the city-wide study. Here, the roles legally assigned to the key actors involved in FSM are briefly presented, based on the key informant interviews and field experience gathered by the World Bank consultant. The list is not exhaustive. How this plays out in reality is covered in section 9.

Table 4 Roles assigned to key FSM stakeholders

Categories	Stakeholder	Assigned roles
National government	Ministry of Local Government, Rural Development & Co-operatives (LGD)	**Sanitation / Drainage / Solid Waste Policy** - Set / evaluate FSM standards - Set / evaluate drainage & solid waste
	Ministry of Housing and Public Works (UDD, HBRI)	**Urban / Housing Policy** - Oversight of spatial planning (UDD) - Development of the Building Code (HBRI)
	Ministry of Environment and Forests (DoE)	**Environmental Standards** - Environmental project clearances - Regulation of industrial discharge permits - Promulgation of standard limits for waste
Local government	RaJUK (Capital Development Authority)	**Planning & Building Standards** - Land use permit (against spatial plan) - Building permit (against building code) - Builders compliance (against inspection)
	Dhaka City Corporations (North & South)	**Ensure Sanitation** - Occupancy Permit (against inspection) - Trade Licenses (against competence) - Manage open drains & small bore drains
	Dhaka Water Supply & Sewage Agency (DWASA)	**Water Supply, Sewage & Drainage Provision** - Manage sewage pumps / treatment plants - Manage storm water drainage system
Private sector & NGOs	Property Developers	Install septic tanks / leach pits or connect to sewerage
	Households	Engage emptiers to remove fecal sludge from septic tanks & unblock sewers
	Sweepers	DCC contract sweeper staff that clean DCC roads & open drains & storm water drains
	DSK (Dushtha Shasthya Kendra)	Manage VacuTug collection services in LIC areas & dump in sewage pump stations

4 Fecal Waste Flow Diagrams

4.1 Introduction

Fecal Waste Flow Diagrams (also known as 'shit flow' diagrams, or SFDs) are an innovation arising from WSP's 12-city study of FSM (Peal et al., 2013). In short, an SFD is a visualisation of how fecal waste (fecal sludge or wastewater) flows along the sanitation service chain. At each stage of the chain, the proportion of fecal waste that is or is not effectively managed to the next stage of the chain is indicated.[6]

This means that:

- where fecal waste is deemed to be effectively managed from one stage of the chain to the next (for example where wastewater from cistern flush toilets is effectively transported through sewers to a designated treatment site, or fecal sludge is transported by tanker to a designated disposal site), the SFD shows the flow of fecal waste continuing along the chain – and the arrow representing that flow of fecal waste to the next stage remains green;

- where fecal waste is deemed to be not effectively managed from one stage of the chain to the next (for example where wastewater leaks from sewers before reaching a designated treatment site, or fecal sludge is dumped into the environment or drainage channels), then the SFD shows the fecal waste "dropping out" of the service chain – and the arrow representing that flow of fecal waste turns brown.

The proportion of fecal waste that is effectively managed all the way to the end of the service chain is indicated as "safe", with the remaining proportion that has dropped-out of the chain deemed "unsafe". The primary destination of that "unsafe" fecal waste is indicated e.g. receiving waters, general environment, drains etc.[7] Thus far, SFDs in different cities have been undertaken using different methodologies, as is often necessary in the context of poor data availability. Furthermore, most SFDs so far (including those in the 12-city study) were undertaken using secondary data and expert estimates. This study is amongst the first to use primary household survey data and field-based observations to construct SFDs. A group of urban sanitation experts is currently discussing the 'roll-out' of the use of SFDs, for which other methodologies will be developed.[8]

One of the benefits of the sampling approach for this study is that it is possible to develop separate SFDs which are (i) representative of the city-wide situation, and (ii) indicative of the situation in low-income settlements (see section 2.2 above)

[6] Previous iterations of SFDs distinguished between safe and unsafe practices, but here we refer to effective/ineffective management. This progression has been made because it is difficult be sure of the safety of the process, but if the fecal waste is managed to the next stage of the sanitation service chain we can say it is considered as an effective process.
[7] It is acknowledged that FS may pass from drains into other water bodies, e.g. rivers, but the diagram focuses on the *primary* destination. It was beyond the scope of this study to be able to track the pathways of sludge beyond the household, e.g. which types of drains did it pass through and where was its eventual destination.
[8] See website for the SFD promotion initiative - http://www.susana.org/en/sfd

4.2 Methodology

For this analysis, several key indicators from the household survey were used. In particular, data from the following household survey questions was used:[9]

A. “What kind of toilet facility do members of your household usually use?”

B. “Where do the contents of this toilet empty to?”

C. “What did you do when the pit or septic tank filled-up last time?”

D. “What was [the faecal sludge] emptied into?”

Of these, question ‘B’ is one of the most crucial for the construction of the SFD. It should be noted that the household’s response is taken as given. It was not possible to confirm responses by observation since enumerators were selected for a background in social research and not sanitation. It was however felt that they could be trained to observe ‘above-ground’ components, so observation of slab, water seal, superstructure, etc. was carried out in all households where permission was given.

Given that ‘B’ is based on household response, possible sources of bias include the household not knowing the true answer, or knowing it but answering differently for fear of being identified as practicing illegal behaviour (e.g. pits/tanks connected to drains). The former is certainly likely, the latter does not seem to be an issue given the vast majority of households who willingly disclosed illegal behaviour.

To analyse this data, an SFD matrix is created, as shown in Figure 4 below. It shows which data sources are used and how they are analysed into levels of effective / ineffective management of fecal waste through the stages of the service chain – with results in the next section.

First, the household survey data on use of infrastructure (questions (A) and (B) above) is used to allocate households to five categories shown in the column marked (1) in the figure below:

(i) **“Sewered (off site centralised or decentralised)”** – toilets connected to sewers (not OSS)

(ii) **“On-site storage – emptiable”** – OSS toilets (involving pits or tanks) which can be emptied. However, they can also be connected to drains through an overflow, to avoid the need for emptying. These toilets are emptiable but may or may not be emptied.

(iii) **“On-site storage - single-use / pit sealed”** – OSS toilets where pits or tanks are sealed and/or abandoned once full. These toilets are emptiable but never emptied.

(iv) **“On-site non-storage - straight to drain/similar”** – OSS toilets which connect to drains or open water bodies (e.g. hanging latrine, or latrine with a pipe connecting the pan directly into a drain). These toilets are therefore non-emptiable.

[9] Full response categories for these questions are included in the survey questionnaire, to which there is a web link in Annex D. In particular, it should be noted that the response categories to question B above were: (i) Directly to piped sewer system, (ii) Septic tank connected to "piped sewer system", (iii) Septic tank with no outlet, (iv) lined pit with no outlet, (v) septic tank connected to drain, (vi) lined pit with overflow to drain/elsewhere, (vii) unlined pit, (viii) directly to sea, lake or river, (ix) directly to drain/ditch

(v) **"Open defecation" –** self-explanatory

The question of emptiability is key. Category (ii) above is denoted as emptiable, meaning that this containment option involves a pit or tank which fills with FS. In Dhaka, many such pits/tanks are also connected to drains through a variety of means (e.g. overflow pipe). This means that while they are emptiable they are not in fact emptied as often as would be expected, or even at all. Between the two extremes of a closed system and a system which never fills up, there is a spectrum of scenarios. For example, some pits/tanks may have an overflow to the drain but may still require emptying if they become blocked. This is partly reflected in the data below.[10]

The data from questions (A) and (B) at the beginning of this section are allocated in column (2) below (a key shows the meaning of the colour-coding of cells by data source). Next, the proportions for each of the stages of the chain are allocated. As can be seen from the emptying column, marked (3), a certain proportion of the population's FS which makes it to that stage is emptied by a service provider, and the rest is not emptied (e.g. overflows to drains). This is estimated by dividing the number of households which reported emptying their pit (question (C) above), by the number of households using emptiable technologies (questions (B) above).

The rest of the matrix follows similar logic. Full SFD matrices for the two sub-samples in Dhaka are provided in Annex A, along with further methodological notes. This section has given a brief overview of where the data underlying the SFDs comes from. The SFDs themselves are more intuitively appealing and are presented in the next section.

It should be noted that since the data comes from a household survey, the proportions in the matrix are proportions of households, not proportions of people or of FS volumes. In Dhaka, the mean household size for sub-samples A and B was 4.8 in both cases.[11]

[10] As will be seen, only 2% of households city-wide reported using a sanitation facility with no outlet, whereas 13% of households city-wide reported experiencing a pit or tank filling up. This suggests that some of those with who cross-connected to the drains did in fact have to empty their pit at some point.

[11] The impression given by the SFD therefore involves assumptions that (i) each person produces the same amount of FS, and (ii) pit accumulation rates are constant across the city. This is an approximation but the most pragmatic approach in the context of uncertainty around FS volumes. FS volume only really becomes an issue when considering the extent of change in service levels needed to deal with the amounts. This study is primarily about identifying the broader picture of *where* the management of FS is or isn't effective, not what volumes are being managed or mismanaged.

Figure 4 Faecal Waste Flow Matrix – empty example

1	2			3						4
		Containment		Emptying		Transport		Treatment		Overall
		of which		*of which*		*of which*		*of which*		Safe:
Type of system	*% pop. using*	*contained*	*not contained*	*emptied*	*not emptied*	*transported*	*not transported*	*treated*	*not treated*	0%
Sewered (off site centralised or decentralised)		100%	0%	100%	0%		100%		100%	
		0%	0%	0%	0%	0%	0%	0%	0%	0%
On-site storage - emptiable		100%	0%		100%		100%		100%	
		0%	0%	0%	0%	0%	0%	0%	0%	0%
On-site storage - single-use / pit sealed		100%	0%							
		0%	0%							
On-site non-storage - straight to drain/similar		0%	100%							
		0%	0%							
Open defecation		0%	100%							
		0%	0%							
		Containment	0%	Emptying	0%	Transport	0%	Treatment	0%	
Unsafe:	0%		0%		0%		0%		0%	
Affected zones (you can adapt the terms to suit the context)		*Local area and beyond via drains (amount direct to groundwater not identified)*		*Local area (via overflowing latrines or dumped FS)*		*Neighbourhood (via leakage/overflow from sewers or drains)*		*Receiving waters (via sewer outfall/discharge)*		

(orange)	from household survey
(yellow)	from secondary data
(grey)	de facto value

4.3 Results

Firstly, the key household survey results which are inputs to the SFD are shown in the tables below. They are reported separately for the city-wide representative sample (sub-sample A) and the slum/poor areas sample (sub-sample B). After that, a separate SFD matrix and diagram for each sub-sample are presented.

4.3.1 Household survey results as an input to SFD

As can be seen from Table 4 below, the vast majority of households in the city-wide sample used a pour-flush latrine (82%). The same category was also the most common in the slum sample, albeit lower (46%). Unimproved latrine technologies (e.g. pit latrine without slab, hanging toilet) were found in the slum sample but not the city-wide sample. No households reported practising open defecation.[12]

Table 4 Sanitation facility used, by technology type

	City-wide		Slums/poor areas	
	%	No. of households	%	No. of households
Cistern flush	18.1	65	0.0	0
Pour/manual flush	81.9	295	46.4	167
Pit latrine with slab	0.0	0	34.7	125
VIP latrine	0.0	0	0.8	3
Pit latrine without slab	0.0	0	6.4	23
Hanging toilet/latrine	0.0	0	10.3	37
Other	0.0	0	1.4	5
Total	**100.0**	**360**	**100.0**	**360**

[12] The city-wide sample is designed to be representative of the whole city, so should include some slum areas. Given the sampling approach, it is impossible to know which of the city-wide PSUs are actually in slums. The data above suggests that not very many were, given the low prevalence of latrine types typical of slum areas in the city-wide sample. We can further pursue this question using the housing characteristics data.

The table above shows the basic categories, but it is also important to consider the proportion of these which are shared. This is relevant, not just in terms of developing the standardised indicators of the WHO/UNICEF JMP, but also because the FSM arrangements for shared latrines are likely to be different from those of 'private' latrines from a management perspective. This is because accountability for dealing with full or blocked pits, as well as payment for FSM services, may be less clear-cut in a 'shared' situation, recognising that this label could refer to a large number of scenarios. The technology and service used would be as for private facilities, while noting that shared pits/tanks would be likely to fill more quickly, depending on the number of users.

As can be seen from Table 5 below, 78% of households city-wide used a facility considered improved under JMP definitions, whereas this was only 17% for the slum sample. It should be emphasised, however, that 65% of the slum sample used a latrine which was an improved technology but shared with other households or a public facility. Overall, 78% of slum households used a latrine (improved or unimproved) which was shared between 2 or more households. Further sections below go into this in more detail.

Table 5 Sanitation facility used, by JMP category

	City-wide		Slums/poor areas	
	%	No. of households	%	No. of households
Improved	77.5	279	16.7	60
Improved shared[13]	22.5	81	65.3	235
Unimproved	0.0	0	5.8	21
Unimproved shared[14]	0.0	0	12.2	44
Total	**100.0**	**360**	**100.0**	**360**

As noted above, the most important question in the survey is where the contents of toilets go after flushing or similar. The standard question in the Demographic and Health Surveys (DHS) incorporate this into the overall sanitation question (see WHO/UNICEF core questions), it was necessary to ask it separately in order to get better quality data.[15] Household-reported data is relied upon for this indicator, while noting that households may not always know the full detail, especially if they are renting, or may answer untruthfully[16]. Furthermore, with a socio-economic survey rather than a technical survey, it was not possible to physically verify household's answers to this question, which would have required a different kind of expertise amongst enumerators. Nonetheless, a large proportion of the enumerator training was spent ensuring that the enumerators fully understood distinctions between the response categories.[17]

[13] The JMP definition of a shared facility is one which is used by 2 or more households (including a public facility).
[14] "Unimproved shared" is not a category usually reported by the JMP, but it is useful to report for our purposes, so we can see the full proportion of households sharing latrines.
[15] As stated above, the question asked was "Where do the contents of this toilet empty to?". The question is answered by all households, regardless of whether they owned a private toilet, managed a shared toilet or used a shared toilet.
[16] We are relatively confident in this data because the figure for sewerage is around 25%, which is more or less what was expected. Of course this does not mean that the waste going into the sewer makes it through the system or is treated.
[17] In Table 6, the data are reported as per the response categories used in the questionnaire, with footnotes in the table below qualifying aspects of the data. The response categories used were developed on the basis of discussion with experts on sanitation in Dhaka regarding prevalent containment options.

The results were grouped into risk categories based on the relative risk to public health from a combination of the type of containment arrangement and where the FS and effluent empty to:

- **Low-risk** categories are those where the FS can be considered to be contained (in JMP terms), at least in relation to the first stage of the service chain.
- **High-risk** categories are those where the FS goes directly into the environment and so potentially poses a risk of exposure to the public, whether via drainage systems or water bodies that people interact with (especially children).
- **Medium-risk** categories are those where there is at least some containment in a pit or septic tank, but those pits/tanks either: a) have outlets connected to drains which allow only partially digested effluent to flow through, or b) are unlined, allowing FS to leach into the surrounding soil and groundwater which may be used for domestic purposes (e.g. washing clothes). These scenarios still represent a risk, but it is somewhat lower than contact with fresh FS as in the high-risk category above

The results are shown in Table 6 below. Unsurprisingly, high-risk blackwater management practices are more common in the slum sample (71%) than the city-wide sample (21%). It is worth emphasising that toilets were connected to drains (either immediately or after intermediate storage in a pit/tank) for 71% of households city-wide, and 87% of slum households.

Cutting the data another way, it is important to note that 75% of households city-wide use what is considered as an on-site sanitation system, whereas 100% of households in slum areas do so. However, in practice the majority of these on-site systems connect into the drainage network, either directly or via an on-plot pit/tank.

Table 6 Management of blackwater – where toilets discharge to

	City-wide		Slums/poor areas	
	%	No. of households	%	No. of households
Low risk	**29.2**	**104**	**11.9**	**43**
Directly to piped sewer system	24.7	88	0.0	0
Septic tank with no outlet[18]	2.0	7	6.4	23
Septic tank connected to piped sewer system	2.5	9	0.0	0
Lined pit with no outlet	0.0	0	5.6	20
Medium risk	**49.7**	**177**	**17.3**	**62**
Septic tank connected to drain	49.7	177	14.2	51
Lined pit with overflow to drain / elsewhere	0.0	0	2.5	9
Unlined pit	0.0	0	0.6	2
High risk	**21.1**	**75**	**70.9**	**255**
Directly to drain/ditch	21.1	75	70.6	254
Directly to sea, lake or river	0.0	0	0.3	1
Total	**100.0**	**356**	**100.0**	**360**

[18] A septic tank without an outlet is really a holding tank, equivalent to a lined pit. In reality, it may or may not be fully lined, or have a sealed base.

With so many pits and tanks connected to the drainage system, it is not hard to see why there is such a limited market for FSM services, as outlined in section 3.2 above. In order to assess the potential demand, households were asked whether their pit/tank had ever filled up (if they had one). The results are shown in Table 7 below. As can be seen, in the city-wide sample, only 13% of those answering the question (i.e. 10% of the 360 households overall) reported having experiencing the pit or tank of their toilet filling up.[19] These proportions are very similar in the slum sample (13% of those responding, 10% of overall slum households).

Table 7 Proportion of pits/tanks which have ever filled-up

	Pit/Tank ever filled up?	No. of households
City-wide		**295**
Yes	12.5%	37
No	87.5%	258
Slums/poor areas		**259**
Yes	13.1%	34
No	86.9%	225

Finally, it is worth considering reported household behaviour in the context of pits filling up. This was assessed by asking about what action the household took last time this happened. As can be seen across both sub-samples, almost all households emptied the pit/tank and then reused it. The nature of the service they used, and associated data, is discussed in section 6 below. Combining these data, the conclusion is that 8% of households in Dhaka overall have emptied a pit or tank, as compared to 10% in Dhaka's slums.[20]

Table 8 Past action after pit or tank filled-up

	City-wide		Slums/poor areas	
	%	**No. of households**	**%**	**No. of households**
Emptied and reused pit/tank	93.8	30	97.4	37
Abandoned and pit/tank unsealed	6.2	2	0	0
Covered and used alternative pit	0	0	2.6	1
Total	**100.0**	**32**	**100.0**	**38**

4.3.2 Presentation of SFDs

Using all these results, two sets of SFD matrices and diagrams were constructed: one for the city-wide sample and one for the slum sample. These are presented as Figure 5 and Figure 6 below. SFDs work on the same principle as the matrix shown above. Household's toilet technology and associated containment method is shown on the left, with intermediate steps and primary destination of the FS shown along the sanitation service chain. What is clear from both SFDs is that the majority of FS in Dhaka is not effectively managed. Some 99-100% eventually ends up in the city drains or receiving waters untreated, regardless of its route. It is

[19] Households were only supposed to answer the question if their latrine was connected to a pit or tank, with a "not applicable" response category for others.
[20] This comes from 30/360=8% and 37/360=10%

notable that only about half of households in Dhaka overall use a toilet which is “emptiable” (see definitions in section 4.2)

For clarity, it is worth briefly describing the city-wide results. Dhaka has a sewer network which covers part of the city, with 25% of households in city-wide sample reporting being connected to a sewer.[21] However, as shown in Figure 5, only about 1.2% of households’ FS which enters the sewer ends up being treated (this comprises the faecal waste of 0.3% of households overall). This is due to leakages in the system and deficiencies at the treatment plant (explained in discussion on treatment in section 7.2.1).

The other 75% of households reported using an improved latrine, though many are shared (and noting the caveats above regarding slums in the city-wide sample).[22] However, as shown below, all of the FS from those toilets ends up in the environment or drains, by three different routes. Some households have latrines with no storage component, i.e. the contents travel straight to the drains. Overall, this is the case for 21% of households’ FS city-wide. If there is containment of some kind (e.g. a pit or tank), for 46% of households’ FS overall, this goes through to a drain via a connection from the pit or tank. In the small proportion of cases where the containment chamber is emptied (8% of households overall), the methods used result in the FS ending up in the drains (see section 5.2.3) Overall then, as shown in the SFD, only 1% of households’ FS in Dhaka is effectively managed.

Considering next the SFD for the slum sample (Figure 6), the main differences are that some people are using unimproved sanitation options (18% of households overall). In slums, only 29% of households use a facility which is emptiable (against 54% city-wide).[23] However, it was found that households in slums are more likely to have decided to empty a pit or tank (see Table 8). This is most likely because in some densely-populated slum areas, drainage is less formal and there may not be nearby drains to connect to.

Of those households with an emptiable pit or tank, about a third have actually emptied it, which equates to 10% of slums households overall using an emptying service. Similar to the city-wide sample, qualitative research in slum areas found that all of the FS that is emptied ends up in the drains and eventually the wider environment. Overall then, 0% of households’ FS in slums is effectively managed.

[21] Households were asked to show their DWASA sewerage bill if they responded with this option. 25% is slightly higher than the general estimate of 20%, but is within the bounds of sampling error in a sample of only 360 households

[22] Note that not all cistern flush toilets go into sewers, and not all pour-flush toilets go into pits/tanks. The small black arrows in the diagram illustrate this. What matters is the blackwater management.

[23] This data comes from Table 6, but is more clearly shown in the SFD tables in Annex B.

Figure 5 Faecal Waste Flow Diagram for Dhaka – city-wide sample

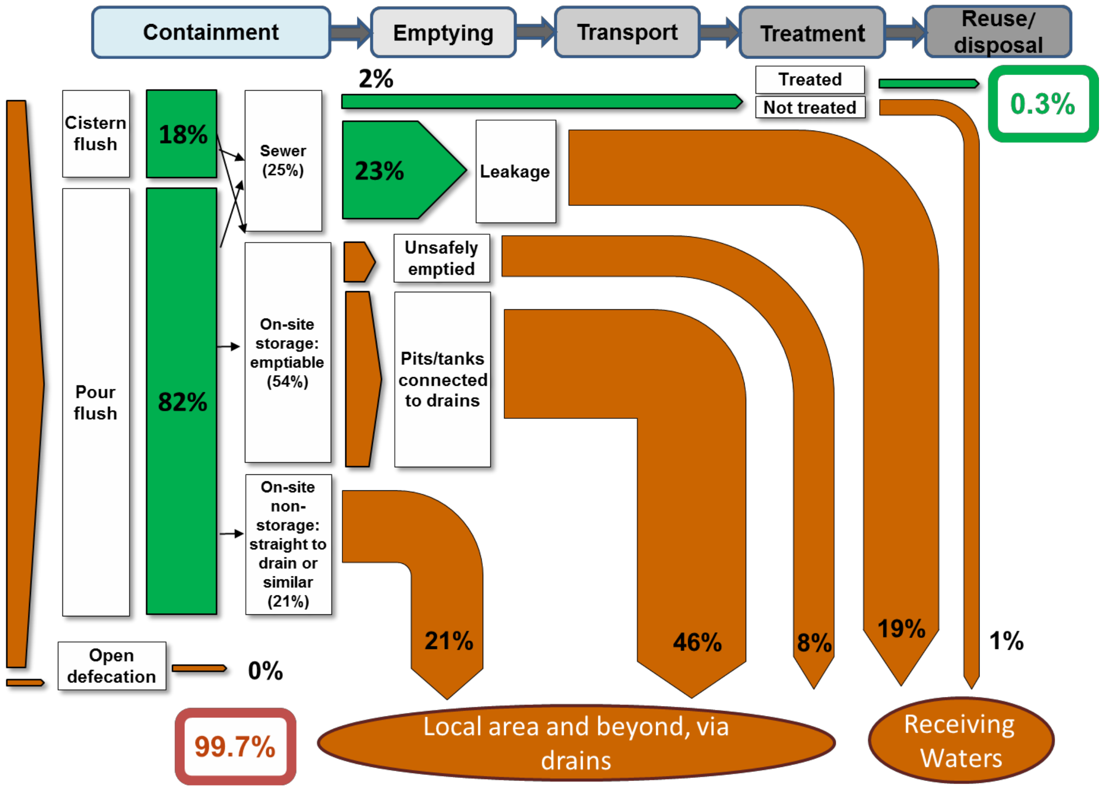
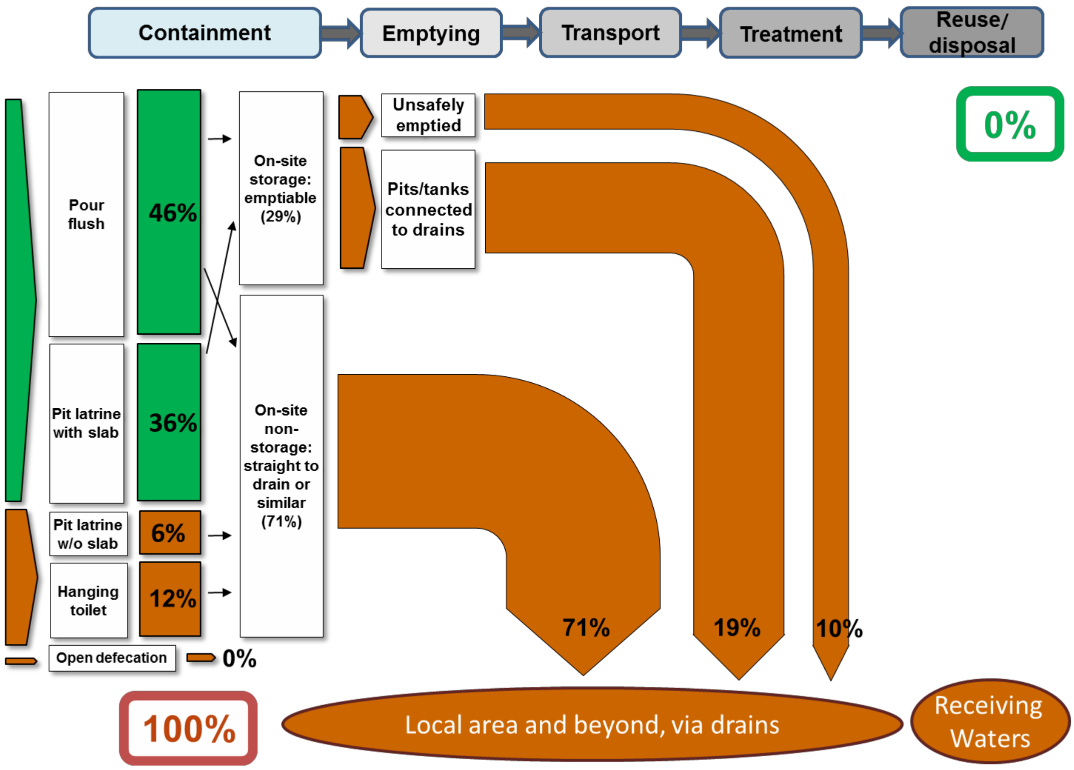


Figure 6 Faecal Waste Flow Diagram for Dhaka – slum sample



4.4 Implications of the SFDs for FSM in Dhaka

The city-wide SFD shows that almost all FS is ending up in the drains or environment one way or another. It is therefore not surprising that a market for FSM services barely exists. Only 10% of households city-wide have experiencing a pit filling up. It must be emphasised that having large amounts of FS in the drains and environment is an externality which affects everyone in Dhaka. Poor FSM is not only a private household matter – it is a public health and environmental hazard. Most of the time, it mainly affects poor households whose children play in and around the drains or contaminated ground. However, during heavy rains, when the drains block up and the city floods, the problem affects everyone. The risk to public health is discussed in section 5.3 below

Both SFDs above are necessarily vague about the destination of the untreated FS (i.e. “local area and beyond, via drains). There are many different kinds of drains in Dhaka – for example, the large storm drains (managed by DWASA), the small-bore local drains (managed by the DCCs) and informal street side drains in lower-income areas (properly managed by nobody). For some of these, FS entering them means contaminating the local environment. For others (e.g. the large underground drains) it means contaminating the Buriganga river further downstream.

There are various implications of the SFDs above for FSM in Dhaka. These are discussed in full in section 10 of this report focusing on implementation options. In short, however, it is clear that key challenges in Dhaka are: (i) preventing newly-constructed buildings from connecting septic tanks and blackwater outlets to the drains, and (ii) progressively disconnecting existing households’ systems from the drains and ensuring proper containment. This will not be an easy process – analysis of the problem is discussed in section 9. Clearly sewerage should play a role, but given that only 3% of sewage entering the system is currently treated, and only 20-25% of households have a sewer connection, its role will continue to be minor even in the medium-to-long-term. Addressing Dhaka’s sanitation crisis by introducing proper containment and systematically getting these facilities connected to the most appropriate technical option(s) to provide a functioning sanitation service chain is clearly a priority.

In terms of FSM services, the SFDs show that at the moment, when households experience a pit or tank filling up, they do use an emptying service rather than abandoning that pit or tank. Some service providers exist (as discussed in section 6.4 below), but markets are thin. As proper containment is introduced, one would expect broadening and deepening of those markets.

5 Public Health Risk Assessment

5.1 Introduction and methodology

A component of the diagnostic study is to assess the extent of public health risk resulting from poor FSM services within Dhaka, representing risks at a city-wide level and for slum/poor areas. The study also seeks to identify the approximate level and location along the sanitation service chain of adverse public health risks.

Methods adopted within the data collection instruments to do this include:

- Identifying types of household facility and emptying services used (supported by direct observation of the cleanliness and functionality of the facility), during the household survey;

- Observing emptying service providers to identify how their practices may introduce risk to the household specifically (containment and emptying stages) and to the wider public at large (emptying, transport and disposal stages) - see Annex D for information on the scoring system used;

- Scoring hazards and vulnerability factors observed during transect walks (see explanation below), along with information about local practices that could result in fecal contamination in the environment (see Annex D for information on the scoring system used);

- Measuring fecal contamination levels in local drains and water supplies, to identify potential levels of exposure to risks; and

- Asking for perceptions of risk related to emptying services, during focus group discussions.

Collating and analysing results from the data collection instruments provides information about sources of risk through the service chain. This includes: how clean and operational toilets are kept within the household; how effectively and safely service providers empty, transport and dispose of fecal sludge; the extent to which infrastructure provides effective handling of fecal sludge and wastewater through the city.

Given the limited extent of data collected for this part of the study, it can only provide a general indication of risk level at positions along the service chain. The study is not intended to report on specific locations or flow paths of FS movement within the sampled PSUs.[24]

For more information about the sanitation-related diseases and the significance of safe management of fecal sludge to protect environmental and public health, see Cairncross and Feachem (1993, pp.11-25), and Strande et al (2014, pp.1-4).

[24] Original datasets contain GPS locations of observed risks in the PSUs that can be examined further

5.2 Results: risks through stages of the FSM service chain

5.2.1 Containment: household facilities, levels of sharing and practices

The standard of household containment facilities has been identified from the household survey, as indicated in Section 4.3.1.

From the survey, **reported levels of sharing** of facilities shows that, in slum areas, 65% of households use an *improved* shared latrine and a further 12% an *unimproved* shared latrine. This compares with 22% of households city-wide using an *improved* shared latrine and no households using an unimproved shared latrine (see Table 5). For shared latrines in slum areas, an average of 11 households share a latrine (median value 7 households), as compared to an average of 5 households sharing a latrine city-wide (median value 4 households). 35% of slum dwellers who use a shared latrine reported sharing their latrine with more than 30 individuals.

Standards of **cleanliness** for household facilities, observed during the household survey, were found to vary between city-wide and slum area facilities.

- City-wide, 100% of observed latrines were found to have a cleanable slab and 96% no fecal or urine contamination on the floor or slab.
- In slum areas, these levels fell to 78% of latrines having a cleanable slab. 71% showed no signs of fecal or urine contamination on the floor or slab, which given the extent of sharing is perhaps a better result than might be expected.

Practices around the **disposal of child faeces** also introduces risks to both households and potentially the wider public. City-wide, 6% of households reported unsafe methods practiced when disposing of faeces of children under 5 years old (disposing into drains, ditches, solid waste or leaving in the open), while in the slum areas this figure rises to 67%. In the majority of cases this is by faeces being disposed into drains or ditches (56%), with remaining practices being through disposing of faeces with solid waste (7%) or faeces left in the open (11%).

Despite such potential risks, levels of diarrhoea are relatively low, as shown in Table 9 below. The household survey gives the following results for self-reported diarrhoea prevalence by the respondent (person answering the questions). As can be seen, prevalence was higher in the slum sample (4%) than the city-wide sample (2%). However, it may be too small a difference to be statistically significant. A similar pattern is seen amongst children under-5. In the city-wide sample, respondents reported that no children under-5 had suffered from diarrhoea in the past two weeks, but this figure was 3% in the slum sample.[25]

Table 9 **Prevalence of diarrhoea among respondents in the last 2 weeks**

	City-wide	Slums/poor areas

[25] These figures are more or less consistent with the Bangladesh DHS 2011 data on diarrhoea prevalence, which found that 4% of children under-5 in urban areas nation-wide had suffered from diarrhoea in the 2 weeks preceding the survey.

	%	No. of households	%	No. of households
None	98.3	354	95.8	345
One	1.4	5	3.9	14
Two	0.3	1	0.3	1
Total	**100.0**	**360**	**100.0**	**360**

It should be noted that diarrhoea prevalence is only one indicator of a contaminated environment. It is increasingly understood that nutrition outcomes, especially stunting (height-for-age) are strongly linked to sanitation through multiple transmission pathways. The Bangladesh DHS 2011 found that, in urban Bangladesh, 36% of children under-5 were stunted. While stunting has numerous determinants, living in such a contaminated environment certainly contributes to those observed outcomes.

Wider risks to public health, beyond risks to families and individuals from poorly-managed containment facilities and practices, arise from poor access to fecal waste management during discharge, emptying, transport and disposal practices.

5.2.2 Emptying: household practices around emptying services

As seen in the results from the household survey and reported during focus group discussions in slum areas, the majority of households rely on using some form of self-built latrine that connects into a drain, either directly or via a pit or septic tank. The data regarding filling-up and emptying rates was discussed in section 4.3.1.

Of those households who have called on emptying services, the reasons have been identified as mainly the pit/tank being nearly full (for both city-wide and slum areas), and only in a few cases the facility overflowing, smelling, or becoming blocked (Table 10).

Table 10 Reason for emptying

	City-wide		Slums/poor areas	
	%	No. of households	%	No. of households
Pit/tank was nearly full	86.7	26	86.5	32
Pit/tank was overflowing	0.0	0	5.4	2
Bad smell	0.0	0	2.7	1
Blocked	13.3	4	5.4	2
Total	**100.0**	**30**	**100.0**	**37**

Satisfaction expressed about the **safety** of emptying services was reported to be high across both city-wide and slum area households.[26] 83% of households city-wide (30 responses) and 87% of households in slum areas (37 responses) stated they were either very satisfied or satisfied with the safety of emptying services. Risk as perceived by householders will not be the same as actual risk resulting from the process, so this information should be considered alongside results from the structured observation (next section).

[26] Households who had used an emptying service provider (mechanised or manual) were asked to rate their satisfaction with the safety of the service – from very satisfied to very dissatisfied. With no definition for "safety" given to households, the response will be based on the perceived level of safety to the household themselves as a result of the emptying activity.

5.2.3 Emptying, transport and disposal: observed practices and risks, in slum areas

Planned observations were carried out during five emptying operations in slum areas (three carried out by manual emptiers and two using mechanised vacuum tankers – the VacuTug). In all five cases, there were no logistical challenges affecting the service providers themselves, as access to the latrine on the compound was satisfactory and access into the pit/tank in each case was by lifting a removable cover slab to gain full access to the pit/tank below.

Using a structured observation format, likely sources of immediate risk from exposure to FS at each step of the process were identified for the Containment, Emptying, Transport and Disposal stages. Treatment and End-use of fecal sludge is not practiced in Dhaka, so these stages of the service chain could not be observed.

Risk levels were taken to be based on exposure as follows:

- at containment stage to the family members/households who use the facility,
- at emptying stage to those in the compound (site) where the facility is located, plus the neighbourhood along the emptying route from the compound to transport/disposal point,
- at transport and disposal stages, affecting a wider geographical area and population, especially where FS is discharged into drains and open water bodies. Disposal of FS into a drain may not present a *direct* risk to public health (unless people enter into the drain and/or use the drain water directly), but there will be high environmental pollution occurring beyond the final outfall of the drain. There could therefore be risks resulting from human contact with wastewater discharges beyond the outfall – but the location of such discharge was not identified within the scope of this study.

Based on the scoring system developed for the structured observation, exposure to risk were recorded using High/Med/Low categories. The specific results are shown in Annex D, while the following sections discuss the broader findings and their implications**Error! Reference ource not found.**. It should be kept in mind that, as the immediate risk was being noted down at each stage in the process, the risk level can vary between stages, depending on the actions taken.

Containment and Emptying: Manual

The containment facilities where manual emptying was observed (three cases) introduced a low risk to the household, as they were in relatively clean condition and the pits/ tanks were not full to the point of overflowing.

The action of manual emptying itself introduced medium risk to the compound and possibly neighbours on two occasions, as spillage occurred during the removal and transfer of fecal sludge from the emptying bucket to ground level buckets/containers or discharge into channels.

- In the majority of focus group discussions, participants identified manual emptying as an unsafe practice, as fecal sludge is discharged into the nearest pond, drain, water body or canal. In no case was FS reported as being transported to a safe discharge point. On two occasions, fecal sludge was reported to have been spilt onto paths and roads during the procedure identified as affecting the health of children, who are often barefoot.

- 81% of households surveyed in slums who had used an emptying service reported using manual emptiers (compared with 97% of households' city-wide) on the basis of their affordability, accessibility and a more flexible and responsiveness service. This was backed up by the majority of FGDs. In slums, 14% reported emptying themselves, which is likely to carry similar or greater risks due to lack of appropriate equipment and skills.

Containment and Emptying: Mechanical

The containment facilities where mechanical emptying was observed (two cases) were considered to introduce a medium risk to the household. The risk was rated as higher, due to the pit or tank being extremely full or overflowing immediately prior to emptying. This is likely to be influenced by the fact that households often have to wait for some days for mechanical emptiers to become available, during which time pits/tanks fill up and latrines may become overfull, back-up and become difficult to keep clean.

The emptying action was observed to pose low risk to the household, as removal and transfer of fecal sludge is well contained in the suction pipes connected directly from the pit/tank to the tanker.

Transport and Disposal: Manual

Manual emptying in each case did not record a risk for a 'transportation' stage, as the fecal sludge was discharged into either a water body (pond), open drain or covered stormwater drain near to the household. In the first two cases, the actual risk is anticipated to be high, due to the potential for spills and direct human contact with fresh fecal sludge – as seen from the photographs below. In the third case (Korail), the transportation process introduced very little, if any, risk to the household.

Disposal locations in the first two cases, being an open drain and dug trench leading to an open waterbody, are considered to be high risk. The disposal of fecal sludge into a covered drain in the third case (Korail) is considered to introduce no direct risk to public health, but rather there will be high environmental pollution occurring beyond the final outfall of the stormwater drain used and there could also be risks resulting from any human contact with the discharge beyond the outfall.

Figure 7 'Transport' and disposal points during observed manual emptying

1: Uttara	2: Shikderbari	3: Korail
 FS tipped directly into a channel	 FS tipped into a dug trench	 FS carried off the property
 that discharges into an open drain	 and discharged, via the trench  into a local pond	 and discharged into a nearby covered drain

Transport and Disposal: Mechanical

Transporting FS in the vacuum tankers was observed to pose little, if any, risk. The FS was safely contained in the tankers without any spillage occurring on route to the disposal point.

Disposal practice by the mechanical emptiers was considered as medium risk. As far as can be ascertained, the eventual discharge from the stormwater or surface water drain may not interact directly with human activities – such as people using drain water for washing, cleaning or other domestic uses, children playing in drains, drains overflowing into properties or drain water reaching low-lying areas. Given the complexity and coverage of drainage networks in Dhaka (and given the constraints of this study), identifying the actual risk from any given disposal practice, its scale and location within the city, is extremely unlikely.

Figure 8 Emptying and disposal points during observed mechanical emptying

4: Tejgaon	5: Korail
 FS backed-up to latrine slab underside before emptying	 FS emptied using the suction hose
 FS emptied directly to VacuTug via the suction hose	
 and later discharged into a shallow drain	and discharged from the VacuTug into a covered drain

The impact more generally of such practices on wider environmental contamination, as measured through levels of *E. coli* found in drain water running through areas within the scope of the study, are reported and assessed further in Section 5.3.

Without enforcement of the by-laws, mandates or rules governing the management of fecal sludge in the surface drains and small bore stormwater drains managed by the DCCs (North and South), or the large bore stormwater drains managed by DWASA, the practice of discharging fresh fecal sludge into the nearest available drain access point will continue.

While Dhaka has a sewage treatment plant at Pagla, it does not accept fecal sludge directly. As such, there is no site in Dhaka available for anyone to discharge fecal sludge in a manner where it can be safely treated.

5.2.4 Transport and discharge: associated with sewerage

The sewerage network in Dhaka is currently estimated to cover 20% of the city population (Dhaka Sewerage Master Plan Report, 2013). The household survey identified that city-wide 25% of households reported having their latrine directly connected to a piped sewer system, with no connections in slum areas. However, not all of the wastewater discharging into sewers reaches the treatment plant in Pagla, due to either leaking sewers or non-functioning pumping stations leading to sewers discharging into nearby drains or watercourses (via overflows).

The DWASA Sewerage Master Plan notes that 9 of the 27 installed pumping stations are not functional, while a further 10 or more may not be working, or are currently by-passed. As a result, it would seem that about 70% of the sewerage network is currently not operational. Getting details of the actual level of failure, enabling leakage rates and overflows to be identified, has not been possible during the course of the study.

5.3 Results: risks from wider environmental contamination

The 40 transect walks (30 conducted city-wide and 10 in slum areas) confirmed that fresh fecal waste is visible or present in the majority of local environments and neighbourhoods – both at a city-wide scale and within slum areas. This is primarily through the practice of latrines emptying either directly, or via pits and septic tanks, into local drains. In many cases these drains are open and fecal waste was directly observed.

Drain water

Where fecal waste was seen in drains on the day of the transect walk (in 50% of locations city-wide and in slum only areas), during the short interview with community members, people confirmed in 80% of both city-wide and slum areas that they would see fecal waste in the drains on a daily basis throughout the year.[27]

When community members were asked about the practice of latrines emptying into drains, in the city-wide areas people reported that this occurs daily in 57% of locations (17/30 locations), while in slum areas people reported this as occurring in 80% of the locations (8/10 locations). Samples of drain water taken in 20 areas (10 city-wide and 10 in slums) confirmed the presence of *E.Coli* in the drains.

Table 11 Observation of FS in drains

	Observed during transect walks	Reported by community
	Fecal waste in drains	**Latrines emptying to drains on a daily basis**

[27] Refer to the description of the Transect Walks in the Methodology section

City-wide areas	50% (N=30)	57% (N=30)
Slum areas	50% (N=10)	80% (N=10)

There is widespread recognition that the practice of discharging fecal sludge to drains throughout the city generates a high environmental health risk. However there is little evidence of chronic health risks resulting from this – indicated by the low prevalence of diarrhoeal disease. This situation is however interspersed with high acute health risks during episodes that generate high exposure levels, such as blockages to drains and drains failing to deal with overloading during flooding, as well as poorly managed emptying practices.

Where the population are likely to be most at risk is where they have the opportunity to come into direct contact with fecal contamination in drain water. For some people, this may be due to a practice of using drain water for non-domestic activities (such as washing vehicles), but the greatest risk often associated with drains is children playing in, or close to, drains without being aware of the risks from contact with drain water, practicing safe handling or effective handwashing afterwards. Although the transect walks did not directly identify cases of children playing in drains, it was clear that children regularly play in close proximity to open drains and are likely to pick-up contamination through for example contact with overflowing drains or walking barefoot next to blocked and overflowing drains.

Dumped fecal sludge, removed from blocked drains

When either the shallow, open drains or deep, closed stormwater drains become blocked (as happens frequently) they are eventually emptied. As the network consists of mainly open drains, the bulk of this work is carried out by manual sweepers, with dredgers used in some cases. The removed sludge will contain a mixture of fecal sludge, sand and silt (and in certain locations of the city industrial pollutants) and is dumped directly next to the drains in the streets or pathways. The extent to which this practice occurs is not clear. The transect walks only noted fecal sludge dumped in one location out of 40, with this practice being reported by local residents as occurring on roughly a monthly basis.

Open waterbodies

When asked about the extent to which fecal sludge reaches open bodies of water (such as ponds, rivers, canals or streams), people reported that this is a daily occurrence in 5 city-wide locations (17% of the 30 study areas) and in 6 slum areas (60% of the 10 study areas). The question did not extend to identifying how the fecal sludge reached the ponds – whether it came directly from latrine outlets, or by manual emptiers disposing of removed fecal sludge into the waterbodies. In either case, open water in the local environment is frequently and significantly contaminated.

Box 1 Solid Waste Management

Health risks from people coming into contact with (potentially contaminated) solid waste in their local environment is not a direct part of this study. However, piles of solid waste accumulating close to where people live was noted in 47% of city-wide areas and 40% of slum areas, with these piles at times obstructing open drains in the area.

A further route of fecal contamination is when the feces of small children who are not using latrines is thrown-out with solid waste. Of households reporting having to handle children's feces, 3 out of 94 families in city-wide areas (3%) and 8 out of 109 families in slum areas (7%) reported throwing the children's feces out with their solid waste. The nation-wide MICS figures for 2006 report these values as 11% for all families and 14% amongst the poorest quintile (MICS, 2006). Levels in the urban context are understandably lower than national figures, but of concern is that the feces of babies and young children are known to contain a higher proportion of disease-causing organisms than adult feces – so contaminated solid waste in the environment poses a potential health risk to the whole community.

Water supply

Dhaka has significantly improved access to piped water supplies throughout the city in recent years. In slum areas in any city however, these supplies often have additional connections informally added to any formal arrangement, resulting in "spaghetti" networks where pipes are connected using temporary joints/seals, leaving domestic supplies prone to contamination. Where pipes run in drains, the risk of contamination can increase significantly.

Transect walks in the 40 PSUs did not identify any situations where the water supply infrastructure as identified as being at direct risk from poor FSM services. Tests on drinking water from piped or groundwater supplies, at the point of delivery, in 40 of the PSUs showed a detectable level of *E. coli* in 3 piped water supplies from city-wide areas (10% of the 30 samples taken), in 1 piped water supply and 1 groundwater source from slum areas (20% of the 10 samples taken in total). While these sample sizes are too small to be statistically significant, they point to the fact that some piped water supplies are becoming contaminated before, or as, they reach households.

5.4 Implications: assessing the public health risk from poor FSM

Risk to public health, as a result of poor FSM services, comes when there is human exposure (i.e. some form of contact) to the hazard (i.e. feces that contains pathogens), through an event (such as walking barefoot over fecal sludge, working or playing in drains that carry fecal sludge discharged from latrines, drinking water or via hands contaminated with feces). The study has identified that all areas of Dhaka are prone to fecal contamination, resulting from fecal sludge being carried in drainage networks and eventually reaching open waterbodies, or being dumped by the roadside when drains are unblocked. In certain areas of Dhaka, exposure to fecal sludge is more direct and hazardous – such as where fresh fecal sludge is discharged directly into open waterbodies (such as ponds) that are used for recreational purposes or domestic water use, or contaminated drains overflowing into living areas. In other situations, the cause and level of exposure may be more difficult to measure, such as the extent to which contamination in water supplies is a result of poor FSM.

It is likely that the drain networks running through slum areas will be more informal and open, as compared to those running through the city as a whole. It is also recognised that parts of the city, most notably the eastern area, become inundated caused by external flooding from rising rivers as well as internal flooding caused by stormwater and the poor drainage infrastructure.[28] What is clear however is that the problem of fecal contamination is occurring throughout the city? Perhaps as a result of the extensive scale of poor FS management, the complex integration of slum areas within the city as a whole and resulting spread of contamination, assessment of the findings so far has not identified a strong association between the locations (PSUs) of poor management practices and any risks identified within that PSU – either through measured contamination of drain water or water supplies, or through observed / reported human behaviours that bring people into contact with fecal sludge.

Further analysis is needed if results of where, how and to what level risk is occurring, are to be clearly identified. In collaboration with the Centre for Global Safe Water at the Rollins School of Public Health, Emory University, results from Dhaka have been initially analysed using an adapted version of the SaniPATH tool.[29] This initial analysis has identified weaknesses in the data available from the Dhaka study to be able to carry out the SaniPATH analysis. These weaknesses are both in terms of the *reliability* of certain results (essentially the microbiological indicators of fecal contamination in drain water and drinking water samples), as well as the *extent* of data available relating to human behaviours in the study PSUs that expose people to pathways of fecal contamination.

At this stage, the study is not able to present an analysis of public health risk from poor FSM services in Dhaka. However, the collaboration has informed ongoing development of a SaniPATH tool for FSM services by; identifying minimum data requirements to conduct a credible public health risk assessment, the need for preliminary assessment of the main pathways of risk and the reporting requirements for target audiences such as municipal managers or World Bank staff. Further collaboration will work towards developing a more effective tool that addresses an appropriate level of data collection and analysis, with improved visual presentation of the results.

[28] Haque, A.N., Grafakos, S. and Huijsman, M. (2010), *Assessment of adaptation measures against flooding in the city of Dhaka, Bangladesh*, IHS Working Papers, Number 25/2010, Institute for Housing and Urban Development Studies, Rotterdam, The Netherlands
[29] SaniPATH is a Rapid Assessment Tool to assess exposure to fecal contamination in urban, low-income settings. Details available at http://www.sanipath.com

6 FSM service potential demand and supply assessment

6.1 Introduction

In economic theory, markets for goods and services operate on the basis of demand and supply. This chapter provides a brief assessment of demand and supply for FSM services in Dhaka. At this stage, it is important to note the difference between potential (or notional) demand and effective demand. The *potential* demand for FSM services is the quantity (and type) of services which would be demanded in the absence of any market failures or distortions. This is different from *effective* demand, which is the quantity (and type) of services actually purchased in the context of current supply and current prices.

A simple way of illustrating this is to note that 75% of households city-wide use OSS, which suggests high potential demand for FSM services. However, only 13% of households report experiencing a pit or tank filling up (see section 4.3), suggesting low effective demand. Reasons for a gap between potential demand and effective demand in Dhaka include: (i) 52% of households city-wide report having pits/tanks connected to drains (reducing or removing the need for emptying), which is illegal and therefore a market failure, (ii) 21% of households city-wide do not even have a pit or tank – their latrine empties directly to a drain or ditch without intermediate containment, (ii) many service providers may not be able to physically access households, which affects the type of services demanded, (iii) market prices for services may be higher than consumers are willing or able to pay, which is a market failure.

There can be different definitions of potential demand in the context of FSM, with varying layers of complexity. The simplest definition is as per the above, i.e. services that would be demanded if all OSS households used emptying services and were willing and able to pay. Qualifications could be added for different scenarios, for example (i) given emptying of pits tanks every 10 years on average, (ii) given regularly desludging once a year, (iii) given that 30% of households are unable to pay the market price and a further 20% are unwilling, and so on. For this study, we have kept things simple.

On the supply side, the types of FSM services the market is currently providing to households were studied.[30] Dimensions of supply include the number of service providers of different types (manual, mechanical etc.), the geographical areas they serve, the prices they charge, and so on.

This section will argue that the main problem in Dhaka is on the demand side. Fewer FSM services are demanded than would be expected given the population using OSS, primarily because people connect to the drains. Where FSM services are demanded, manual emptying predominates because slow traffic and poor accessibility to households demanding emptying inhibits mechanical emptiers from entering the market, due to low perceived profitability.

[30] FSM services are obviously also demanded by the government, businesses etc. but households are the focus of this study.

6.2 Methodology

This sub-section sets out key dimensions of demand and supply, and the data collected related to those, from the various instruments. It was not intended to collect data on all of these aspects, given the broad scope of the research and the limitations of some of the instruments used.

6.2.1 Demand

The research framework (see section 1.3) poses the following question: "What is the existing customer demand and preferences for FSM services?", i.e. the current effective demand. This is discussed in three parts: (a) physical and economic determinants of household demand, (b) household satisfaction with current services, and (c) the barriers which households face in obtaining FSM services.[31] This list is not meant to be exhaustive, but rather those considered important for answering the questions in the research framework.

Physical and economic determinants of household demand

It is useful to separate the physical and economic determinants of household demand, because the differences between them have implications for any interventions; either in stimulating or responding to that demand. Physical determinants are related to geography and infrastructure, whereas economic determinants are more to do with markets and finance.

The main determinants are set out in Table 12 and

Table 13 below, which list various key determinants and the way they have been measured them by the research instruments, as well as where it was chosen not to collect data in this area.

Table 12 Physical determinants of demand for FSM services

Dimension	Instrument used to collect quantitative data
1. Accessibility of location	
Equipment access – likelihood of equipment of different sizes (manual emptier, VacuTug, tanker truck, etc.) being able to access the facility to empty it	Household survey questions about equipment access and emptying point. Also transect walk questions around conditions of roads/paths in the area
Type of building – whether single-storey or multi-storey, and privately owned or in shared ownership	Household survey question
2. Fill rate	

[31] Given our focus on household demand, the primary concern is demand for emptying services rather than the rest of the sanitation service chain. The research framework also asks about levels of satisfaction by providers of emptying services with current transport, treatment and disposal/end-use arrangements. As the scale of formalised emptying services is so limited and there is no effective treatment or end-use for fecal sludge in Dhaka, this aspect does not form a significant part of the study.

Dimension	Instrument used to collect quantitative data
Volume of containment – the nature of the containment method (e.g. whether a pit, tank, or no real containment) and its volume	Household survey question on type of containment; but not volume (as household estimates thought to be unreliable)
Number of users – the number of household members (i.e. the owner household plus any sharing households) determines volumes entering the pit	Household survey questions around household members and numbers of households sharing
Climate, soil type and groundwater – the fill rate is not a simple function of the previous two determinants. Ambient temperature, soil type and groundwater table can all strongly influence the rate of filling and digestion of fecal sludge.	Qualitative only, through key informant interviews, plus secondary data.

Table 13 Economic determinants of demand for FSM services

Dimension	Instrument used to collect quantitative data
3. Financial	
***Ability to pay* (ATP)** – poor people do not always have the available finance to pay for FSM services.	No formal assessment of ability and willingness to pay, as this was to be added at the request of the World Bank in each city. However, data were collected on capital expenditure on latrine construction and the price paid last time the pit or tank was emptied (if relevant).
***Willingness to pay* (WTP)** – people may have access to the finance required but not be willing to pay for the service at the market price, for any number of reasons.	
4. Incentives	
Tenancy status – households who rent property from a landlord may not have authority to deal with sanitation matters. Landlords may not want to pay for tenants' ongoing services, connecting latrines instead to a direct discharge. Tenancy status therefore influences the incentives and decision-making role of the likely service purchaser.	Household survey question
Alternative sanitation options – if there is space, then households can dig a new pit and cover the old one. If there is not, the household may still abandon the latrine and use an alternative option (shared/public latrine or open defecation) rather than use an FSM service	No data, since it is hard to gauge what options are open to households. The household survey did however ask what they planned to do next time their pit or tank filled up.

Household satisfaction with existing services

Household satisfaction with the performance of service providers will be a determinant of demand. This was addressed in two ways through household survey questions based on a four-point Likert scale.[32] Firstly, households were asked to rate their satisfaction level with various aspects of sanitation facilities used, including quality of construction, ease of access, privacy and cleanliness. Secondly, households which had used an emptying service last time their pit or tank had filled up, were asked to rate the service provider on price, overall service quality, safety and ease of obtaining service.

Other barriers which households face in obtaining FSM services

Some reasons for a gap between potential and effective demand for FSM services in Dhaka are already listed above (e.g. connecting outlets to drains, physical access to households and willingness to pay). However, there are many other potential barriers which households may face in securing FSM services (some of which are included in the economic and physical determinants in the tables above).

There are further barriers to accessing services which it may not have been possible to predict *ex ante*. These were therefore explored in qualitative research, particularly through Focus Group Discussions with community members in slums areas. Several of the discussion questions focused around perceptions and opinions of existing services, and what participants would like to see in terms of improved services in the future. Discussions were semi-structured, with participants able to discuss questions more openly, allowing further determinants of demand not otherwise addressed in the household survey to be identified.

6.2.2 Supply

On the supply side, the research questions were around the current status and quality of FSM service delivery. This was divided into assessments of physical capacity of service providers (number of providers and the scale of service reach) and technical/institutional capacity (the scope and quality of services). This is assessed along the sanitation service chain. All of these factors were assessed mainly through Key Informant Interviews with service providers (SPs) themselves, as carried out by local consultants contracted by WSP. The following areas were to be covered:

- **Physical capacity**
    - Scale – number of SPs, their staffing capacity and areas they serve
    - Turnover – monthly income/expenditure of SPs
    - Clients – number of clients in past month
- **Technical/institutional capacity**
    - Formality – whether formal (i.e. licensed/registered) or informal
    - Compliance – local regulations, or fines/persecution imposed
    - Skills/equipment – types of skilled staff and equipment available

Much of this data came from the report submitted by the WSP consultant Mark Ellery. Answers on all these dimensions were not always available or forthcoming.

[32] Categories included “very satisfied”, “satisfied”, “dissatisfied” and “very dissatisfied”

6.3 Findings – household demand for FSM services

The results in each key area are presented below, with an overall assessment provided in the concluding section, alongside implications for FSM in Dhaka.

6.3.1 Determinants of household demand

6.3.1.1 Accessibility of location

Whether a service provider can actually get to the facility requiring emptying (as well as the household's perception of that) will be a key determinant of whether services are demanded. Data on this were collected from several angles, and were analysed starting from road/path systems in the community, before focusing down to the household level and, ultimately, the facility itself.

Some of the transect walk data sheds light on the kinds of housing density, paths and roads experienced in the studied areas.

Table 14 provides scoring data separately for sub-samples A and B. [33] In terms of housing density, only 30% of PSUs scored 4 or 5 in sub-sample A, as compared to 70% in B.[34] There are similar differentials for paths and roads. In terms of implications for FSM services, what can be concluded from this table is that mechanised emptying equipment (such as the DSK VacuTug) would find it relatively easy to access households city-wide. Only 10% of PSUs city-wide had roads (in general) which were not wide enough for a car to pass. This figure was 80% for the slum PSUs, indicating that existing mechanised emptiers would find it hard to access the majority of slum households.

Table 14 Scoring for housing density, paths and roads from transect walks

	City-wide			Slum/low-income		
Score	**Housing density**	**Paths**	**Roads**	**Housing density**	**Paths**	**Roads**
1 = lowest	7%	50%	23%	10%	0%	0%
2	20%	33%	33%	0%	0%	0%
3	43%	3%	17%	20%	10%	10%
4	13%	13%	17%	10%	60%	10%
5 = highest	17%	0%	10%	60%	30%	80%
TOTAL	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

NB. Scores indicate relative impact on effective FSM, while values per parameter show the percentage of transect walks for which this score was given. There were 30 and 10 TWs in sub-samples A and B respectively – see footnote for detail.

The type of building also influences the extent and nature of the emptying likely to be required, though a large number of variables will affect this. Dhaka is increasingly developing high-rise

[33] Scores of 1-5 have been used in each city study to represent a qualitative assessment of the relative impact from each physical aspect of the PSU on being able to achieve effective and safe FSM services in that locality, with 1 representing the lowest impact and 5 the highest impact. Annex D **Error! Reference source not ound.**includes further explanation of the scoring mechanism

[34] It should be noted that there were 30 transect walks in sub-sample A (city-wide), but only 10 in B.

buildings and, as Table 15 below shows, the majority of households city-wide (53%) live in buildings of more than one storey, whereas this was only the case for 5% of households in the slum sample. The nature of containment, and associated access to pits/tanks, is therefore likely to be considerably different city-wide and in slums. In addition, the management of that containment in a large building is likely to be different too. Accessibility to then pit/tank is only tangentially related to this.

Table 15 Type of building occupied

	City-wide		Slums/poor areas	
	%	No. of households	%	No. of households
Private residence (single storey)	22.5	81	51.7	186
Private residence (multi-storey)	25.3	91	1.9	7
Shared residence (single storey)	22.5	81	42.8	154
Shared residence (multi-storey)	27.8	100	3.3	12
Other	1.9	7	0.3	1
Total	**100.0**	**360**	**100.0**	**360**

Focusing on the toilet itself, Table 16 below shows the accessibility of the main pit/tank structure, followed by the presence of a purpose-built hatch (as one would expect with a correctly-constructed septic tank). Following the theme from the TW data, households in slum areas were again harder to access at the household level, with "poor access" for 93% of households (against 69% for the city-wide sample).[35] With regard to the pit/tank having access points or hatches to facilitate emptying, it was more common for city-wide households to have one (31%) than in slum areas (5%).[36]

Table 16 Accessibility of toilet for emptying equipment

% of household latrines observed	City-wide (%)	Slums (%)
Access for mechanical emptying equipment		
(1) Poor access (only manual possible)	**69.4**	**93.1**
(2) Reasonable access (small machines possible)	**23.1**	**6.4**
(3) Good access (large machines possible)	**7.5**	**0.6**
TOTAL	**100**	**100**
Access point/hatch for emptying		
(1) Yes; purpose built hatch	**30.6**	**4.7**
(2) Yes; squatting plate must be removed	**53.9**	**55.8**
(3) No; slab must be broken for access	**15.6**	**39.4**
TOTAL	**100**	**100**

Overall, from the perspective of accessibility it is clear that city-wide, households and the contents of their pits/tanks are far more accessible to formalised emptying services (i.e. beyond using buckets and ropes) than in slum areas in particular. This is an unsurprising finding, but

[35] This data comes from observations by our enumerators during the household survey. There were three categories: "Poor access, only accessible to hand-carried emptying equipment", "Reasonable access for small (manual or mechanised) emptying equipment" and "Good access for medium/large size (mechanised) emptying equipment". Definition of these categories was covered during the training.

[36] This was also an observation. There is room for confusion between categories 2 and 3, so we would emphasise comparison between category 1 and and the total of the others.

the ability to back up assumed situations with hard data should help to explain how the accessibility of households and their latrines should be a key concern in any interventions to stimulate demand for FSM services.

6.3.1.2 Fill rate

Data on the type of containment was already shown in Table 6 in section 4.3.1 above. As noted above, data were not collected on the volume of pits/tanks, since household estimates were thought to be unreliable. Opel et al. (2012) did collect data on this indicator using a survey of 467 households in what are most likely slums areas of Dhaka.[37] They estimated that the average size of a septic tank was 14m^3 and a pit 2.5m^3, but it is not clear how this was done since it was a household survey rather than a physical survey. Numbers of observations are not disaggregated and the estimation method is not clear, so these figures should be viewed with caution (see later comment at the end of this sub-section).

While not collecting volume data, households were asked how long it usually took for their pit to fill up, which was considered more relevant, and a more reliable indicator for households to estimate. The results are in Table 17 below. It should be noted that there are few observations since so few households have experienced pits filling up at all (due to so many latrines being connected to drains). The data shows that across the city, for many households that do experience pits filling up, this happens at least once a year. Pits/tanks took less than 12 months to fill up for 49% of households city-wide and for 76% of households in slums. Reasons for this are considered in the next section, but could be related to smaller pit/tank size and/or a higher number of users per latrine, given the high prevalence of sharing.

Table 17 Average time taken for pit or tank to fill-up

	City-wide		Slums/poor areas	
	%	No. of households	%	No. of households
Less than 6 months	13.5	5	35.3	12
6 to 12 months	35.1	13	41.2	14
12 to 18 months	8.1	3	17.6	6
18 to 24 months	5.4	2	5.9	2
About 3 years	0.0	0	0.0	0
About 4 years	8.1	3	0.0	0
About 5 years	5.4	2	0.0	0
Don’t know	24.3	9	0.0	0
Total	**100.0**	**28**	**100.0**	**34**

Moving to the data on shared latrines, the mean number of households sharing each latrine was 1.2 city-wide and 8.4 in the slum sample (considering the whole of both sub-samples and coding private latrines as 1).[38] This fits well with the overall data on sharing as indicated in

[37] The sampling frame is not clear from the paper, but the methodology notes a focus on “areas mainly in the fringe of the city which require emptying”. This data may therefore be most comparable to our slum sample.
[38] For these estimates, households with private latrines (not sharing with any other households) are included and coded as 1. If those households are excluded, the means become 5.3 and 10.9 for sub-samples A and B respectively. In other words, from the city-wide sample, the average latrine used by 1.2 households but the average shared latrine is used by 5.3 households.

Table 5 in section 4.3.1. Where toilets are shared, it is worth considering the numbers of *people* which were sharing in more detail, as is shown in Table 18 below.[39] This comes directly from data reported by households, as opposed to from estimations based on secondary data; it should be noted that the average household size was 4.8 in both sub-samples

As can be seen, the majority of latrines in the city-wide sample were used by fewer than 6 people, since most households (78%) did not share their latrine with other households. In the slum sample, however, 35% of households reported that the latrine that they use was shared by more than 30 people (with only 9% sharing with 5 people or fewer). To some extent, this can be explained by the use of public toilets. Relating this data to demand for FSM services, we would expect the average latrine in Dhaka's slums to fill up faster than the average latrine city-wide, since more people use it, all things being equal. However, this does not account for other factors relating to fill rates (e.g. size of pit/tank).

Table 18 Number of people using the same sanitation facility

	City-wide		Slums/poor areas	
No. of people using the same facility	**%**	**No. of households**	**%**	**No. of households**
1 to 5	56.0	201	8.6	28
6 to 10	26.5	95	10.4	34
11 to 15	7.8	28	15.0	49
16 to 20	3.6	13	16.8	55
21 to 30	1.9	7	14.7	48
More than 30	4.2	15	34.6	113
Total	**100.0**	**359**	**100.0**	**327**

Returning to the figures from Opel et al (2012) on average septic tank / pit volumes and assuming that these represent slum areas of Dhaka, then using these volumes and the values from this study for average users of household / shared facilities in defined slum areas, it can tentatively be concluded that septic tanks or pits would take somewhere between 10-20 years to fill with fecal sludge. This assumes that septic tanks are generally used in shared facilities with at least 20 users sharing and pits are used in households with at least 5 users sharing. It also takes a conservative value for sludge accumulation of 40 litres/person/year[40] for both septic tanks and pit latrines and assumes that the systems are operating correctly, with final effluent discharging to soakaways.

Where households have reported emptying their containment facility, the frequency of emptying is much shorter (typically less than 12 months), highlighting that the effluent discharge arrangement is not operating correctly, or does not exist. The removed contents comprises the generated fecal sludge (i.e. including urine, water used for anal cleansing and other liquids added to the pit such as wastewater, subtracting what infiltrates through the lining of the pit or tank.)

Rapid filling is therefore likely to occur during times of heavy use of the facility, or where the tank/pit cannot leach liquid into the surrounding ground, especially during the wet season and when the ground is saturated. As shown in Table 18Table 17, pits/tanks filled up much faster

[39] This data was asked directly in a survey question as a categorical variable for the categories shown: "How many people use this toilet regularly?"

[40] These are common figures used for excreta sludge held in wet conditions – based on the gradual build-up (accumulation) of sludge, allowing for decomposition and compacting of the sludge, over time

in slum areas. The dense soil conditions within Dhaka city are known to hinder effective infiltration, this is not a surprising finding, but again points to reasons why people rely so much on drains to frequently remove the majority of the content of their tanks/pits from their property, without having to pay for regular emptying services.

6.3.1.3 Financial aspects

As noted above, collecting data on ATP and WTP was beyond the scope of what was achievable rigorously in the questionnaire time available. However, data were collected on the price paid the last time an FSM service was used, and whether households thought that price was fair.

First though, it is worth briefly considering finance for containment. Households were asked how much they spent (in cash) to build their toilet at the time when it was built (including materials and labour), if they spent cash at all. For the city-wide sample this question was only answered by those in higher wealth quintiles so the data is not that representative (mean is $579, n=52). However, for the slum sample, the mean for an improved latrine was $153 (n=61) and for an unimproved latrine was $19 (n=19).[41] In terms of paying to use a toilet, this was very uncommon. Only 3% of households in the slum sample reported paying to use their toilet, and 0% in the city-wide sample. Finally, regarding repairs/maintenance to toilets in the past 12 months (including repairs to mechanism, superstructure, or drainage, as well as FSM emptying services), the mean was $53 city-wide (n=42) and $33 in the slum sample (n=41).[42]

Overall, this data gives us a picture of city-wide households investing more in their latrine than slum households, which is logical since their incomes are higher, amongst other reasons. In addition, it shows that, while few people pay to use toilets, those that do have toilets are investing significant amounts of money annually in their upkeep (while noting that only 11-12% of households in each sub-sample reported having this expenditure in the last 12 months).

With regard to payment for FSM services the last time emptying took place, the mean amount paid was $30 city-wide (n=26) and $13 in slums (n=28). 48% of households city-wide reported that the price they paid was “too high”, with this rising to 64% for slum households. Almost all households paid the full amount on delivery, and for both sub-samples three quarters of households paid a flat rate, with the remaining quarter paying a volumetric charge.

6.3.1.4 Incentives

The incentives that drive demand for improved FSM services are influenced by who is responsible for the ongoing maintenance to keep toilets functioning, including whether it is shared or not. While the household survey shows that approximately 50% of households rent their property, both at city-wide scale and in slum areas, management responsibility for toilet facilities varies more significantly between the two sub-samples.

City-wide, 77% of households used a private household toilet (on plot), while in slum areas this was 19% of households. However, only 26% of households city-wide and 41% of

[41] Nb. we did not ask how long ago this was, so are unable to account for inflation and exchange rates, so the results are indicative only. We used the rate 1 BGD taka = 0.013 USD

[42] Both city-wide and in slums, most households reported that this expenditure was mainly for repairs to the bowl/slab etc. or for drainage. Only c.20% in both sub-samples reported that the expense was for pit emptying.

households in slums reported being responsible for managing their facility (assumed to be in relation to maintenance and repair needs of physical components of the toilet itself as well as the maintenance, repairs and emptying of what the toilet empties into – i.e. a septic tank or pit). Landlords were reported to be responsible for managing toilets in 68% of cases city-wide, which does not tally completely with only 50% renting, which may illustrate some confusion over the definition of "landlord" in Bengali. Landlords and NGOs together managed 50% of facilities in slums; 39% and 12% respectively. The confusion over landlords could be explained by the high proportion of households being based in multi-storey buildings in sub-sample A (see Table 15 above), whereby even if the flat is owned, FSM may still be perceived to be the responsibility of the overall building owner/manager, or some kind of caretaker. This could explain why such a high proportion of households city-wide use a private toilet (77%) but such a low proportion reported being responsible themselves for managing it (26%).

From this it can be ascertained that, even where households use a private toilet within the dwelling, city-wide they are less likely to be responsible for servicing that toilet and/or what it is connected to (i.e. a septic tank or pit) than households in slum areas. With such a significant percentage of facilities under the management responsibility of landlords/managers, it is clear that they are a key stakeholder in decision-making around investments and plans to improve infrastructure and FSM services to support ongoing functionality of toilets from a city-wide perspective, as well as in slum areas.

Where households invest in a toilet facility, they are likely to have stronger incentives for seeing this toilet continue to function. City-wide, 100% of facilities were reported as having an overall durable structure (with cleanable slab, waterseal, roof and providing privacy). Of houses owning toilets in the slum sample, almost 90% of households made a level of investment in their own toilet. 52% in a durable toilet, with a further 16% having a non-durable superstructure but a cleanable slab (with or without a water seal) and 21% a durable superstructure but with a non-cleanable slab.[43]

6.3.2 Household satisfaction with current services

Households were asked to express their satisfaction with current services – both the sanitation facility itself and the emptying services used – across a range of factors, as shown in the tables following. City-wide, the vast majority (over 95% in all cases) reported being satisfied or very satisfied with the sanitation facility, across all 4 categories of satisfaction. For slum areas the emphasis shifted, with the majority being either satisfied (43-50%) or dissatisfied (35-43%) across the 4 categories.

Table 19 Satisfaction with sanitation facility

a. City-wide

	Very satisfied (%)	Satisfied (%)	Dissatisfied (%)	Very dissatisfied (%)	Total (%)	No. of households

[43] Definitions used are: Very basic = Non-durable superstructure without water seal / cleanable slab; Basic = Durable superstructure without water seal / cleanable slab; Weak improved = Non-durable superstructure with cleanable slab / cleanable slab & water seal; Strong improved = Durable superstructure with cleanable slab, roof & privacy / same + water seal

Quality of construction	15.8	81.7	2.5	0.0	**100.0**	360
Ease of access	17.5	78.9	3.6	0.0	**100.0**	360
Privacy	41.4	56.7	1.9	0.0	**100.0**	360
Cleanliness	32.8	65.6	1.7	0.0	**100.0**	360

b. Slums/poor areas

	Very satisfied (%)	Satisfied (%)	Dissatisfied (%)	Very dissatisfied (%)	Total (%)	No. of households
Quality of construction	3.3	50.0	36.7	10.0	**100.0**	360
Ease of access	3.9	46.9	43.3	5.8	**100.0**	360
Privacy	15.8	45.0	35.3	3.9	**100.0**	360
Cleanliness	6.4	43.3	43.1	7.2	**100.0**	360

For households who reported using a service provider (8% city-wide and 10% in slum areas), satisfaction levels for 3 of the 4 categories of service provision were similar between city-wide and slum areas. The biggest difference in the sub-samples came in satisfaction for the ease of obtaining services, with more households dissatisfied in slum areas. Price seems to be the factor with the biggest dissatisfaction, across both sub-samples.

Table 20 Satisfaction with emptying service provider

a. City-wide

	Very satisfied (%)	Satisfied (%)	Dissatisfied (%)	Very dissatisfied (%)	No. of households
Price	6.7	53.3	40.0	0.0	30
Service quality	3.3	83.3	13.3	0.0	30
Safety	3.3	80.0	16.7	0.0	30
Ease of obtaining service	0.0	80.0	20.0	0.0	30

b. Slums/poor areas

	Very satisfied (%)	Satisfied (%)	Dissatisfied (%)	Very dissatisfied (%)	No. of households
Price	2.7	45.9	48.6	2.7	37
Service quality	0.0	83.8	16.2	0.0	37
Safety	5.4	81.1	13.5	0.0	37
Ease of obtaining service	2.7	59.5	32.4	5.4	37

Households in both city-wide and slum areas also identified their *intended* action once their pit/tank fills-up (whether it had filled-up previously or not) as per the table below. Less weight was placed on this data than the action after the pit last filled up, as it may not be carried out. Nonetheless, it does signal market intention in some sense. In addition, all households were permitted to answer (regardless of whether they had emptied in the past) as shown by the higher total respondents. As can be seen, manual emptying is the preferred option by a long margin in both sub-samples. It is intriguing that such a high proportion of households in slum areas planned to manually empty themselves. Unfortunately, the data do not shed light on the reasons for this stated preference, but it may be down to willingness and ability to pay.

Table 21 Intended action after pit/tank fills-up

	City-wide		Slums/poor areas	
	%	No. of households	%	No. of households
Empty by a household member	0.0	0	25.7	56
Empty by a manual emptier	93.4	285	72.9	159
Empty by a mechanical emptier	6.2	19	0.5	1
Cover and seal pit	0.0	0	0.9	2
Abandon toilet without covering	0.3	1	0	0
Total	**100.0**	**305**	**100.0**	**218**

6.3.3 Barriers faced by households in slum areas, in obtaining FSM services

Focus group discussions (FGDs) held in slum areas identified that the key barriers that households face relate both to costs/affordability and awareness/information about (other) available FSM services.

Families living in slums lack a reliable income as a result of working as day labourers and/or being on very low incomes. Where households have hired the services of manual emptiers, this can result in a trade-off with other significant household expenditure. During FGDs, two individuals reported that these costs affected them being able to pay school fees or for medicine, while other families in two communities were reported as having to borrow money to pay the emptying charge.

Where shared latrines with septic tanks are used, people are more aware of the services provided by mechanical emptiers, but in no case were these services reported as having been used. In some cases because the tanks haven't yet needed emptying (built within in the last 4 years), or the VacuTug can't reach the facility. In no case did FGDs report people receiving support for emptying services – either for household or shared toilets – with support only extending to the construction of the toilets themselves. Households are generally not aware of the actual costs of improving on current emptying services – i.e. changing from manual emptying to mechanical emptying – but typically identified that the cost would be high. Improving current emptying services was only seen as realistic in relation to shared latrines, where costs could be shared between households.

6.4 Findings – supply of FSM services

As set out in section 6.2.2, the questions on the supply side related to the current status and quality of FSM service delivery. This was divided into assessments of physical capacity of service providers (number of providers and the scale of service reach) and technical/institutional capacity (the scope and quality of services).

6.4.1 Services effectively supplied

The first stage of the supply analysis should be to consider what services are supplied in the market, where effective supply intersects with effective demand. Some relevant context was already provided in section 4.3.1 by the SFDs, especially Table 7 and Table 8. Those tables show that when pits fill up, people generally empty them rather than abandoning them (presumably due to lack of space and the sunk cost of the substructure, e.g. concrete rings). The data show that city-wide, 8% of households in Dhaka overall have emptied a pit or tank, as compared to 10% in Dhaka's slums.

The households which emptied their pit last time it filled up were also asked the emptying method and type of provider used. City-wide, 97% of emptying households reported using informal manual sweepers to empty their pit or septic tank, against 78% of households in slum areas.[44] The results for the slum sample are shown in Table 22 below.[45]

Table 22 Emptying method cross-tabulated with service provider type – slums

	By hand	Manual pump	Mechanical machine	No. of households
Household member	5	0	0	5
Neighbour	0	1	0	1
Informal provider	25	4	0	29
Company/NGO (formal)	2	0	0	2
Total no. of households	**32**	**5**	**0**	**37**

These results again highlight the continuing high dependency on manual emptying. This is true both at a city-wide level (virtually to the exclusion of all other options) and within slum areas (where 17% of households using manual emptying reported doing it themselves).

Where technology was used, it was a manual pump (14% of emptying households used this technology, mostly with an informal provider doing the work). Mechanical emptying services are virtually absent. None of the emptying households in slums used this kind of service, and only 3% of the city-wide emptying households used one.

Households were also asked about where the FS was discharged to during emptying. Households were only asked the initial discharge point, since they would not always be in a position to know where service providers eventually discharged to. Results are shown in Table 23 below. In both sub-samples, 73% of emptying households reported that sludge was discharged directly into drain/water body/field from the pit/tank. The vast majority of the others, in both cases, reported discharge into a drum or container – the eventual destination after that

[44] This compares with 69% of households reporting using manual emptiers in the WaterAid Landscape Analysis and Business Model Assessment in FSM report (BMGF, 2011). The report notes that the results are based on a non-representative sample of households. Furthermore, it is not that clear whether the indicator refers to all households interviewed or only to the last time households experienced emptying (as in the present study), so the indicator is possible not comparable.

[45] The city-wide table is not shown because it does not add much, since 97% of emptying households used informal manual emptiers.

is unknown, but from the observations and secondary data, this is also likely to be a drain or water body.

Table 23 Discharge point of pit/tank contents during emptying

	City-wide		Slums/poor areas	
	%	No. of households	%	No. of households
Directly into drain/water body/field	73.3	22	73.0	27
Into a pit in the compound that was then covered	3.3	1	2.7	1
Directly into drum/open container (and presumably then into drain/water body/field)	23.3	7	24.3	9
Total	100.0	30	100.0	37

With regard to the type of payment made for services, about three quarters of emptying households reported flat rates being charged, both in the city-wide sample and the slum sample. The remaining households were charged on a volumetric basis. The mean amounts paid are shown in Table 24 below. As can be seen, the average amount paid in the city-wide sample was more than double that of the slum sample. One on level this is surprising given that, in both sub-samples, the most common service used was an informal manual emptier charging a flat rate. It is most likely that it illustrates effective price discrimination on the part of the sweepers, given the flexible nature of prices for such services in Bangladesh.

Table 24 Average amount paid for emptying services

	Ave. amount paid (USD)	No. of households
City-wide	$30.35	26
Slums/poor areas	$12.58	28

6.4.2 Service provider capacity

Manual emptiers

In terms of physical capacity, there are two main service provider types: manual sweepers and NGOs with VacuTugs. Taking the sweepers first, these were historically comprised of Hindu low caste Dalit community members employed by the municipality to clean roads and drains and remove solid waste. They are also engaged on a contract basis by private households to empty septic tanks and pit latrines, as well as to unblock individual sewer lines and drains. Municipalities historically also created separated colonies (i.e. housing areas) to house these low-caste sweepers, which continue to house their descendants who today may be employed by government departments, industries and private households. The number of sweepers active in the private FSM market is very hard to estimate – no estimates were found in secondary literature. In addition, the private demand for the emptying of tanks and pits is decreasing. Government quotas and inheritance jobs for low caste sweepers are being gradually replaced by more influential Muslim sweepers who are able to pay to get these jobs.

The informal manual emptying service is generally quick response with sweepers generally being close by and keen for the work. In most cases these sweepers are employees of the DCCs (or if not employed by the DCCs at least they are often housed by the DCCs) but are contracted privately for the provision of the service. Often the 'call-out' for this private service of emptying is obtained through the public channels of the DCCs. The manual emptying service is also versatile as it can easily include the unblocking of pipes, accessing difficult locations as well as the pumping and carting away of the sludge. As a result of most of the work being engaged informally by households negotiating the contract through the conservancy inspector, the private cleaning fee is loaded to include a fee for the conservancy inspector.

Mechanical emptiers

There are very few sludge trucks in Dhaka which, on the face of it, is astonishing for a city of its size in which such a high proportion of people using OSS. It is not so surprising in the context of so much FS going into the drains. The main service providers who operate a mechanical emptying service are NGOs. One is *Dushtha Shasthya Kendra* (DSK), a local NGO that commenced primary health care in some of the slums in Dhaka City in the late 1980s. Since then, DSK has become a major provider of water and sanitation services to urban slums. They initiated the provision of a mechanized fecal sludge emptying service, after gaining approval from DWASA to discharge fecal sludge into the Asad Gate and Tejgaon sewage pumping stations. DSK reportedly has two VacuTugs but only one is operational.

Another NGO, the Population Services and Training Center (PSTC) also has a VacuTug. In spite of advertising their FSM services (via leaflets, banners etc.), the VacuTug service is no longer operational due to lack of demand. This was compounded by competition from manual emptiers and their obstruction of VacuTug services in some places. Travel across the city to discharge fecal sludge was also a huge problem. Without local safe places to discharge fecal sludge it was felt that the safe collection and transportation of fecal sludge will never be viable for the slow-moving VacuTugs. Finally, UNICEF recently donated two sludge trucks to DWASA.

Factors affecting household decisions about which service provider to use

While the VacuTug emptying service DSK provides is hygienic, it faces various practical challenges including poor access to latrines that are not close to roads, competition from more responsive manual emptying services, and extreme traffic congestion to reach the sewerage dumping points (which are not necessarily even operational). As a result there is limited demand for these mechanized fecal sludge emptying services and high incentives for the operators to save time and reduce transport costs by discharging the fecal sludge into storm water drains.

The VacuTug service is limited in reach, scale, utility and accountability. The VacuTug service does not provide other unblocking services and cannot reach locations where the pit is far from the road. They also generally charge a fixed fee regardless of pit size. Employees seem to have some incentives to try to secure business but it appears as though their salary is not linked to the amount of work they generate.

In most cases, the quicker response time makes manual emptying more attractive to households because they generally only request this service once their system already starts to overflow (and they have no liberty to wait too long for emptying). As a result, the niche demand for VacuTug services for emptying pits is low (i.e. very deep pits that are close to the road). Price is probably not the key driver. A WaterAid study on reasons for choosing manual emptying across three different cities found that found less than a quarter of households chose manual emptying because of the lower price compared with mechanical emptying (Opel et al. 2012). The main driver for households in choosing informal manual emptiers over formal mechanical emptiers was the relative ease of accessing the manual emptiers with their flexibility for attending call-outs at any time of day and night also being a significant factor.

7 Fecal Sludge Reuse Options

7.1 Fecal sludge characteristics

All of the samples of fecal sludge removed from on-site sanitation facilities in Dhaka were very liquid, and could flow easily. The fluid nature of the wastes made it possible to empty pits and tanks either manually (using buckets) or mechanically (using suction tankers). Suction tankers were able to use pipes of approximately 100 mm diameter without any problems, because the sludge behaved as a free-flowing liquid.

Samples of fecal sludge were collected from five districts within Dhaka for laboratory analysis, with samples from each district being taken from latrines and tanks during both emptying and discharge. Samples taken from tankers during discharge may have included fecal sludge from more than one latrine. Results of the laboratory analyses are summarised in Table 8.1 below.

Numbers of bacteria were high, as was to be expected. Two different media were used for culturing *E. Coli* bacteria; the media being MFC (Membrane Fecal Coliform Agar) and EMB (Eosin Methylene Blue Agar). Both media gave broadly similar results, although bacterial counts using the MFC medium were consistently slightly higher than those using EMB medium. Helminth egg numbers were much lower than expected, with a maximum count of 781 eggs/L, compared to counts of approximately 4000 eggs/L reported from other cities.

Most of the other parameters measured were also low, with COD and BOD values indicating very weak waste strengths. These values, together with the very liquid consistency of the fecal sludge, imply that the fecal sludge samples were very dilute, containing high proportions of water. The COD:BOD ratios were within the range from 2.01 to 2.54, suggesting that the wastes are predominantly organic, from domestic sources and relatively fresh. The measured nutrient contents (Nitrogen and Phosphorus) were variable.

7.2 Current treatment and reuse, and possible future options

At present there are no systems in place for promoting better standards for fecal sludge treatment and reuse within Dhaka, and no formal reuse arrangements exist. Some research has been undertaken to assess the possibility of reusing fecal sludge for agriculture (rice and vegetable crops) in Bangladesh (Dey, 2015) although detailed results have not yet been published. By-laws promote and encourage containment of fecal sludge, but most septic tanks and leach pits discharge directly to storm water drains, so wastes are not contained. There is no likelihood of wastes being collected, treated and re used in the foreseeable future because the wastes are not contained effectively, and there are no clear incentives for anyone to improve fecal sludge service quality standards.

Currently there is one wastewater treatment plant (at Pagla), which does not function efficiently. Pagla STP is located on a 110.5 ha site to the south east of Dhaka City, approximately 8 km from the city centre. The Master Plan quotes a design capacity for Pagla STP of 96,000 m^3/day, and 120,000 m^3/day at peak flow rate. This treatment plant does not currently treat fecal sludge, although there are plans within the DWASA Master Plan for a possible future upgrade of the Pagla treatment plant to include septic tank sludge management. The Master Plan states that Pagla has sludge drying ponds, and land available for sludge drying and disposal facilities on-site. It also states that Pagla is conveniently close to rural and agricultural areas where sludge may be re-used, and that trials could also be conducted into effluent re-use in nearby agricultural areas.

Although analyses of fecal sludge samples suggested that the wastes are predominantly organic, it has been noted that sludge samples collected from open storm water drains contained fecal sludge, sand and industrial pollutants. The presence of industrial chemicals limits the opportunities for reuse of sludge taken from the drains, and reuse of this sludge should be discouraged.

The fecal sludge characteristics show the wastes to be very liquid, very dilute, and very weak. These characteristics suggest that the fecal sludge may be too weak or dilute to be of much value for any type of beneficial re-use. However, it was a very small sample (n=5), and the Master Plan recommends pilot tests for re-use of sludge as an agricultural fertiliser, and effluent re-use in nearby agricultural areas.

Table 25 Fecal sludge characteristics from five districts of Dhaka.

Parameter	Range of values (Manual emptying)	Range of values (Mechanical emptying)	Comparative septage values *
E.coli (MFC media) (cfu/100 mL)	1.6×10^4 to 6.4×10^4	6.1×10^3 to 8.0×10^3	
E coli (EMB media) (cfu/100 mL)	1.4×10^4 to 4.2×10^4	1.8×10^4 to 5.4×10^4	
Total helminth eggs (No/L)	267 to 781	408 to 562	~ 4,000
Total solids (mg/L)	19,420 to 57,272	12,778 to 72,694	30,000 (< 3%)
Suspended solids (mg/L)	17,868 to 55,484	10,852 to 70,896	~ 7,000
COD (mg/L)	300 to 672	480 to 678	< 10,000
BOD (mg/L)	118 to 306	266 to 447	
COD:BOD ratio	2.01 to 2.54	1.65 to 1.93	5 to 10
NH4 – nitrogen (mg/L)	20 to 1,100	130 to 1,900	< 1,000
Total nitrogen (mg/L)	30 to 10,700	200 to 1,400	
Total Phosphorus (mg/L)	170 to 900	120 to 200	

* Ingallinella et al, 2002

7.2.1 Treatment

The Master Plan for Dhaka states that the treatment facilities at Pagla WTP consist of sedimentation tanks, facultative ponds and disinfection, although the sedimentation tanks do not collect and remove sludge, sludge has accumulated in the facultative ponds, and the disinfection stage does not function. Pagla also has sludge lagoons, but no facilities for treatment or disposal of sludge from septic tanks.

It is estimated in the Master Plan that approximately 30% of the population is potentially served by the sewerage system, with only 20% having connections to the sewers. Several sewers and manholes have become blocked and fallen into disrepair. Sewage that should flow to Pagla from some parts of the city for treatment is therefore currently discharged, untreated, into storm water drains and nearby lakes. In the Master Plan it is estimated that flows entering Pagla STP are within the range 30,000 to 40,000 m^3/day. As Pagla STP has a design capacity of 96,000 m^3/day, the estimated flows into Pagla STW imply that it is significantly under-loaded, and that it could achieve good quality treatment. However, the effluent quality does not currently meet the effluent standard for BOD_5.

Calculations carried out by WSP's short term consultant (Mark Ellery) suggest that only 1.2% of wastewater entering the system is actually treated at the WWTP, which is down to leakage (from people cross-connecting to drains and poor O&M) and poor treatment for the wastewater which does eventually make it to the WWTP. He measured capacity throughput at the outlet weir of 250 l/s (which implies 22 MLD entering the plant).[46] Because many of the processes require some manual oversight he assumed 8 hours per day of operation, and 50% efficiency based on general observations at the WWTP. This implies about 3.6 MLD is actually treated by the WWTP. With an assumption of 118 litres per capita per day of wastewater generated, and about 2.75m people connected, that implies 325 MLD entering the system. Overall then, only about 1.2% of wastewater entering the sewerage system is effectively treated.

[46] However, the WWTP had only been turned just before the team's arrival (scum on the top of the clarifiers had not been collected by the rotating arm and there were septic bubbles rising from the sludge).

8 City Service Delivery Assessment

8.1 Introduction

The FSM City Service Delivery Assessment (CSDA) is a crucial part of the analysis of FSM services. It answers an overarching question around the quality of the FSM enabling environment, the level of FSM service development and the level of commitment to FSM service sustainability. The aim of the CSDA is to allow an objective assessment of FSM service performance through all stages of the service chain, so as to identify priorities for reform. The Prognosis for Change (in the next section) then attempts to explain *why* the CSDA looks like it does.

The CSDA format builds on an approach developed under the 12-city study (Peal et al. 2013). In turn, the 12-city method was based on similar exercises in water and sanitation (e.g. Country Status Overviews produced by WSP).

The CSDA is arranged around three broad areas: enabling services, developing services, and sustaining services. This is illustrated in Table 26 below, alongside the key question associated with each area, and the indicators used.

Table 26 The CSDA framework for FSM

Area	Question in research framework	Indicator
Enabling	What are current policies, planning issues and budgetary arrangements?	Policy Planning Budget
Developing	What is the level of expenditure, degree of equity and level of output?	Expenditure Equity Output
Sustaining	What is the status of operation and maintenance, what provisions are made for service expansion and what are current service outcomes?	Maintenance Expansion Service Outcomes

8.2 Methodology

The CSDA aims is to be fully objective and transparent, so the analysis is clear and stakeholders can engage with it and update it over time as the situation improves. It is primarily a qualitative analysis, based on a review of key documents and interviews with stakeholders at the city level. As set out in section 2.1, WSP's overall study design was that the OPM/WEDC team designed the methodology, but did not do primary data collection. For analyses such as the CSDA and PEA, it is very hard to separate data collection from analysis. Therefore, the collection and preliminary analysis was conducted by a short-term consultant contracted by WSP, Mark Ellery.[47]

[47] The analysis for the SDA and PEA chapters of this report are therefore strongly based on Mark Ellery's internal report produced in December 2014.

There are several questions beneath each of the nine overall indicators in Table 26 above, with 21 questions in total. For each question, there are objective criteria to enable a score to be given for the city, with 0 (poor), 0.5 (developing) or 1 (good) on that question. Each question is scored along the whole service chain from containment to disposal. An example is given in Table 27 below, for the first question under the "policy" indicator.

Table 27 Example CSDA question, criteria and scoring

Question	Containment	Emptying	Transport	Treatment	End-use / disposal	Indicator/ Score
Policy: Is FSM included in an appropriate, acknowledged and available policy document (national / local or both)?	0.5	0	0	0	0	• 1: policy is appropriate, approved (or in draft form), acknowledged and available • 0.5: policy is appropriate, approved (or in draft form), but not clearly acknowledged / available • 0: policy not available, or inappropriate to the context

Once all 21 questions are scored, the next step is to aggregate those scores into a city scorecard, by summing together the scores for each indicator (policy, planning etc.). Because there are different numbers of questions for each indicator, a final step is required, which is to normalise the scores to a total out of 3 for each indicator. This is achieved by dividing the city score for that indicator by the maximum possible city score, multiplying by 3, and finally rounding to the nearest 0.5. This process delivers the overall CSDA scorecard. The output for Dhaka is shown in Figure 9 below.

Figure 9 CSDA scorecard for Dhaka

	Containment	Emptying	Transport	Treatment	End-use/ Disposal
Enabling					
Policy	1.5	0.5	0	0	0
Planning	1	0	0	0	0
Budget	0	0	0	0	0
Developing					
Expenditure	0	0	0	0	0
Equity	0	0	0	0	0
Output	0	0	0	0	0
Sustaining					
Operation and maintenance	0	0	0	0	0
Expansion	0	0	0	0	0
Service	0.5	0	0	0	0

City typology	Enabling	Developing	Sustaining

Poor
Developing
Good

8.3 Findings

The overall CSDA scorecard for Dhaka is shown above as Figure 9. An explanation for each score allocated to the full set of 21 questions is shown in Annex C, while the following summarises the implications of those results.

8.3.1 Enabling

The challenge of tackling Dhaka's fecal sludge management requirements is enormous. After many years of discussion however, the political climate is changing and commitments around FSM services are higher on the agenda of D-WASA and the DCCs. FSM is not fully defined within existing legal or regulatory frameworks, so the issue of where future responsibilities will lie and the necessary institutional framework to secure change are a key part of the negotiations, supported through the establishment of a new ministerial steering committee. While discussions continue however, so will the fully informal nature of existing services – notably in relation to containment and emptying stages of the sanitation service chain.

Households and landlords throughout Dhaka have made significant investments in containment facilities so that use of sanitary latrines is at 95%.[48] Such investments overcome the problem of localised fecal contamination through open defecation, as a short-term response to the national target to "contain feces". However, given the fact that so many latrines are connected to drains (directly or indirectly) such changes have simply shifted the problem of managing fecal waste away from homes and local neighbourhoods, via drains, into a broader challenge of addressing pollution of public spaces and waterbodies. Like international targets, the national target itself does not address either the quality of containment, or post-containment stages of the service chain until effluent discharge. There has been little notable public investment in Dhaka, in regard to strengthening stages of the service chain, accountability mechanisms or a legal and regulatory framework. The challenge for both public and private service providers in particular is ensuring adequate institutional capacity and resources to improve on the availability of affordable containment and emptying arrangements, while connecting household discharges to something other than drains that will eventually eliminate both public and environmental risk through establishing a fully-functioning service chain.

8.3.2 Developing

There is currently no identifiable public expenditure in FS infrastructure or services, with the result that the availability of appropriate, affordable and safe services to the city population is almost non-existent. This is notable especially in relation to the standards of containment and emptying facilities for the urban poor, but affects all of the city's population through the ineffective transport and disposal stages of the service chain. Any future application of subsidies or taxes would need to ensure adequate funds are reinvested into low income areas to address the problem.

Property owners of new developments across the city easily find ways to side-step the building codes and challenges found to be associated with them (such as dense soil or restricted land area making soak pits unrealistic, or connections to sewer lines frequently being blocked). Connecting to existing storm water drains is increasing the practice of shifting fecal waste out of local areas, at the expense of contaminating public spaces and the wider environment. Households living in the ever-increasing number of multi-occupancy dwellings are not responsible for such decisions, which are taken by the landlords/managers of such dwellings, and will often have no knowledge of the actual infrastructure, operation and maintenance requirements beyond their latrine.

8.3.3 Sustaining

Operation and maintenance costs for FS services are primarily carried by households through their investment in self-financed sanitation infrastructure and paying for any informal emptying services. There are no government-provided services and only limited provision by civil society of public latrine blocks – and even then maintenance and emptying of shared facilities falls to the users. Any public costs are negative and externalised as city-wide environmental health degradation and localised public-health risks resulting from incidents such as flooding, drain blockages and unsafe emptying procedures. The non-enforcement of building codes is

[48] In slum areas, this "investment" may be in terms of using shared latrines – often shared with significant numbers of other users. This externalises costs for individuals, notably in relation to time spent using these facilities.

resulting in existing sewered facilities being cross-connected to drains, or newly built facilities directly connecting to storm drains, to overcome problems of frequent sewer blockages. Public statements obliging households to build septic tanks and soak pits, in the absence of broader improvements to ensure functionality of connected services, will continue to be unsuccessful.

Current service outcomes, representing the city as a whole and for slum areas only, are shown in Section 4.3 as Figure 5 and Figure 6 respectively. These clearly demonstrate the extreme lack of effective management of fecal waste through all stages of the service chain. The result is public health risks for those affected by flooding, blocked drains and poorly managed emptying services (notably the urban poor), but also environmental contamination affecting all areas of the city.

8.3.4 Implications of the CSDA scorecard

The resulting CSDA scorecard of the FSM service delivery assessment in Figure 9 reveals a complete absence of public policy, capital investment and operational oversight of FSM. This has resulted in a situation where the majority of fecal waste is discharged to existing storm water drains.

This current practice provides a relatively ‘desirable’ option for householders, landlords and developers, as it removes the effort and financial cost of periodic maintenance and emptying correctly built septic tanks and pits, to keep them functioning. It does however place significant challenges for finding solutions. With no public investment in FSM services, the informality of unregulated private provision is set to continue. This can only change when any newly adopted FSM Framework translates into clearly defined, capacitated and financed action, with the aim of providing a fully-functioning service chain for all of Dhaka’s fecal waste flows. This will require recognition, dialogue and engagement of public, private and civil society bodies to ensure appropriate infrastructure and services can be systematically developed and adapted to respond to the various contextual challenges of the city (space, tenancy, flooding, poverty, etc.). Any increasing formality of the dominant informal nature of FS services may need to focus on opportunities in the transport, conveyance and end-use stages of the service chain – before tackling the containment and emptying stages.

All of this suggests that bringing change to fecal sludge management practices in Dhaka will demand significant reform of the regulatory systems that currently govern all stages of the service chain. In the context of the general failure of existing regulatory systems, clearly segregating the roles for regulation of failure by central government, from that of licensing of compliance by local governments, from that of service management by providers, may improve the incentives for overall compliance and investment.

9 Prognosis for Change

9.1 Introduction

This chapter provides a Prognosis for Change (PFC), by considering the positions of various stakeholders, in particular the institutions and incentives at play. In the sanitation sector, key studies considering these questions include a multi-country study carried out by WSP with OPM (WSP, 2010) and a series of papers by the Overseas Development Institute (ODI, 2013). In addition, SANDEC's recent FSM book includes a chapter on stakeholder analysis, which is a key methodology in this kind of analysis (Strande *et al.*, 2014). Through this Prognosis for Change (PFC), it is intended to understand three things, which are worth briefly outlining.

Firstly, a PFC considers how "institutions" function. Here, institutions are defined as "the rules and norms governing human interaction", rather than a narrower definition of organisations. Institutions can be formal, such as codified laws – one example in FSM might be a by-law about where FS can be legally dumped. More importantly, institutions also can be informal, such as social norms. For example, prevailing attitudes towards reusing FS in agriculture are an informal institution.

Secondly, a PFC considers the incentives which institutions provide to stakeholders. A stakeholder is any individual or group with an interest in the outcome of a policy. In FSM, some examples of relevant stakeholders may include (but are certainly not limited to) sludge truck companies, the City Council, or slum-dwellers. Stakeholders can be defined broadly or narrowly as required by the breadth and depth of the analysis. For example, the earlier three stakeholder examples could be narrowed to *recent entrants* to sludge truck market, the *planning department* of the city council, or *female* slum-dwellers. This would allow more nuanced analysis rather than taking whole organisations as homogenous.

Finally, a PFC considers how stakeholders exert influence. Here, influence is defined as the formal or informal power to cause something or to prevent it from happening. In FSM, it might be worth considering city council by-laws on FS. A city council may have formal legal power, but if all their by-laws are openly flouted by service providers without fear of punishment, then their influence is very low by that measure. However, they may have informal power to influence FSM in other ways, for example in the ways their employees act when they find a blocked sewer pipe.

In addition, in order to be practically useful, a PFC should also consider the implications of the findings for effective engagement in a reform or change process. This involves an assessment of the options for engagement, and weighing them up in the context of the prevalent power dynamics and the likely response of stakeholders.

Methodology

In this study, developing a PFC was only one concern alongside a large number of other research priorities, as set out in Table 1 near the beginning of the report, which lists all the project components. There was therefore a balance to be struck. The approach in this broad study was to link a focused PFC closely to the service delivery assessment (see section 8 above). The aim is therefore to explain *why* the SDA is as it is – in other words, to explore why the service delivery blockages exist, and what entry points are available to stakeholders to try and resolve them.

Undertaking a PFC is a primarily qualitative exercise. It relies on targeted interviews or focus groups with stakeholders, alongside secondary data in the form of key sector documents, reports and studies. As noted in section 8.2 for the SDA methodology, the OPM/WEDC team did not conduct primary data collection and preliminary analysis under this project, which was done by other people contracted by the World Bank. Interview notes and reports from other consultants were primarily used to construct this PFC. In order to keep the length of this report manageable, only a brief summary of the full analysis conducted by the team is provided in this section.

Developoing a PFC requires a structure in order to be clearly analysed and communicated. There are a bewildering number of tools available, which can be applied to particular questions so as to explore some of the issues described above. Many tools which are commonly used, including in this study, are contained in a sourcebook which OPM produced for the Wold Bank (Holland, 2007).. Rather than take up more space with explanation here, it is better to go straight into the findings. Briefly, however, the main tools used include stakeholder mapping, process mapping and stakeholder analysis.

Findings

Dhaka’s FSM context

As noted above, the main objective is to explore why the SDA results are as they are. For Dhaka, the SDA is almost entirely red (i.e. “poor” scores), albeit with some orange (“developing”) scores for policy and planning around the containment stage of the chain. Scores for the rest of the chain are universally zero except for policy around emptying, where the score of 0.5 is only given because D-WASA has given two NGOs permission to discharge VacuTug contents into the intakes of two of their 30 sewage pump stations. Overall then, the job of the PFC in the Dhaka context is to try and explain “why is nothing happening on FSM” and what is the prognosis for change?

At this stage, it is worth reconsidering Dhaka’s context and the responsibilities of key actors, which were already set out in section 3 above. In summary, three key characteristics of Dhaka’s context include:

(i) rapid population growth alongside vertical expansion of the city into apartment blocks and high-rise buildings,

(ii) use of “sanitary” latrines approaches 95%, but almost none of the resulting FS is effectively contained. 99% of the waste enters the drains and local environment, either by a “long route” (e.g. pits/tanks with overflow to drains) or a “short route” (e.g. directly to drains with no intermediary containment) – see SFD in section 4.3.2,

(iii) a defective sewer system theoretically serving 20% of the population, but with only 3% of wastewater entering the system actually being treated.

All this results in very low demand for FSM services, with the only households using proper containment being (a) those in slums with no nearby drain, and (b) houses which have not connected their latrines & septic tanks to drains – anecdotally, these are more likely to be older residences according to some key informants. This in turn results in a thin market, with hardly any service providers providing mechanical emptying. The key service providers are manual emptiers, but their services are only demanded by a small proportion of the city's population.

There is emerging recognition that this situation cannot continue and, recently, ITN-BUET was engaged to draft a Fecal Sludge Management Framework for Dhaka City, with the assistance of the Gates Foundation. The impetus for this was discussions around the sewerage master plan for Dhaka.[49] While the draft master plan itself is extremely ambitious (aiming to move from 20% sewerage coverage in 2015 to 70% by 2025), discussions around it resulted in movement towards acknowledgement that FSM has a role to play. This acknowledgement was hard to avoid in the light of slow progress in extending sewerage coverage and problems with the effectiveness of the existing network.

The ITN-BUET framework proposed a sanitation tax on all households by local governments for the public good of FSM, the establishment of an environmental police, and a database of disposal systems and payments for delivery of fecal sludge. Following the presentation of this draft to the National Forum on WSS, the Ministry has requested ITN-BUET to develop a draft National Fecal Sludge Management Framework under the guidance of a Ministerial committee. In effect, this is a welcoming of the Dhaka framework, though it remains in draft.[50]

These are bold proposals to improve FSM in Dhaka, in the context of the existing situation suiting many stakeholders. The use of storm drains for eventual FS disposal to some extent makes life easier for many stakeholders. The impetus for the decision is therefore discussed in more detail alongside the use of tools below, alongside the caveat that nothing appears to have changed on the ground as yet.

In some ways, the current situation persists not only because it suits people, but also because of the apparently low *visible* costs it imposes on the majority. For example, there is hardly any expenditure on FSM services, any health impacts may not be perceived to be related to FSM, and potential costs of sewerage system blockages are avoided by cross-connecting to the drains. The hidden costs become far more apparent during the rainy season when the drainage system becomes overloaded and low-lying areas of the city are flooded, especially poor areas. The nature of these costs, and whether they are as low as they are perceived by stakeholders, is addressed in Section 11 on the economics.

Overall, the context is an almost absent market for FSM services despite a rapidly growing population. Most FS is simply not managed – the problem is avoided by FS being re-routed to the drains either directly or indirectly. There is, however, an emerging discussion around resolving this situation. The next section maps out stakeholders' current responsibilities.

9.1.1 Mapping institutional responsibilities

As set out above, the focus is how institutions function, the incentives which those institutions provide to stakeholders, and how those stakeholders exert influence. It is therefore important to understand who those stakeholders are, alongside their formal and informal roles. A useful

[49] The World Bank is financing the Dhaka Water & Sanitation Project (DWSSP) for the preparation of the Sewerage Master Plan for Dhaka. including the prioritization of key investments in the wastewater management and sanitation system.
[50] This situation may have changed even since Mark Ellery conducted the key informant interviews in June-December 2014. We will update this report in discussion with Mark and others active in the going World Bank project, before any versions of this report are shared externally.

tool for this is stakeholder mapping, as set out in Table 28 below. This table represents a summary of a far longer and more detailed table, which has been shortened in the interests of space.

Stakeholders are categorised by type (e.g. national or local government, NGO etc.), and their formal role in FSM in Dhaka is listed. In the next column, the reality of how they operate (often informally) is described. A final column summarises the core challenge represented by how that type of stakeholder operates.

Table 28 Mapping stakeholders and their responsibilities for FSM

<table>
<tr><th>Type</th><th>Stakeholder</th><th>Formal role</th><th>The reality</th><th>Core challenge</th></tr>
<tr><td>Nat'l govt</td><td>Ministry of Local Government</td><td>Set sanitation standards (incl. FSM) and advise local govt</td><td>No policies / standards on FSM, but FSM strategy and framework recently drafted</td><td>Ministries can't enforce standards due to non-compliance and insufficient staff</td></tr>
<tr><td rowspan="3">Local govt</td><td>RaJUK - capital development authority</td><td>Provide building permits and inspect for compliance (incl. septic tanks)</td><td>Regularly plans developments without seeking DWASA / DCC advice. Too little capacity to properly inspect builders</td><td rowspan="3">DCCs are not managing sanitation externalities, Sewerage system is not fully effective, RaJUK not sharing planning approval</td></tr>
<tr><td>Dhaka City Corporations - municipal authorities (x2)</td><td>Ensure adequate sanitation (now interpreted to include FSM), manage small-scale drainage (open & small bore drains)</td><td>Only recently aware of responsibility for FSM. No rules or by-laws related to FSM.</td></tr>
<tr><td>DWASA - utility</td><td>Manage sewerage (pipes, pumps and WWTP), and large-scale storm water drainage</td><td>70% of sewer pump stations non-functional so, anecdotally, DWASA staff cross-connect sewers to storm water drains</td></tr>
<tr><td>NGOs</td><td>DSK - NGO service provider</td><td>Manage VacuTug FS emptying service, dump in sewage pump stations</td><td>Hygienic collection, but low demand for services. Often dump in storm water drains due to distance, traffic or lack of functional pump stations</td><td>only 10% of people in Dhaka use an emptying service, and they prefer the speed/ease of informal manual emptying</td></tr>
<tr><td rowspan="3">Private sector</td><td>Property Developers</td><td>Install septic tanks & leach pits or connect to sewerage system</td><td>Often connect buildings directly to storm drains, or build sham septic tanks to fool RaJUK</td><td rowspan="3">developers and households connecting everything to drains, sweepers like the status quo because it gives them work, their DCC managers are happy because they get a cut</td></tr>
<tr><td>Households - service users</td><td>Pay sewer bill or engage formal service providers to remove FS from septic tanks</td><td>Often pay DCC sweepers informally to empty FS (usually into drains), or cross-connect their sewer/septic tanks to storm drains</td></tr>
<tr><td>Sweepers - service provider</td><td>Paid by DCCs to clean roads & drains</td><td>Often second jobs emptying septic tanks / pits & unblocking sewers</td></tr>
</table>

Overall, the message of the above table is that very few stakeholders are fully implementing their formal responsibilities with regard to FSM. The current situation suits many stakeholders, whether it is the property developers cutting corners because it saves them money or households paying informal manual sweepers because they are quicker/cheaper. It seems that no single stakeholder has blocked progress particularly, but rather the status quo suits almost everybody, despite being affected by the externality of poor FSM, whether they know it or not.

9.1.2 Illustrating the incentive problem

It is helpful to consider the ongoing problem of poor FSM in Dhaka in two dimensions. The first dimension is static, that is, the way households and businesses are dealing with their FS at present. At present millions of people in Dhaka have their latrine outflow directly or indirectly connected to some kind of drain. The second dimension is dynamic – the city is changing rapidly, both spatially (e.g. more high-rise buildings, slums transferring to periphery) and demographically (population growth and inward migration).

In terms of policy, the static problem requires a response which could be implemented slowly over time – for example, there may be ways of persuading or obliging households to disconnect their toilets from the drains. The dynamic problem, however, requires engagement in areas that are more the domain of urban planning than sanitation policy and practice. If property developers are to be prevented from connecting the wastewater outflow of new buildings to the drains, they must be compelled to build proper septic tanks which are not connected to drains. As new migrants to Dhaka arrive, and as existing households upgrade their living conditions, they must have sanitation options open to them offer the potential of effective FSM.

It is possible to illustrate the first aspect of the dynamic problem by using a tool called process mapping. This aims to understand the interaction of formal and informal “moments” in a process, and to identify entry points for engagement. It is important to identify the roles of stakeholders in a process, how and where they exert influence over the process, and the incentives they face in the informal system.

The process for constructing a new building in Dhaka is shown in Figure 10 below. The central column shows the formal process which is supposed to be followed by the property developer, RAJUK (the capital development authority) and the occupants of the eventual building. The third column, however, shows elements of the informal process, i.e. what really happens. For example, RAJUK is supposed to consult the DCCs and DWASA about services to be provided (e.g. water supply, sewerage, drainage, solid waste etc.) when a new building is constructed. However, this may be limited to only the bare minimum (e.g. water) or RAJUK may sometimes simply expect services to be provided. Another example would be that the developer is supposed to construct septic tanks (and leach pits) which be easily accessed for desludging, but in reality they connect these to the drains. There is also some anecdotal evidence of developers constructing ‘sham’ facilities to fool or placate overworked RAJUK inspectors.

Figure 10 Process mapping for new building construction

Entry points	Formal Process	*Informal Process*
	Developer applies to RAJUK for permit	
	↓	
Improve application scrutiny by all parties	RAJUK reviews application and consults other relevant authorities linked to FSM service provision (e.g. DCCs, DWASA)	*RAJUK expects DCC/DWASA to provide services, without asking*
	↓	
	RAJUK approves construction	
	↓	
	Developer constructs building with septic tanks & leach pits not connected to drains	*Developer connects toilets or septic tanks directly to the storm water drains*
	↓	
Improve quality of inspections by RaJUK	RAJUK inspects during and after construction for compliance	*Not enough RAJUK staff to do proper inspections & enforce compliance*
	↓	
	Occupants of completed building arrange for emptying of septic tanks when req'd	*Occupants do nothing, as all waste goes to drains*

In terms of entry points, there are two ways in which the formal process could be improved so as to make it less likely that the informal process is followed. Firstly, process for planning applications could be tightened up, so that the DCCs and DWASA have greater scrutiny of what is going on. This would not necessarily be easy to implement, and would bring new problems (e.g. time/inclination of staff to engage, desire to slow down development due to red tape, etc.). In any case, the relevant DCC and DWASA staff involved in the planning process would need time to engage. A second entry point could be at the inspection stage. If RAJUK's inspectors were better resourced, or if their incentives were better aligned towards preventing unscrupulous property developers from connecting to the drains, then this could improve the situation.

Several more key processes could be mapped, to try and identify more entry points. The main message of this sub-section is that informal processes, and the incentives which make them happen in that way, are crucial to understanding why good ideas do not always work out in practice.

9.1.3 The influence and interests of stakeholders in FSM reform

When considering reform options, it is crucial to consider how stakeholders might respond, e.g. who would be supportive, who would oppose – in other words, their interest, or whether they stand to gain or lose from any change. With a limited amount of time and effort to put into preparing the ground and working with different stakeholders, it would be wise to use that time efficiently and target it at the right people. Therefore, information about stakeholders' interests is not enough. It must be used in combination with an analysis of their relative influence. It is not worth spending as much time on people who oppose the reform but have no power, as with those who oppose it but have decisive power to prevent it from happening.

For example, it would be useful for those leading on FSM reform to consider whether each stakeholder in Table 28 would support or oppose a move towards better containment and emptying practices in Dhaka. This could help start a conversation about stakeholder engagement in reform processes.

For example, the DCCs would stand to gain in terms of a smaller load being placed on their small-bore drainage system, which might be expected to become blocked less often as a result. If FSM reform creates more work for them, in terms of the new responsibilities now apparent (see Table 28 above), then this might make them less enthusiastic.

Informal sweepers are in a similar situation. Stopping latrines being connected to drains would work well for them in the short term, in the sense that they would get more business doing pit emptying. However, they may be wary of market developments which would enable mechanical truck emptiers to break into their market into the medium term. However, sweepers have relatively little influence over FSM reform. They can affect the day-to-day situation on the ground (for example, there is anecdotal evidence that sweepers have interfered with the ability of mechanical operators to empty pits), but they are not an influential constituency on the whole. It is also worth noting that many of them are DCC employees, who carry out private emptying work on the side.

Households and property developers, on the other hand, might be expected to oppose reforms, as they do not perceive the societal damage costs of inaction, but only the personal costs they would bear from a change to the situation. Both would stand to face higher costs, households from having to adapt their toilet facility and eventually pay emptying fees, and property developers from having to spend more on proper septic tanks and appropriate access to them. Both are likely to be influential, households in terms of public opinion, and developers in terms of their political connections.

9.2 Implications for FSM in Dhaka

In conclusion, this chapter has summarised aspects of the analysis conducted through key informant interviews by World Bank consultants, to help explain why the SDA looks as it does. That is, why is the whole SDA showing poor FSM service delivery overall. The fact that the whole thing is red, not just parts of it, has precluded a focused look at key parts of the chain, which may be more appropriate in other cities.

The implications of all this for FSM in Dhaka is mainly that it is crucial to maintain momentum on the emerging reform agenda. Progress could easily stall if opposing forces emerge to try and block it, or if DCC and DWASA drop it due to lack of priority. The various analyses above, as well as a lot more in the associated report by Mark Ellery, show that while the *status quo* suits almost everybody, there are also many stakeholders who would gain from reform as well. The only influential stakeholders who risk losses are households and property developers, so special care must be taken to try and win them over.

Householders may be responsive to public education campaigns which increase awareness of the impacts of poor FSM, especially during or after times of flooding when the contents of the drains suddenty matters to everybody. As for property developers, the cynical view is that they will get away with whatever they can. They may well oppose reforms. However, as long as those in favour can form a strong coalition to put things through, it is unlikely that the costs to the developers of proper containment are significant enough to warrant them wanting a fight. All they have to do is put in septic tanks, and the costs of emptying and maintaining those are borne by those eventually managing the building, who in turn can pass them onto the occupant households.

Strategies are needed to bring along those stakeholders who might be expected to be cautiously in favour. RAJUK, the DCCs or the sweepers could easily become obstructive if they perceive a risk of losing out. What the process mapping shows, even of one process, is that institutions such as regulations and by-laws do not always operate in the way they are supposed to. It would be disappointing if reform efforts culminated only in yet another set of by-laws which are ignored by all stakeholders. Special care must therefore be taken to ensure that any reforms properly consider the changes in incentives they may cause, or indeed fail to cause.

To address the “so what” questions which are often a response to this kind of analysis, a section at the end of the next chapter (which focuses on intervention options) considers the feasibility of proposals in the context of the above analysis.

10 Intervention options

This section proposes interventions to improve fecal sludge management services in Dhaka and provide an effective enabling environment within which those services can be appropriately developed and sustainably managed. These interventions are initially informed by results of the survey data that highlight problems with existing services (as most clearly represented in the fecal waste flow diagrams). Th interventions most directly affecting service delivery are then considered in the context of results from using the broader detailed diagnostic tools, in particular the service delivery assessment (SDA) and the Prognosis for Change (PFC), as presented in other sections of this report.

This section does not identify or propose specific and detailed actions to be taken, who is best placed to undertake those actions, what information is needed in advance of taking action (such as additional feasibility studies), or the likely outcome of those actions. A number of studies and initiatives are ongoing in Dhaka to do this. The intervention options presented here take account of those studies and can hopefully support the further development of details and recommendations from those other studies.

To support planning decisions for improving FSM services over time, this chapter starts by referring back to key results responding to the question *"Where are we now?"* using the fecal waste flow diagrams as a means to illustrate the key challenges. It then goes on to propose responses to the question *"Where do we want to get to?",* that acknowledge components of the enabling environment, current studies and ongoing sectoral reforms, as well as good practice and relevant experience from elsewhere.

Addressing the next question *"How do we want to get there?"* is a further process that requires strong leadership at city level, engagement of city authorities and key stakeholders, detailed studies and analysis to identify specific plans and solutions that can support an incremental and strategic planning approach. Some ideas on how a phased and pragmatic approach may be necessary for this process to take shape are identified in Section 0).

10.1 Identified weaknesses, through the service chain

The key starting point for presenting weaknesses in the existing services is the fecal waste flow diagrams, as they identify the extent to which FS is managed (or not) through the current sanitation service chains (sewered and non-sewered).

From these diagrams, "problems" or "weaknesses" in the process of managing wastewater and FS at the key stages in the chain can be highlighted (see following figures), pointing to where interventions are needed to improve the *status quo*.

Figure 11 City-wide faecal waste flow: results and problems

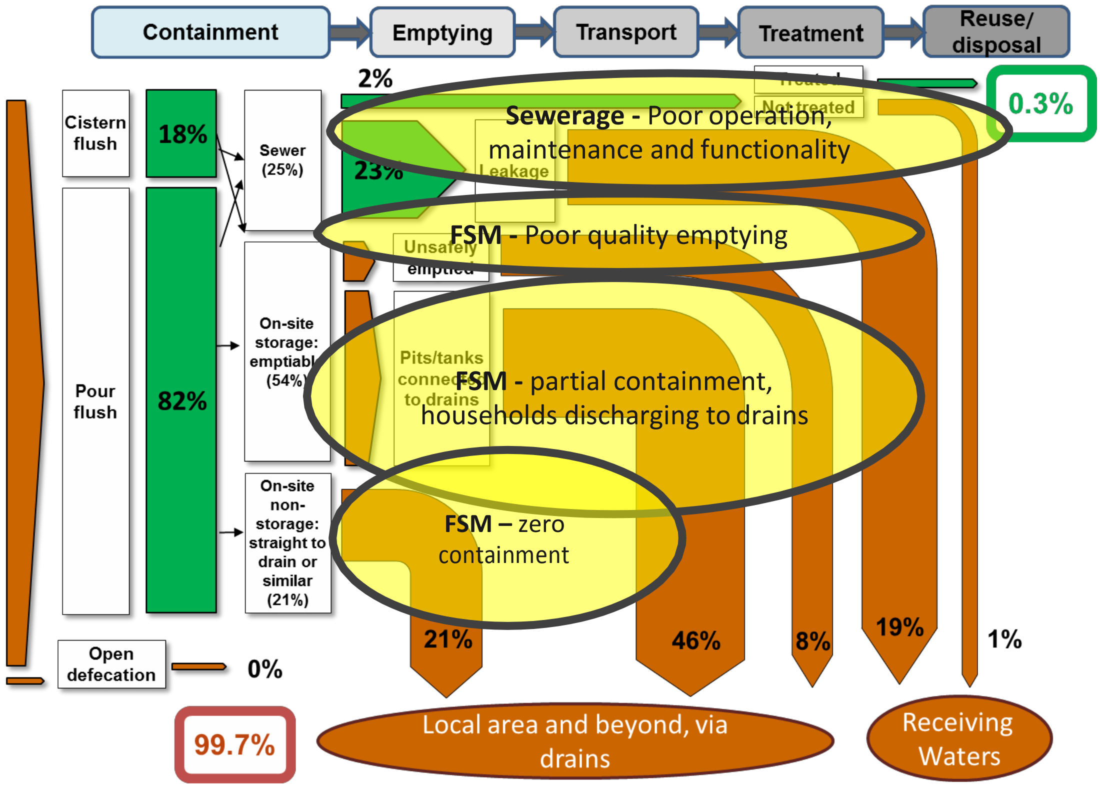
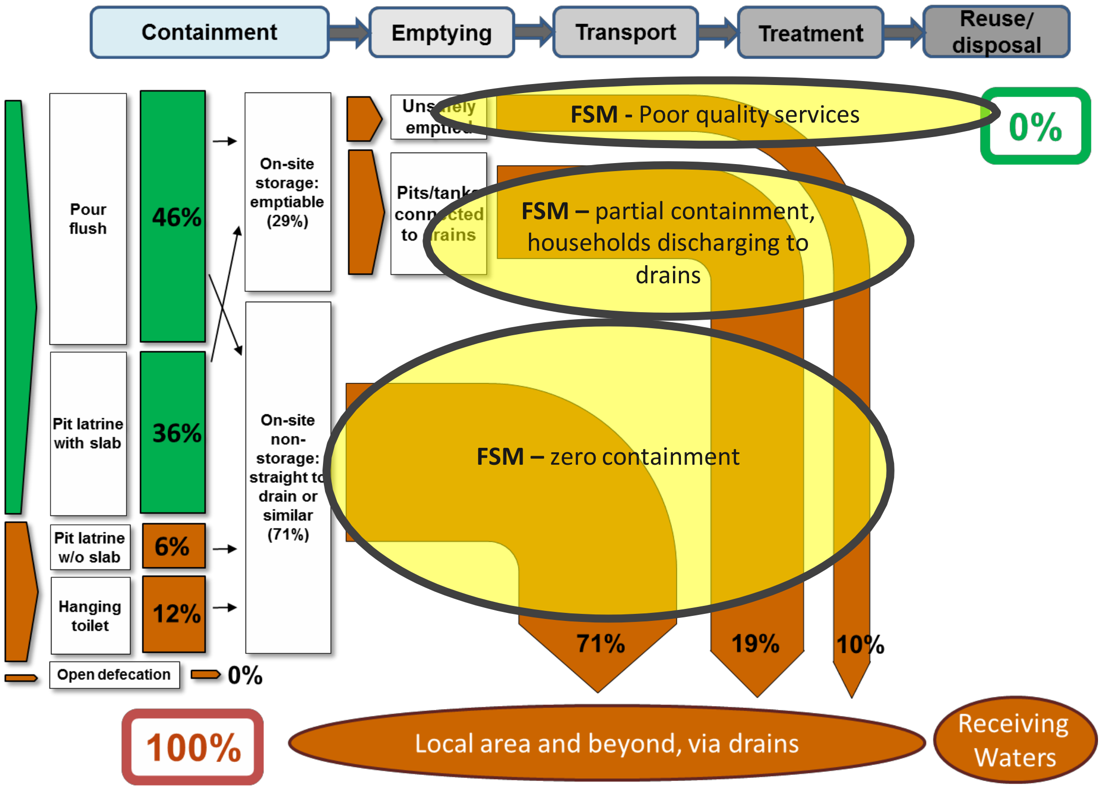


Figure 12 Slum area faecal waste flow: results and problems



10.2 Proposed solutions, through the service chain

Taking the highlighted problems, it is possible to identify possible solutions to address them, based on findings from the FSM study, results and discussions emerging from ongoing studies within the city – such as the recommendations from the DWASA Dhaka Sewerage Master Plan Project (March 2013), DWASA Low-Income Customer Service Improvement Plan (LICSIP, May 2015), and the Dhaka Water and Sanitation Project (DWSSP) consultancy identifying sewage collection and treatment options for Uttara and Mirpur (on-going).

These proposed solutions are grouped according to the types of containment / discharge arrangements (system type), then consider possible interventions through the later stages of the service chain.

At the level of analysis possible from the FSM study, the solutions are not identified on the basis of specific locations within Dhaka, although they provide guidance on what needs to be addressed within the city as a whole and for slums in general. This level of detail and analysis requires further data sets and investigation, such as ongoing through the DWSSP consultancy. These findings can offer guidance as to the types of interventions to be explored in more depth as part of that and other work.

Table 29 on the following pages sets out possible technical interventions, whereas the sections following the table consider interventions more related to the enabling environment. The options in the table are not necessarily mutually exclusive and in presenting the “Where do we want to get to?” they do not specify interim or staged approaches. These are discussed in the following section. Some examples of where these kinds of options have been successful in other cities around the world are also provided within the subsequent section.

Table 29 Technical interventions to improve service delivery, based on existing system type

System type / key problems	Potential solutions					
	Containment	**Emptying**	**Convenyance**	**Treatment**	**Disposal**	**End-use**
Sewers • Poor retention of connections • Limited O&M / functionality (leakage, blockages, overflows, etc.) • Ineffective treatment / poor effluent standard	Enforce building codes for new-build housing; i.e. connected to existing or planned sewers Disconnect household connections to drains, where household is within 100m of operational sewer Provide incentives for households to connect to sewers (low- or zero- cost connection fee, staged payments, etc.) and penalties for households that disconnect where functioning sewers are available	N/A	Prevent illegal connections, clear blockages, ensure functioning pumping stations Increase monitoring and recording of sewer conditions Increase capacity and resources to respond to O&M needs, achieve call-out services (blockages, collapses, pump station failure, etc.) and maintain sewer functionality Extend sewer lines into designated, targeted locations	Improve functionality of Pagla Sewage Treatment Plant (STP) – ensure it is functioning to design standard. Manage existing facilities better and extension of treatment units as and where required Allocate funds for operation and maintenance purposes	Improve effluent discharge points to minimize environmental risk Monitor and report on effluent standards	Identify options for regulated end-use of treated effluent from STPs – e.g. irrigation
On-site: emptiable • Poor quality (unsafe) emptying practices	Enforce regulations to prevent cross-connections to drains where containment facilities exist Improve the design and construction of	Extend/ improve emptying options and services: a) Modified STs/pits: fast response time,	Identify, research, pilot and develop a range of innovative transport solutions (mechanised or human powered) to access diverse locations, offering a	Introduce a range of FS treatment facilities: DEWATS, dewatering/drying beds with possible co-composting of dried	Identify unofficial disposal/ discharge sites and address key public and	Explore opportunities for FS end-use in agriculture (nutrient value), industry (e.g. energy value as

System type / key problems	Potential solutions					
	Containment	Emptying	Convenyance	Treatment	Disposal	End-use
• Limited coverage of emptying services • High rates of connecting to drains	septic tanks (STs) and pits, with correct standards followed: a) Modified STs and pits with separate grey/ blackwater discharge; greywater to drains, blackwater to a 'holding tank' (modified ST with no outlet) where no piped system available b) Standard STs and pits: combined grey/blackwater discharging to small bore sewer (SBS) c) Modified or new interceptor tank: combined grey/blackwater discharging to small bore sewer (SBS)	good access, small volumes, affordable b) Standard STs/pits connected to SBS: mid- to larger-volumes, good access, safer emptying & disposal practices Identify and support entrepreneurs who can provide a range of appropriate emptying services, that are affordable, accessible and safe for households, the public and environment	more affordable and responsive service – smaller vehicles, more flexibility, shorter routes. *(e.g. WSUP pilot studies with tricycle units)* Introduce transfer stations for small-vehicle operators – linked to larger collection services to take FS to treatment (where distance to discharge point is uneconomical) *(e.g. WSUP pilot study)* Construct small-bore sewers, connecting households with improved STs/pits or new interceptor tanks to decentralised treatment facility	sludge and municipal solid waste Introduce FS-handling station to the STP sites, or dedicated FS treatment plants operated locally Locate decentralised treatment sites to ensure safe and efficient access for emptying service providers – where households discharge to drains and provision of sewers is highly unlikely (RajUK to support process of land approval and purchase)	environmental health risks. Identify reasons for continued use of unofficial disposal and: - if lack of provision: provide more official discharge points and treatment sites, or - if distance: introduce transfer stations and enforcement Modify existing sites and manage new FS disposal sites – to minimise risk to public and environmental health	a dried fuel source, anaerobic digestion), etc.
On-site: non-emptiable	Modify existing STs/pits, as per part (a) for *on-site*	As above	As above	As above	As above	As above

System type / key problems	Potential solutions					
	Containment	Emptying	Convenyance	Treatment	Disposal	End-use
• Poor containment infrastructure • Direct discharge to environment	*emptiable* above, so as to convert them to being both emptiable and providing effective containment Introduce new/ improved on-site containment, e.g. interceptor tanks, septic tanks or pits, for household/ community or public facilities – constructed and located to make emptying possible.	Increase emptying services to additional facilities				
No containment facility • Direct discharge to environment	Invest in additional communal/public facilities – to reduce sharing to acceptable levels – connected to local sewer networks Invest in new household-level container-based options, where acceptable to users Identify technical options for low-lying and flood-prone areas for household /	Ensure additional communal / public facilities are connected into localised sewer network Increase emptying services to new facilities: see above Identify and invest in new/ innovative servicing of household containment options that have no outlet	As above	As above	As above	As above

System type / key problems	Potential solutions					
	Containment	Emptying	Convenyance	Treatment	Disposal	End-use
	communal/ public level of facilities	*(e.g. WSUP's SWEEP teams)*				

10.3 The Service Delivery Context: priorities to address

The WSP desk study review of Dhaka city FSM, conducted as part of the Review of Fecal Sludge Management in 12 Cities (Peal et al, 2013), placed Dhaka within the 3 city typologies as a **Type 1 city: Poor FSM**. For Type 1 cities, the WSP report states that investments in infrastructure would be ineffective if carried out in isolation to addressing the broader enabling environment, due to the absence of an overall FSM framework at the time of the study.

Based on analysis of broader findings from the FSM study, the following sections consider the key areas of the Enabling Environment (as defined and grouped within the Service Delivery Analysis of *Enabling, Developing and Sustaining* components) and identify priority actions to support any infrastructure-focused investments in Dhaka. While drawing on the SDA results as presented in Section 8 and Annex C, it also accounts for current studies and ongoing sectoral reforms taking place in Dhaka, as well as good practice and relevant experience from elsewhere.

10.3.1 Enabling: policy, planning and budget

Policy: Ongoing policy revisions must give attention to the needs of all aspects of the FSM service chain (particularly emptying, convenyance, treatment and disposal), not only access to containment infrastructure. This will require significant investment of time and resources to achieve, but should start with clear commitments from the lead agencies to an agenda for change and recognition of FSM services as a key component of Dhaka's sanitation provision for the foreseeable future. Establishing a separate strategy for FSM services is seen as a good starting point by a number of stakeholders. It is currently a strategic component of the National Strategy for Water Supply and Sanitation (2014), with a draft FSM framework in place for consultation.

Regulation: A strong set of regulatory laws, bylaws and enforcement procedures will be needed, reflecting updated policy and strategy to ensure construction standards for containment infrastructure and services along the FSM chain (emptying through the treatment / disposal) are adhered to. This requires commitment from all key players, including the Ministry of Environment, RAJUK, City Corporations, DWASA, service providers (formal and informal) and households – so that each is aware of their duties, responsibilities and rights.

Institutional roles: there remains a significant absence of clearly understood roles assigned to appropriately regulated and resourced institutions in relation to sanitation and FSM services. This remains a key aspect in the ongoing process of developing and adopting a new FSM Institutional Framework for Dhaka (discussed in more detail in the Prognosis for Change section), prior to approval and adoption. In addition, mechanisms to support and encourage stronger inter-agency cooperation, reporting and response will be essential for the FSM Institutional Framework to be successfully implemented. This process may require – and be supported by – the establishment of a designated and dedicated national agency addressing the range of on-plot sanitation, FSM services and sewerage services, as in the case of ONAS and ONEA in Senegal and Burkina Faso respectively. The FSM framework, in place for consultation, proposes a few organisations for these purposes. At city level, it may be prudent to identify a single body to hold principal oversight and accountability for the full sanitation service chain (incorporating sewerage and FSM services), with appropriate actors (government, private sector or CSOs) delegated the responsibility to deliver defined services along stages of the service chain where they have the greatest potential to deliver effective, efficient and safe services. Amendments to the City Corporation Act (2009) and WASA Act (1996) could then ensure that FSM services are more explicitly defined, using current terminology and giving clarity to the agreed mandated roles of these principal actors.

Service provision and planning: Service improvement plans at a city-wide level, as well as to specifically identified (targeted) areas, must continue to thoroughly assess the feasibility of a range of technical options (i.e. beyond the more typically constrained choice of septic tanks and soak pits, or conventional sewerage), affecting all stages of the service chain. This can include options for household container-based latrines, holding tanks or interceptor tanks for households, means of reducing the BOD of effluent discharging from tanks, pumps for safer manual removal of FS from pits and tanks, local treatment units for larger installations such as multi-occupancy high rise dwellings or community-based facilities (e.g. anaerobic baffled reactors), non-conventional sewerage networks (including small-bore sewers), transfer stations with/without on-site partial treatment and so on. Those responsible for developing improvement plans need to identify a range of cost-effective operation, maintenance and management arrangements that can be competently managed at as local a level as is necessary and reasonable (i.e. the principle of *subsidiarity*). These may include for example, responsibilities to arrange desludging of septic tanks for individual households, or those shared within a compound, or for making repairs to tanks, connecting pipework and valve chambers, and so on.

Such an approach requires incentives to encourage the uptake and running of effective services – these could be linked to further business opportunities for those showing themselves to be competent. Any such service arrangements must respond to current and expressed needs of those to be served, in line with *Developing* components (next section). It should also be noted that without improving on containment infrastructure, and so reducing the extremely high levels of connectivity to drainage infrastructure, little else is likely to bring about significant change in the FSM service chain.

Budget: Development of comprehensive FSM plans have to identify realistic budgetary requirements that can inform the required level of public and external investment in infrastructure and services, through the service chain. The ESI Toolkit is a good first step in this process.

10.3.2 Developing: equity and outputs

Equity *Choice / reducing inequity:* the city needs to identify a wider range of responsive, accessible and affordable FS emptying and transportation options that can service existing and newly developed household containment facilities. This process needs to bear in mind and develop variable costs for variable service levels: so for example customers receiving on-site services are paying less than those receiving sewered services (see under Cost Recovery for examples).

- The emptying services that people currently have access to – formal mechanised vacutug (in some areas), or informal manual emptiers – may benefit from a wider range of options. Enabling and encouraging a greater range that can overcome some of the limitations experienced by existing service providers (limited access and space in high-density areas, procedures involving direct contact with fresh fecal sludge, etc.), within a regulated service sector, is likely to increase competition and therefore promote greater customer-focus and cost-control amongst service providers. The service chain must respond to both current user demand, as well as the generally expressed willingness to pay more for responsive and reliable emptying services.[51] To achieve this, services must be able to access some of the hardest to reach communities, be easy for households to contact and provide more flexible call-out and payment arrangements – all of which were identified as constraints during consultation with focus groups..

[51] People consulted in focus groups stated a level of interest to pay more for improved sanitation and FS services, but these comments were not made within a structured willingness-to-pay study.

- A range of technical options for alternative sewer arrangements (Small Bore and Settled Sewers) is proposed in the LICSIP and DWSSP reports. The proposal of a zero-fee connection is intended to encourage higher connection rates. However, more detailed assessment of the feasibility of each option in terms of cost-effective operation, maintenance and management arrangements must be thoroughly and critically explored to identify the most likely opportunity for functioning systems in a range of localities. At the same time, the DWSSP Uttara and Mirpur study (Interim Report, May 2015) must give greater attention to options for improving and servicing on-site sanitation systems.

Outputs *Quantity / capacity:* The SFDs presented earlier show that even if households have emptiable latrines, emptying does not achieve safe disposal of FS. It has also been identified that demand for emptying from the current formal providers is not achieving a self-sustaining business opportunity and may even be declining.

- **Where facilities are connected to the existing or future conventional sewer network**, attention must be given to ensuring continued functionality of sewers, for example through quick action taken to address reported blockages, sewer collapse and failures in pump stations. LICSIP introduces the implementation of penalties for customers refusing to connect to sewers, once they become available in an area. However, only where sewer functionality is maintained can cross-connections being made to drains be expected to stop, or environmental standards and a "polluter pays" principle be enforced to any level of success.

- **Where facilities are to be connected to new non-conventional sewer arrangements**, it will be essential that the roles and responsibilities of the various actors are clearly defined (the draft FSM framework entrusts this responsibility to the city corporations) *and resourced*. Areas needing specific attention will include: arrangements for operation and maintenance of settling (septic/ interceptor) tanks and service lines within properties, plus arrangements for emptying tanks (LICSIP includes options for scheduled emptying arrangements by D-WASA to improve functionality); or responsibility for repairing manholes at the point where the service line and small bore line connect needs to be clearly defined. An effective scheduled emptying service, funded by costs levied onto water bills, could significantly improve response times for pit/tank emptying. A range of emptying services would then need to be available, to match the level of access to facilities for road-based emptiers.

- **For those households that will continue to use on-site systems**, emptying and transportation service providers (formal and informal) will need to have the means and support to gain access to other convenient, flexible and safe emptying equipment, transporting fecal sludge to managed disposal locations where they can discharge sludge for safe disposal or treatment. As identified in the LICSIP study, the use of effectively managed transfer stations and decentralised treatment facilities at strategic locations within the city could support this.

- **Where septic tanks / pits are currently discharging into drains**, the de-connection of such arrangements is seen as a crucial issue. Mechanisms to effectively achieve this will require, for example; public awareness campaigns and consultation, enforcement of the regulations and imposing fines, technical interventions at household level to improve the construction quality and accessibility of containment facilities, helping households to identify and make use of emptying service providers. Such actions are crucial to protecting those most at risk from contaminated drainage water in low-lying and flood-prone areas. In reality, an incremental approach to addressing this difficult issue will be required, as considered further at the end of this Section10.5.

Outputs *Quality and reporting:* The faecal waste flow diagrams and proposed technical interventions outlined in Table 29 show that the greatest complexity in the service chain presently occurs at the containment and emptying stages. Current practices of handling fecal sludge introduce significant risk to the public and wider environment through a lack of facilities to contain fecal waste, combined with unregulated and unsafe disposal practices. The study has highlighted the huge and city-wide scale of the problem and a range of interventions will need to be matched carefully to current practices, as well as opportunities and constraints that exist in different locations within the city. The following comments support the technical recommendations identified as Potential Solutions in the earlier Table.

- Considering *existing* infrastructure and services: 21% of households city-wide and 71% of households in slum areas have a non-emptiable arrangement (e.g. toilet empties straight into a drain). In such cases, the toilet would need converting to include some form of emptiable containment or to connect to sewer arrangement. Meanwhile 84% of households in cities and 65% of households in slum areas with emptiable pits/tanks have not had them emptied, as they discharge into drains or elsewhere. In these cases, stronger enforcement is needed to ensure these households take steps to convert existing pits/tanks into holding tanks as a step towards complying with the law, as well as increasing availability of emptying / transport services, so that they can physically connect into a viable and functioning service chain.
- New infrastructure provision must enable better containment of fecal sludge, either through correctly constructed on-site sub-structures (septic tanks or pits) with access for emptying built-in, and/or correctly constructed connections to effectively managed off-site networks.

Only when a minority of households practice informal or illegal practices can meaningful reporting occur in relation to poor construction practices, or illegal discharges resulting from poor servicing of on-site facilities and poor maintenance off-site facilities. Currently the majority follow this practice.

10.3.3 Sustaining: O&M, expansion and service outcomes

Cost recovery and standards: Cost recovery mechanisms will need to address all stages of the service chain – considering costs affecting households, service providers and financial transfers from other sectors. An approach is successfully being implemented in Hai Phong, Vietnam where households connected to the sewer are charged a fee for wastewater services, while households who are not connected to the sewer are charged a lower ‘environmental fee’. In Maputo, Mozambique a similar arrangement is applied for solid waste services. The draft FSM framework for Dhaka proposes a sanitation tax to cover costs associated with collection, treatment and disposal of FS.

- Any development of service standards must be informed by an assessment of what can be realistically achieved (as opposed to what may ultimately be required over time to achieve levels of “good practice” or nationally recognised service level standards) within a given timeframe and under a range of contextualised constraints, incrementally working towards improved standards over time and as service levels improve and infrastructure becomes available. Minimum standards can be set that ensure basic protection of public health and critical services (such as water supplies).

- A willingness-to-pay survey was not a component of this study and it is not clear that a WTP survey has been conducted as part of current studies looking at identifying options within Low-Income Communities in general, or target areas in particular. WTP information is most useful and reliable in the context of clearly-defined service options, which do not yet exist in Dhaka – so would be a valuable component of prior to committing to specific service investment plans and programmes.

Key to this process will be a review of the tariff structures for water supply and sewerage currently in operation in Dhaka. Many stakeholders note that the heavily subsidised sewerage charges leave little financial ‘space’ within which to set lower, appropriate tariffs for FSM services. The ongoing review of tariffs by the Water Supply and Sanitation Regulatory Commission is seen as a critical component.

Demand and sector development: As plans for service enhancement are developed, it is important to engage civil society, households, landlords and informal service providers, in ways to stimulate demand for improved FSM services. This could help to generate interest and commitment to carrying out duties to improve the service chain, where each actor has most influence and the most to benefit.

Customer demand for improved services remains latent while proper containment is almost non-existent and access to service options is so highly constrained. This report identifies key determinants affecting household demand – including limited access for service providers, low percentages of pits/tanks that ever fill up (and long filling times where they do fill), lack of awareness of services and affordability of those services. These findings could be used to undertake carefully-designed formative research to identify the motivators and messages for a behaviour change communication and promotion campaign to stimulate willingness to pay for improved infrastructure and services. Such a campaign should be undertaken alongside changes in legislation, enforcement of building standards for correctly-constructed containment facilities (septic tanks and pits) and the availability of FSM services.

- Focus group discussions with residents of slum areas highlight a general willingness from households to contribute towards more effective and responsive emptying services. This willingness is however significantly constrained by households’ lack of access to formal financial services (especially to help with large one-off payments such as mechanised emptying), or if as tenants they have little influence over services installed and managed by landlords. Consideration should be given to how, for example, existing savings and loans schemes supporting water and sanitation improvements, or tenancy agreements stating minimum service standards tenants can and should expect from landlords, could support households and informal service providers to improve containment, emptying and conveyance stages of the service chain – to reduce unregulated and unsafe practices.

- As service improvement plans are considered, discussed and developed, representatives of landlords, service providers and residents need to be brought into this process.

10.4 Resulting hierarchy of interventions

1. *Conveyance, treatment, end-use:* Issues formalising transport, treatment and end-use stages of the service chain (the downstream stages) need to be addressed, in parallel with addressing the containment and emptying stages, so that FS can be received and managed when upstream arrangements are improved. Effective business models need to be identified, which ongoing studies WSUP may be in a good position to help identify.

2. *Containment:* The number of existing sanitation systems that discharge directly or indirectly to drains needs to be reduced – particularly where this has a direct impact on public health through overflowing drains in low-lying areas. This requires a systematic and progressive process of disconnecting existing systems from the drains as alternative ‘outlets’ are introduced. These alternatives may include, for example: conventional sewers where these are extended (particularly for servicing public / communal toilet blocks), interceptor tanks discharging to small-bore-sewers; holding tanks frequently serviced by small mechanised emptying trucks; pits serviced by improved (safe) manual emptying using a devise such as

the Gulper. Newly-constructed buildings should not be permitted to discharge fecal materials directly to drains. The aim should be to focus on achieving properly constructed containment, and to ensure that sanitation facilities are systematically serviced by the most appropriate technical option(s).

3. *Emptying:* Entrepreneurs and NGOs require encouragement to offer a range of affordable mechanical or improved manual emptying services, and to be able to respond quickly, especially for shared sanitation facilities and for the urban poor. Licencing, service agreements and contracts issued by the regulating agency could help service providers to invest in equipment and business operations, as well as improving the regulation of service standards. The WSUP study into business models may a helpful starting point, to further explore suitable arrangements to achieve appropriate service standards.

The experience from Dakar, Senegal of the Market Structuring of FSM Program (PSMBV) would be worth exploring further. This programme identifies institutional structures, customer-based services, private sector incentives and regulation, as well as technical innovation and development through the full FSM service chain.[52]

Any improvements to sanitation services should also seek to achieve the following overarching aims:

- ensure the needs of vulnerable family members (including elderly and disabled people, pregnant women, and small children) are considered in the provision of facilities and services; and

- adopt an integrated response to addressing sanitation, solid waste, and drainage infrastructure and services. Only in this way can equitable, functional and sustainable services be delivered.

Adopting a phased and pragmatic approach

Given the extent of the lack of effective and safe sanitation services, a pragmatic approach is needed for Dhaka. Only in this way will all customers be eventually able to access services in some way or other, informed by the range of customer types and supported by a broad range of service level options appropriate to different income levels.

As part of this approach, it will be important to identify key time-bound stages that can respond to the *"How are we going to get there?"* question, within a strategic planning process. It would be helpful to identify milestones for phases of incremental improvements in all FSM and sewerage services, within the current planning timeframe of 2015-2035. Objectives can be set for each phase, with specific indicators and activities identified to support those objectives – including minimum standards to protect public and environmental health. For this process to work, decision-points will be needed to identify where in the city and at what phase services will aim to be predominantly i) FSM services for on-site sanitation, ii) a mixture of conventional sewerage and non-conventional piped networks with supporting services, or iii) conventional piped sewerage networks.

If the intention is to incrementally connect customers to effective and safely managed sewerage services, this may require the adoption of certain non-standard approaches, that are gradually addressed and overcome with time. For example, in low income communities in particular, but also in other parts of the city as and when appropriate, this may mean prioritising investments in improving household, communal and public containment facilities (various forms of tanks have been mentioned

[52] More details can be found on the website: http://www.onasbv.sn/en/

previously) while developing a series of transfer stations for FS handling and decentralised treatment sites (STPs and FSTPs).

As options for piped networks (predominantly non-conventional for LICs) are identified, planned and implemented, it may be necessary to allow the improved tanks to continue to discharge effluent into the drains (open surface and deep stormwater drains), without prosecution, *until* a piped network (conventional or non-conventional) is available and functioning for the users to connect into. This could be by way of offering a “grace period” to customers, before which penalties will not be applied providing the containment facilities are correctly operated and maintained (i.e. regularly desludged), and with clear guidance about the conditions under which penalties would be imposed once sewer connections become feasible. In the interim, households discharging to stormwater drains could be charged on the basis of using the drains as a form of combined sewer. Basic treatment would need to be provided at the drain outlets (primary screening and management of the discharge points as a minimum) to reduce impacts on the environment and public health risks. Special attention would be important to those drains most at risk of discharging into living environments, especially in low-lying areas. This sort of approach, though unconventional and requiring careful management to ensure transitioning as soon as feasible, would allow the development of sewered networks to be planned in line with changes to urban settlements, as the city develops and sewers can be introduced throughout the city, or new forms of sanitation are identified.

10.5 Feasibility of these options in the context of the Prognosis for Change

As set out above, these intervention options were developed with a solid understanding of the PFC (section 9). Therefore, they are all deemed feasible, if carried out in an appropriate sequence with the engagement of the right stakeholders. Nonetheless, it is worth specifically highlighting what will be the key factor requiring special consideration in the context of the PFC, particularly the stakeholder analysis. That factor is enforcement of laws and regulations, particularly at the containment stage of the chain.

There are three key aspects of this: (i) ensuring existing emptiable systems are disconnected from drains (or replaced with an appropriate sewered option), (ii) ensuring existing non-emptiable systems are upgraded, (iii) ensuring newly constructed buildings have an appropriate system. Each of these is a slightly different problem, but all have one thing in common. There is currently little incentive for the household or property developer concerned to act. This is because the externality is public and dispersed, while addressing the problem would involve the stakeholder incurring private costs themselves.

Therefore, it is crucial that interventions aimed at converting existing containment infrastructure, or ensuring developers don’t break the law, are planned in the context of this incentive problem. Public education will not be enough. There must be a credible threat of penalties, through publicising of fines imposed on households and developers. It would be worth studying other sectors in Dhaka which have successfully enforced the law in this way and, if there are no examples, looking further afield, including to other countries.

11 Economic analysis of intervention options

The costing is based on secondary data. All costs and benefits are given at the HH level, since the secondary data was not suitable for extrapolating total costs and benefits for Uttara and Mirpur as a whole. Results should therefore be treated with caution.

11.1 Introduction

Economic analysis compares interventions on the basis of how much they cost and what benefits they bring. This chapter presents a cost analysis of possible sanitation intervention options for the slums of Uttara and Mirpur and a partial damage costing. The analysis spans the sanitation chain and is broken down by cost component allowing a detailed view of where costs are incurred and their significance in generating value for money.

Two key pieces of information are required to conduct this analysis. Firstly, an estimate of the damage cost which monetises the negative consequences of poor sanitation i.e. the cost of doing nothing. Secondly, an estimate of the costs of the proposed intervention is required. This second component requires that there is a clear intervention designed for a well-defined population and that the components of that intervention can be costed.

11.2 Methodology

Four hypothetical intervention options were tested; three non-conventional sewer models drawn from the Low-Incomes Customers' Service Improvement Plan (LICSIP) (DWASA 2015); and one postulating a hypothetical situation for full fecal sludge management based on secondary cost data drawn predominantly from an unpublished 2012 study (Mikhael (2012)). The damage cost analysis is based on the survey data collected as part of this study, covering the health and time cost impacts associated with diarrhoeal disease. There were insufficient data to model other negative impacts associated with poor sanitation included in the damage cost module of the ESI Toolkit (e.g. water resources, broader environmental impact, tourism etc.).

These intervention options are hypothetical and do not necessarily reflect what may be technically feasible. The main objective is to illustrate the types of costs which might be incurred for different interventions. The aim on the benefits side is a secondary one, and compares the benefits of the hypothetical interventions leading to calculation of the net present value.

In each case, the sanitation chain was modelled for the whole population of Uttara and Mirpur. In other words, for each of the three scenarios it is assumed that the whole population moves from whatever they are currently using to a single homogenous sanitation option along the whole chain, although in reality this is unlikely to happen

11.3 Sources and analysis of data

Data on intervention costs was collected from published and unpublished studies on the costs of different sanitation technologies in different contexts. Where possible data was used that pertains to Dhaka, where this was not possible this was expanded to include data available from other urban areas of Bangladesh, and if not available, then other South and South East Asian cities. All cost data were derived from secondary sources, and these are quite limited given the relatively low number of comparable FSM systems (cf sewerage systems). The cost data available were often lump sum costs and had to be converted into per capita costs. These secondary costs come in a variety of units. First the costs are adjusted for inflation and all converted to Taka. Beyond that the unit has to be adjusted before it can be applied to a population. All cost data were converted into a per capita figure. For onsite technologies this is done based on the number of HHs that would use that latrine. The logic behind this is that sharing latrines is widespread and the cost per capita is largely driven by the extent of sharing. The survey conducted for the slum sample indicates that 78% of households share a latrine with 1 or more other households. On average, 7 households share one latrine and given an average household size of 4.8, of those who share toilets the average is 34 people sharing one latrine. In all models it is assumed that all HHs move to having a private onsite facility, which represents a considerable and unrealistic change from the existing situation especially given space constraints. Hence this analysis is illustrative only.

Per capita costs for the other parts of the sanitation chain (extraction and conveyance, treatment and disposal and reuse) are estimated on a volumetric basis and as such are less sensitive to assumptions surrounding sharing. The logic behind this is that the volume of fecal waste that any system would need to deal with does not vary with the level of sharing; although the frequency of extraction and conveyance will increase if many people are sharing a small facility. As such, the costs associated with treatment and disposal and reuse are sensitive to assumptions surrounding the volume of fecal matter produced per capita.

There is a danger in applying limited secondary data to hypothetical models. Firstly, the original cost figure is rooted in the context from which it came; which is not necessarily the same as the context in which they are being applied. In selecting the input data the costs most relevant to the hypothetical situations were selected. The hypothetical options described also highlight the situations in which the intervention would be suitable and the key assumptions used in calculating the costs. The second major challenge is that it is not immediately apparent how the costs are calculated in the secondary sources. If any given cost figure does not include the full costs of delivering that part of the sanitation chain it will be underestimated relative to more complete costings.

11.4 Summary of the three hypothetical intervention options

Four models were considered; the data sources for these and a brief summary of the proposed models follows.

i) Full coverage of non-conventional sewerage I: small bore sewers connected to sewer lines (SBSs).

	Onsite facility and collection	Extraction and conveyance	Treatment	Disposal and Reuse
Technology	Flush to sewer	SBS	Additional WWTP capacity	None
Main sources of data	Hutton (2012)	DWASA (2015)	DWASA (2015)	-

Small bore sewers are small diameter pipes which rely on gravity to transport the waste directly from the latrine into the conventional sewer system. They rely on a minimum of 50 lpcd of greywater to move the blackwater through the system. This implies that all households convert to a private ‘flush to sewer’ latrine from whatever they are using now (known from survey data), and the sewers lead to WWTPs. The additional capacity required is built into the DWASA cost data. The LICSIP report states that SBS are a good option for areas where there is a low risk of eviction, are within 600 metres of a planned or existing DWASA sewer, and where there are few existing operational septic tanks.

It should be noted that a SBS sewer system was installed in Mirpur in 1991 under the Dhaka Urban Infrastructure Improvement Project (DUIIP); the system was not effectively commissioned and subsequently failed. The reasons for the system's failure include:

i) The institutional responsibilities were not defined for the various activities required to assure operations and maintenance.
ii) Lack of maintenance of the sewer system and de-sludging of the interceptor tanks may have led to early failure of the system.
iii) Only 50-60% of the original appraised pipe connections to interceptor/septic tanks were installed by the DUIIP. Un-served houses were probably never connected to the sewer pipes in order to minimise expenditure.
iv) The SBS system was developed for low income areas with single storey houses and one toilet per family. Presently most of the low income areas have developed to middle income areas with fully developed multi-storey buildings. The SBS system was reportedly not designed to serve the increased number of people and it is likely that parts of it have been destroyed during later development. The sizing of the pipes and interceptor tanks cannot meet the current needs in the middle income areas.
v) Community participation is a critical factor to ensure proper O&M of the facilities and ultimate delivery of services. Periodic cleaning of the interceptor tanks is the responsibility of the owners. However there are no septic tank sludge management facilities available in Dhaka and there is limited incentive for sludge tank emptying. The awareness of periodic interceptor tank de-sludging has not developed, as most of the tanks are not in use and are currently filled with garbage.

Consequently the DWASA Master Plan recommends that the SBS systems are *not* suitable for areas in which there is high population growth, areas where there is a high risk of population overspill from a growing area, and areas where it is anticipated that many multi story buildings will be constructed over the lifespan of the system. The LICSIP estimates that SBSs may be suitable for 30% of low income households.

ii) Full coverage of non-conventional sewerage II: small bore sewers connected to Anaerobic Baffled Reactors (SBS ABR).

	Onsite facility and collection	Extraction and conveyance	Treatment	Disposal and Reuse
Technology	Flush to sewer	SBS ABR	Additional WWTP capacity	None
Main sources of data	DWASA (2015)	DWASA (2015)	DWASA (2015)	-

ABRs are a form of decentralised waste water treatment that remove solids at points throughout the network, the effluent flowing from the ABRs is largely solid free but high in pathogens and flows on into the main network through SBSs. This route down the chain implies that all households convert to a private flush to sewer latrine from whatever they are using now (known from survey data), and those SBS lines lead to the ABRs which in turn are connected to the main sewer lines via SBSs.

In the LICSIP SBSs with ABRs are taken to be a suitable option for communities that are farther than 600 metres from a planned or existing DWASA sewer line and have suitable space for the

ABR. This option is subject to some of the same vulnerabilities as the SBSs. The lessons and conditions applying to the SBSs implementation in Mirpur in 1991 also apply here. The LICSIP estimates that SBSs connected to ABRs may be suitable for 30% of low income communities.

iii) Pour flush latrines connected to Septic tanks and Settled Sewers

	Onsite facility and collection	Extraction and conveyance	Treatment	Disposal and Reuse
Technology	Flush to sewer	Settled sewers and mechanical emptying	Additional WWTP capacity	None
Main sources of data	DWASA (2015)	DWASA (2015)	DWASA (2015)	-

This option proposes that grey and blackwater are mixed at the HH level and flow into a septic tank connected to a settled sewer itself flowing to a conventional sewerage. The septic tanks require desludging; this is to be done by mechanical emptying. The sludge is taken directly to a sewage treatment plant or to a sewage treatment plant via a transfer station.

For this option there must be sufficient space to construct the septic tanks and communities should have a low risk of eviction. This LICSIP states that this option is suited to areas where there are already a number of existing septic tanks. Settled sewers also require less greywater than SBSs and as such this option may be more suitable to areas where the greywater per person per day is below 50 Litres. The LICSIP estimates this option may be suitable for 40% of low income communities.

iv) Fecal sludge management technologies

	Onsite facility and collection	Extraction and conveyance	Treatment	Disposal and Reuse
Technology	Flush to an accessible lined pit, septic tank or similar	Small vehicle transport direct to treatment	Sludge drying beds	None
Main sources of data	Hutton (2012)	Mikhael (2012)	Mikhael (2012)	-

This option assumes that all HHs move to having some form of safe containment facility wherefrom the sludge is conveyed either by a small vehicle directly to treatment or via transfer stations. Treatment in this case is sludge drying beds. In all of the cases it is assumed that all Households (HHs) move to having an individual private connection. Again, it is not completely clear from the source data which costs are included and which are not.

This option is suitable for where there is adequate space for the sludge drying beds; the closer drying beds are located to the communities which they would serve the more efficient the system becomes by reducing journey time. This cost study assumes that the drying bed would be located 11 kilometres from the community served. A second important option for this intervention is that the small vehicle used in the extraction and conveyance of the fecal matter can reach the latrines as proposed in a recent study of Ward 2 and 11 of Mirpur. In Ward 2 12% of households are considered to be in areas where fecal sludge management is the only option (i.e. these areas are unsuitable for simplified sewage). In Ward 11 7% of HHs are in areas that must be served by fecal sludge management technologies (Mikhael 2012)

As discussed below, all three of these would be quite extreme changes in the context of current levels of private latrine ownership, septic tank use and sharing of latrines by multiple households.

11.5 Design populations

Table 30 presents the total populations in Uttara and Mirpur. The figures presented in the technology cost analysis are based on the 2015 design population.

Table 30 Design populations for the technology costing

Area	Population 2011 (DWASA masterplan)	2015 design population	2020 design population	2025 design population	2030 design population	2035 design population
Uttara (catchment)	505,375	667,410	945,000	1,325,000	1,850,000	2,547,000
Mirpur (catchment)	2,175,834	2,411,099	2,864,000	3,294,000	3,750,000	4,211,000
Uttara and Mirpur	2,681,209	3,078,510	3,809,000	4,619,000	5,600,000	6,758,000

The second key piece of information in determining the design populations for any given intervention is the starting sanitation situation. This is assumed to have two key dimensions relevant to this analysis; the type of latrine/ catchment and the blackwater disposal method. The survey data for the slum sample under this study (sub-sample B) provides the basis for this assessment as it is representative of slums in Dhaka and consequently the slums of Uttara and Mirpur. In addition, 20 of the 30 sampling units were in Uttara and Mirpur.

Table 31 outlines the current sanitation situation of slum communities in Dhaka.

Table 31 Current sanitation situation of slum communities in Dhaka

	Pour flush latrine	Pit latrine with a slab	Pit latrine without a slab	VIP	Hanging Latrine	Other	Total
Septic tank Connected to a drain	13%	1%	0%	0%	0%	0%	**14%**
Septic tank with no outlet	4%	2%	0%	0%	0%	0%	**6%**
Lined pit with no outlet	0%	6%	0%	0%	0%	0%	**6%**
Lined pit with overflow to drain	0%	1%	1%	0%	0%	0%	**2%**
Unlined pit	0%	1%	0%	0%	0%	0%	**1%**
Directly to drain	29%	24%	5%	1%	10%	1%	**71%**
Total	**46%**	**35%**	**6%**	**1%**	**10%**	**1%**	**99%**

Where HHs already possess part of the proposed technology a proportion of the total secondary cost was excluded. These is only done for the HHs facility not the other parts of the sanitation chain as the rest of the sanitation chain is taken to be largely absent based on the slum SFD done as part of this research.

11.6 Technology cost analysis

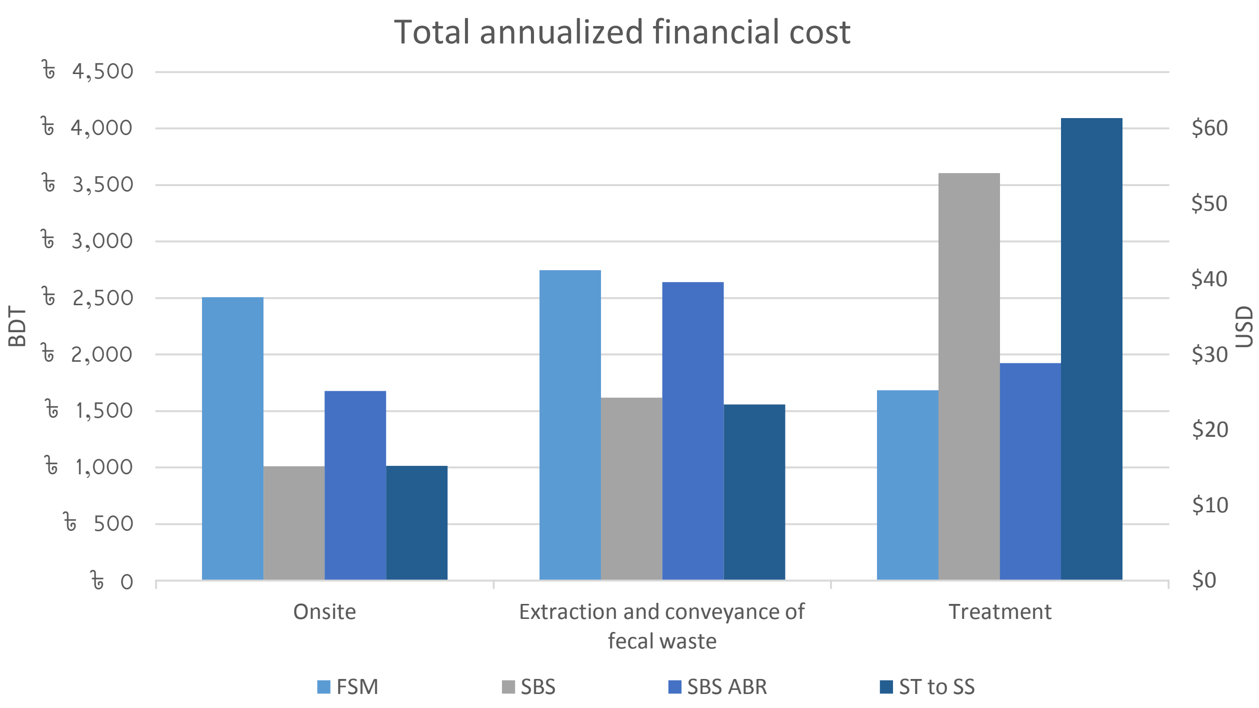
Figure 13 presents the total annualized costs for the three routes through the sanitation chain which are proposed in the LICSIUP report. Annex E contains a table summarising the data underscoring these calculations. Overall the SBS ABR option has the lowest overall cost per HH. The FSM option is the cheapest with regard to treatment and the most expensive with regards to onsite facilities (i.e. containment). This is largely driven by the high conveyance costs associated with the FSM option, this is discussed more below.

The graphs presented below use abbreviations for the different options; Table 32 is a key to these.

Table 32 Key to abbreviations used

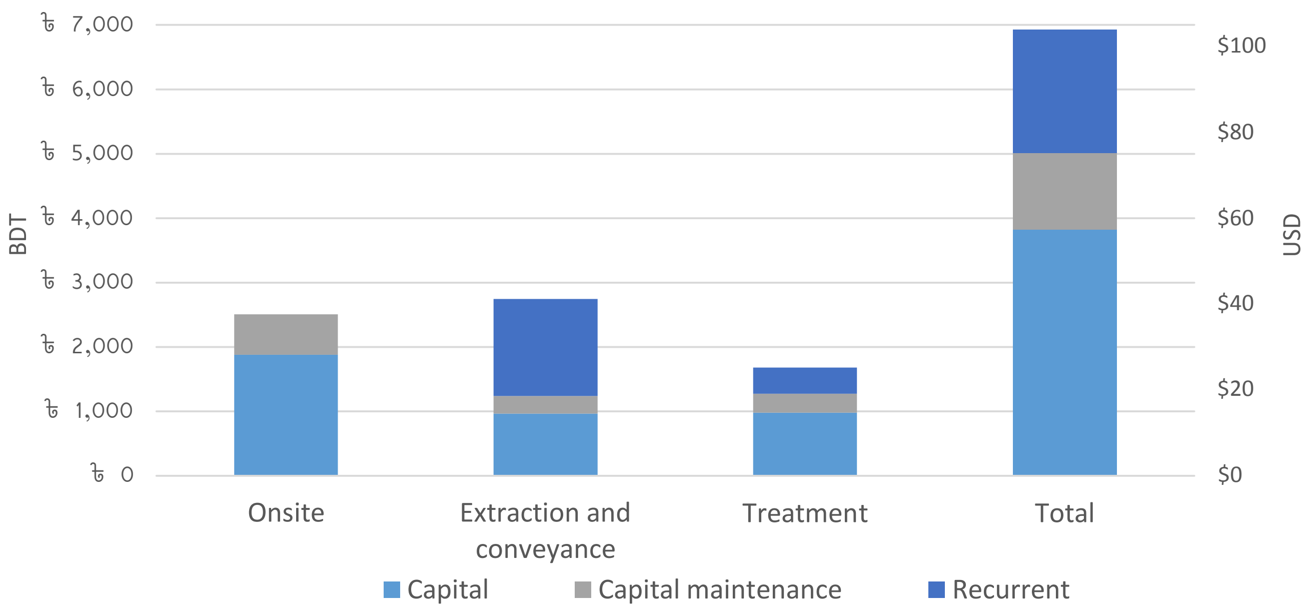
Abbreviation	Description
FSM	The fecal sludge management option – Fecal waste is emptied by a vacutug and transported directly to sludge drying beds.
SBS	Small Bore Sewers connected to DWASA main sewers.
SBS ABR	Small bore sewers connected to DWASA sewers via anaerobic baffled reactors
ST to SS	Septic tanks connected to settled sewers themselves connected to DWASA sewers.

Figure 13 Total annualized costs of technology options for Mirpur and Uttara



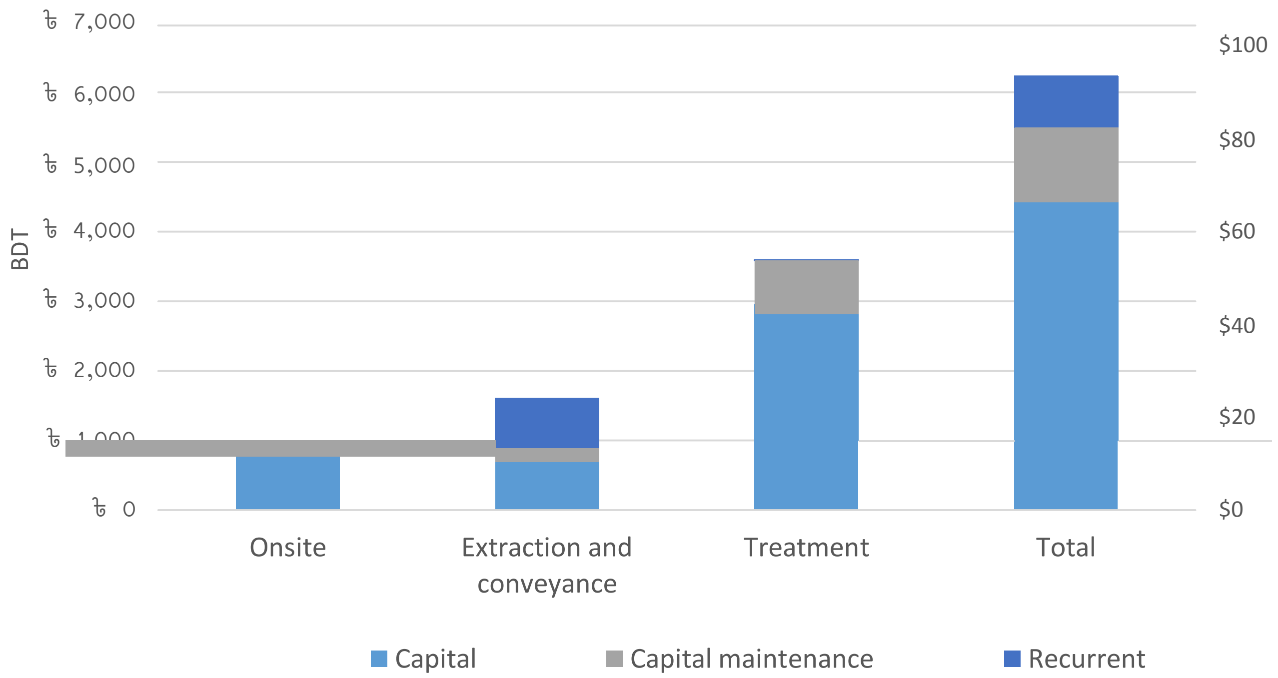
Figures 14, 15, and 16 present the cost components of each option and each part of the sanitation chain, by cost category. The other key driver of costs are the recurrent and capital maintenance costs associated with the FSM conveyance option (vacutugs). These compare unfavourably with the costs given in the LICSIP for SBS and SBS ABR recurrent and capital maintenance costs. The high recurrent costs for the FSM option are based on a study by WaterAid (WaterAid 2011) which contains a detailed and comprehensive breakdown of costs including personnel. The basis for recurrent costs included in the LICSIP are less clear and may pertain only to infrastructure, meaning this is not a like-for-like comparison of costs. The other key driver of the FSM costs are the capital costs of infrastructure.

Figure 14 Annualized cost components of FSM (cost per HH in Taka)



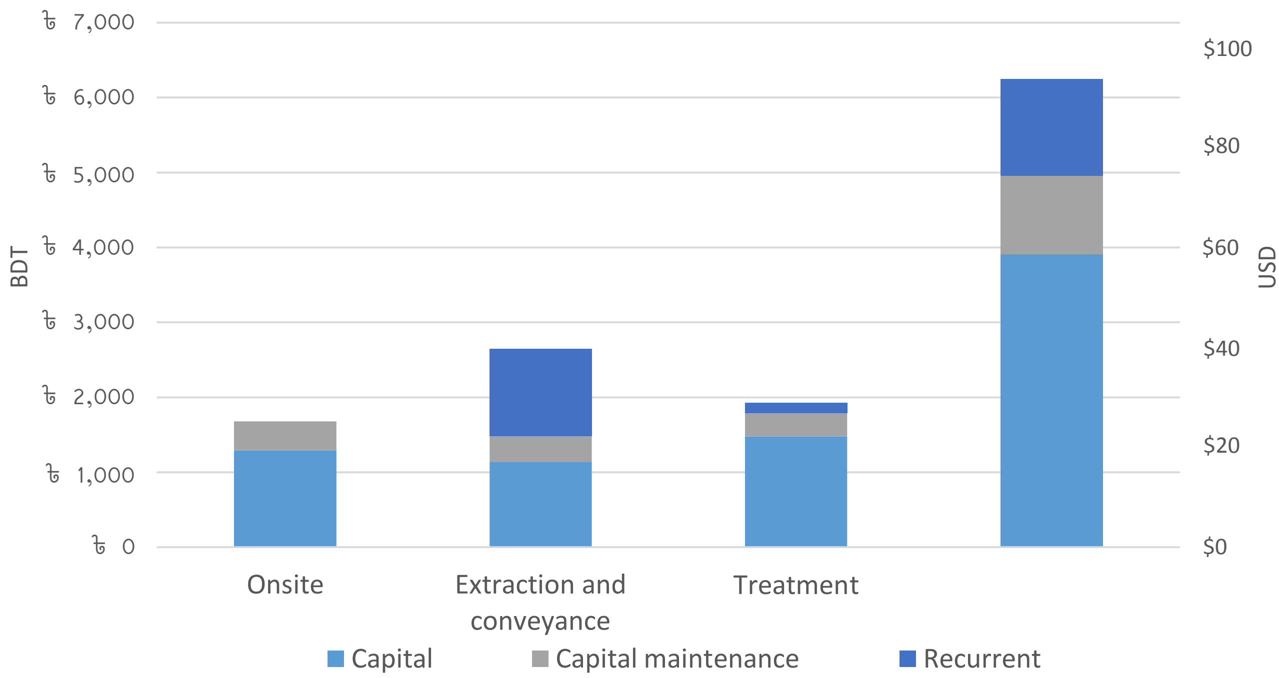
The FSM costs for capital expenditure compare unfavourably to those in the LICSIP options; this is likely driven by the source data in this case. As with all four of the option presented recurrent costs are highest in the extraction and conveyance part of the chain. The treatment costs associated with the sludge drying beds compare favourably to the conventional options considered in the LICSIP.

Figure 15 Annualized cost components of SBS (cost per HH in Taka)



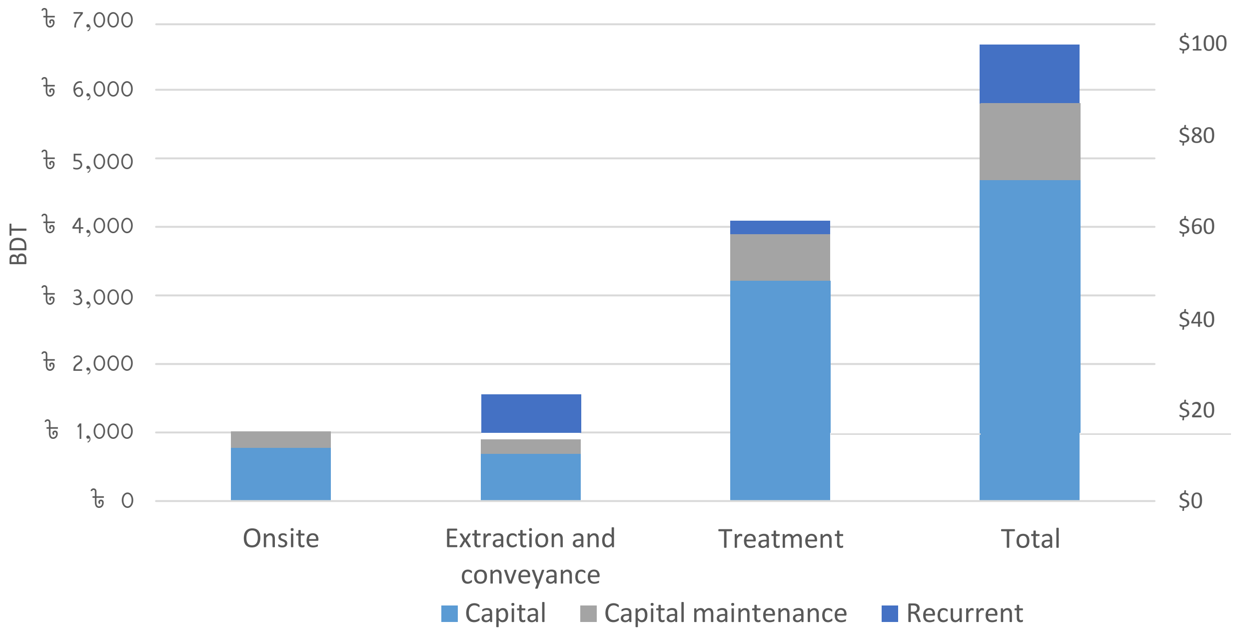
Unlike the other non-conventional sewerage options the costs of treatment for the small bore sewers connected to the conventional sewer network are high. Comparing the SBS option with SBS combined with ABRs the overall cost of treatment is considerably lower for SBS with ABRs, though this is counterbalanced by the high extraction and conveyance costs associated with the SBS ABR option. Of all the options the SBS option has the lowest onsite and extraction and conveyance capital costs.

Figure 16 Annualized cost components of SBS ABR (cost per HH in Taka and USD)



The treatment costs associated with the SBS ABR option are roughly half of those of the other simplified sewage options. However the extraction and conveyance costs are the highest of all three. This is driven primarily by the high recurrent costs associated with the use of the ABRs.

Figure 17 Annualized costs for septic tanks connected to settled sewers (Costs per HH in Taka and USD)



Of all the simplified sewage options the septic tank connected to settled sewer is the most expensive by a small margin. The single largest set of costs are those associated with treatment infrastructure capital expenditure. The annualized costs of extraction and conveyance and the onsite technology compare favourably to the other simplified sewage options and the FSM option.

Relative to the technology cost analysis in Mikhael (2012) the costs of FSM conveyance compared to sewage are high; this is partially as the options it is being compared to are non-conventional and low-cost sewage options. This may be because the costing in the LICSIP report only applies to the areas where the option is suitable. In Mirpur it is estimated that simplified sewage is unsuitable for 12% of the population in Ward 2 and 7% Ward 11.

Though these hypothetical routes down the sanitation chain have been applied to the whole population it is more appropriate to interpret the costs as unit costs for a *HH where the technology is applicable*, and as such not to treat them as costing which could apply to the whole population.

11.7 Damage costs and cost effectiveness analysis

As mentioned in the introduction the damage costing here is based only on the impacts from diarrhoea (premature death, morbidity, and productivity loss). This was based on household survey data for Dhaka's slums, including questions on self-reported diarrhoeal episodes. The premature mortality estimate is based on national level figures on the probability of dying.

Table 33 Health impacts of poor sanitation in Uttara and Mirpur (Taka)

	Total costs in BDT (USD)		Proportions	
	Per household	Per capita	% of damages costed	% of GDP
Health care related costs	3,511 ($53)	732 ($11)	24.5	0.98
Premature loss of life	10,843 ($163)	2,259 ($34)	75.5	3.03
Total	14,355 ($215)	2,991 ($45)	100	4.01

The Barkat et. al. (2012) analysis of the economic impacts of poor sanitation in Bangladesh estimates that poor sanitation costs 6.3% of GDP nationwide. In the 2012 analysis premature death attributable to diarrhoea accounted for a total of 37% of the economic costs of poor sanitation; which is equivalent to 2.33% of GDP.

Table 34 present data on the cost of avoiding mortality and morbidity. These figures assume that half of the cases of diarrhoea are avoided through the interventions. There is an emerging consensus that if the cost per DALY averted is less than three times annual GDP per capita it may be considered cost effective and any intervention that costs less that annual GDP per capita are highly cost effective.

Table 34 Cost Effectiveness analysis Taka (USD)

	FSM	SBS	SBS ABR	**ST to SS**
Cost per death averted	1,616,493 ($24,247)	1,455,065 ($21,826)	1,457,071 ($21,856)	1,554,138 ($23,312)
Cost per case of illness averted	2,536 ($38)	2,283 ($34)	2,286 ($34)	2,438 ($37)
Cost per DALY averted	143,595 ($2,154)	129,255 ($1,939)	129,433 ($1,941)	138,056 ($2,071)

Under this definition all four of the interventions are classified as cost effective. The cost per DALY is between 1.9 times GDP per capita (FSM) and 1.73 times GDP per capita (SBS). The interventions fall out of this cost effectiveness bracket if they mitigate less than 29-32% of the damage costs and become highly cost-effective if they mitigate over 90-96% of the damage costs.

11.8 Conclusions and implications for FSM in Dhaka

Overall, the value of the analysis is in drawing together the costs data relevant to Dhaka in a comparable form using standardized units. Drawing only on secondary data is also the primary limitation of this analysis as the costs presented in the literature are described using a wide variety of terminology and calculation methods. Hence, there is a risk that the comparison of costs using data from different sources is inaccurate at best, or invalid at worst. Due to these limitations it is difficult to develop any implications for FSM in Dhaka; primary data collection and data from operational services is required before the technology costing can be taken to be reflective of the costs of implementing different sanitation interventions.

12 Conclusion

This report has outlined the main findings of a case study on faecal sludge management in Dhaka, Bangladesh. This section concludes summarising the key points of each aspect of the analysis. It ends with recommended intervention options, as well as implications of the 'prognosis for change'.

Fecal waste flow diagrams (SFDs) were constructed based on a household survey and secondary data, one for the a city-wide situation and one for a slum-specific view. The analysis makes it clear that in both cases, almost all fecal sludge ends up in the drains or environment one way or another. Only 10% of households city-wide have experiencing a pit filling up.

Analysis of demand and supply for FSM services finds that demand is very low and supply is weak. That is not surprising in the context of the SFD, and particularly the household survey finding that only 13% of households city-wide who had a toilet with a pit or septic tank had ever experienced it filling up. The drains are effectively running as sewers. Various other facts affecting demand for FSM services (type of building, accessibility of facility, fill rate and the extent of sharing) are also considered. On the supply side, there are very few mechanical emptiers in operation. The bulk of service provision, when demanded, is carried out by manual emptiers. Of those households who had emptied a pit tank city-wide, 97% had used a manual emptier last time. This is also reflected in reported intentions next time the pit or tank filled up.

Findings from the transect walks emphasise that all of Dhaka is affected by poor FSM – it is not only a problem for slum-dwellers. Latrines empty into drains throughout the city, and drains run through all areas – slums and non-slums. Having large amounts of FS in the drains and environment is an externality which affects everyone in Dhaka. Therefore, poor FSM is not only a private household matter – it is a public health and environmental hazard.

The Service Delivery Assessment shows that there is a severe shortage of public policy, capital investment and operational oversight of FSM services throughout Dhaka. This allows the current practice of latrines emptying into drains, in place of safe emptying practices, to continue. This in turn removes many of the efforts and financial costs required to achieve effective construction, management and maintenance of appropriate infrastructure. The result is significant challenges for finding solutions, which will only come about when an FSM Framework translates into clearly defined, capacitated and financed action. The overall aim of the Framework and actions must therefore be to provide a fully-functioning service chain for all of Dhaka's fecal waste flows. This requires recognition of the scale of the problem, dialogue and engagement of public, private and civil society bodies to ensure appropriate infrastructure and services can be systematically developed and adapted to respond to the various contextual challenges of the city (space, tenancy, flooding, poverty, etc.).

All of this suggests that bringing change to fecal sludge management practices in Dhaka will demand significant reform of the regulatory systems that currently govern all stages of the service chain. In the context of the general failure of existing regulatory systems, clearly segregating the roles for regulation of failure by central government, from that of licensing of compliance by local governments, from that of service management by providers, may improve the incentives for overall compliance and investment.

Economic analysis of four hypothetical intervention options was undertaken, three of which are non-conventional sewer models and one of which was full fecal sludge management. This aimed to illustrate the types of costs which might be incurred for different interventions. In each case, the sanitation chain was modelled for the whole population of Uttara and Mirpur, where an intervention financed by the World Bank is to take place. Since the analysis is hypothetical, its value is in drawing together the costs data relevant to Dhaka in a comparable form using standardized units. There is a risk that the comparison of costs using data from different sources is inaccurate at best, or invalid at worst. Due to these limitations it is difficult to develop any implications for FSM in Dhaka; primary data collection and data from operational services is required before the technology costing can be taken to be reflective of the costs of implementing different sanitation interventions.

A 'Prognosis for Change' assessment surmises that the externalities of poor FSM are both public and dispersed, whereas addressing the lack of proper containment would involve private costs (from households and property developers). A credible threat of enforcement, which would raise the cost of inaction on the part of these stakeholders, is therefore critical. Proper containment will require the enforcement of ensuring existing emptiable systems (pit/tank) are disconnected from drains, that existing non-emptiable systems are upgraded, and that newly-constructed buildings have an appropriate containment system. Change is achievable on this front, but interventions will not be successful unless they address the incentives which deliver the current outcome, which is the drains running as sewers.

Recommended intervention options from the study are identified, grouped according to the key stages of the sanitation service chain. These relate to the following areas, and are discussed in detail in section 10.

- Formalised and operational *transport, treatment and end-use* stages of the fecal sludge service chain need to be identified and put in place, enabling fecal sludge to be safely received, treated and managed as upstream arrangements are improved. Effective business and financial models will be needed for each stage.

- Systematic and progressive steps to improve existing *containment infrastructure* must include disconnecting latrine outlets from drains as alternative 'outlets' are introduced. Newly-constructed buildings should not be permitted to discharge fecal materials to drains. For on-site systems, the aim must be to introduce correctly built containment that enables systematic and safe emptying services to function.

- A range of affordable mechanical, or improved manual, *emptying* services are needed that can respond quickly to demand, especially for shared sanitation facilities and for the urban poor. Licencing, service agreements and contracts can help service providers to invest in improved business operations, as well as improve regulation to achieve service standards.

The main implication of the study's findings for FSM in Dhaka are that it is crucial to maintain momentum on the emerging reform agenda. Progress could easily stall if opposing forces emerge to try and block it, or if DCC and DWASA drop it due to lack of priority. While the *status quo* suits almost everybody, there are also many stakeholders who would gain from reform as well. Influential stakeholders who risk losses are households and property developers, so special care must be taken to try and win them over.

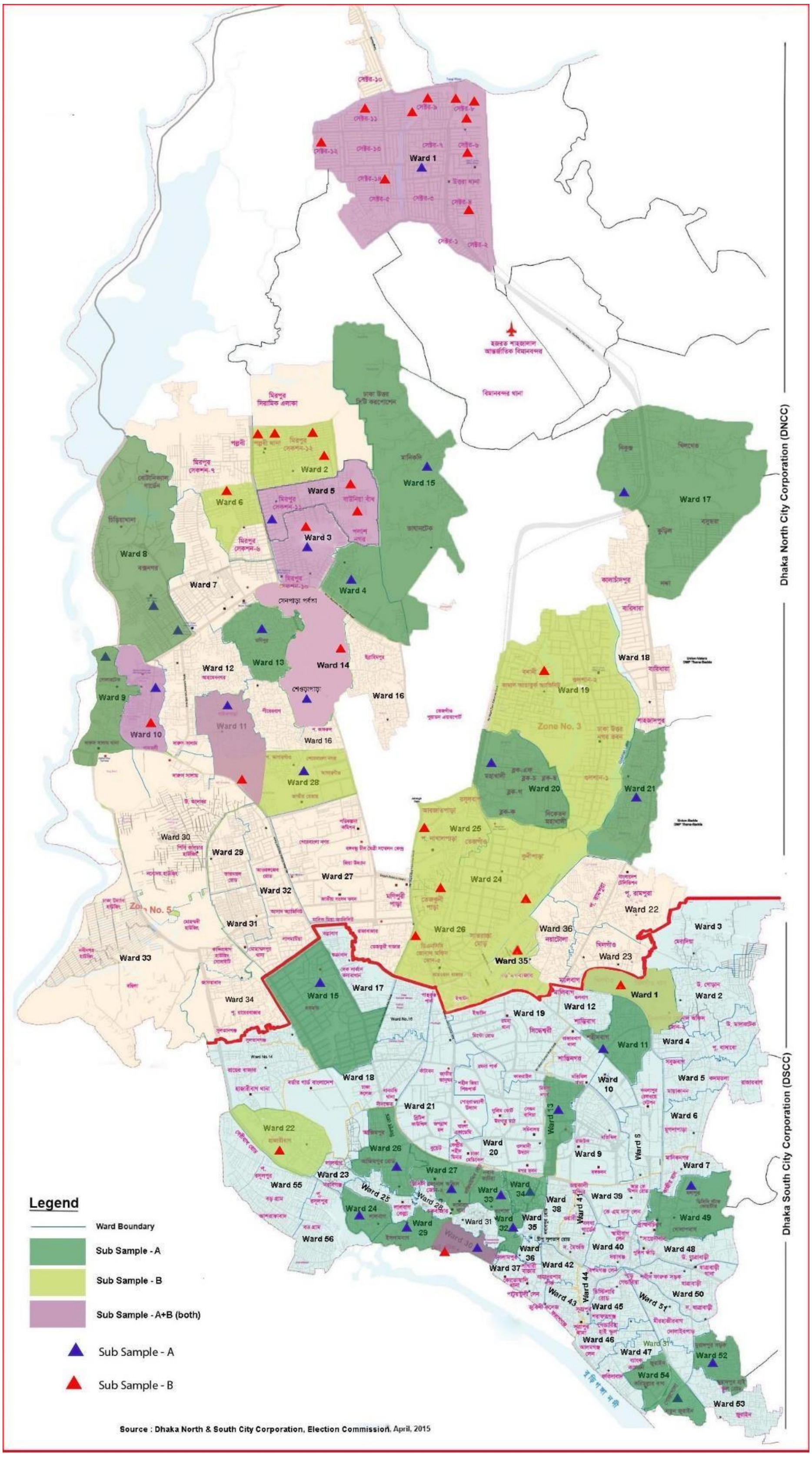
The intervention options proposed were developed based on the prognosis for change (PFC). Therefore, they are all deemed feasible, if carried out in an appropriate sequence with the engagement of the right stakeholders. However, there are some factors which will require special consideration in light of the PFC, particularly the stakeholder analysis. That factor is enforcement of laws and regulations, particularly at the containment stage of the chain.

There are three key aspects of this: (i) ensuring existing emptiable systems are disconnected from drains (or replaced with an appropriate sewered option), (ii) ensuring existing non-emptiable systems are upgraded, (iii) ensuring newly constructed buildings have an appropriate system. Each of these is a slightly different problem, but all have one thing in common. There is currently little incentive for the household or property developer concerned to act. This is because the externality is public and dispersed, while addressing the problem would involve the stakeholder incurring private costs themselves.

Therefore, it is crucial that interventions aimed at converting existing containment infrastructure, or ensuring developers don't break the law, are planned in the context of this incentive problem. Public education will not be enough. There must be a credible threat of penalties, through publicising of fines imposed on households and developers. It would be worth studying other sectors in Dhaka which have successfully enforced the law in this way and, if there are no examples, looking further afield in Bangladesh or to other countries..

Annex A Map of sampled areas

Figure 18 Map showing sampled wards and location of sampled PSUs



Annex B Faecal Waste Flow matrices

This section contains the raw data which goes into producing the SFDs. As an example, in the city-wide matrix in Figure 19 below, 21% of households in Dhaka use an OSS latrine which empties straight to a drain without any intermediate containment. A further 54% use an OSS latrine which in theory empties to a septic tank or pit which contains FS, but in reality the vast majority of these pits/tanks (84%) are also connected to drains. Therefore, FS is only partially contained and eventually, as the chamber becomes full, it will flow through to the drain any intermediate storage. As a consequence, only 8% of households' FS is actually emptied (54% * 16% = 8%).

Figure 19 Faecal Waste Flow matrix – city-wide sample

		Containment		Emptying		Transport		Treatment		Overall
Dhaka - city-wide		*of which*		*of which*		*of which*		*of which*		**Safe:**
Type of system	*% pop. using*	*contained*	*not contained*	*emptied*	*not emptied*	*transported*	*not transported*	*treated*	*not treated*	**0.3%**
Sewered (off site centralised or decentralised)	25%	100%	0%	100%	0%	7%	93%	17%	83%	
		25%	0%	25%	0%	2%	23%	0%	1%	**0.3%**
On-site storage - emptiable	54%	100%	0%	16%	84%	0%	100%	0%	100%	
		54%	0%	8%	46%	0%	8%	0%	0%	**0.0%**
On-site storage - single-use / pit sealed	0%	100%	0%							
		0%	0%							
On-site non-storage - straight to drain/similar	21%	0%	100%							
		0%	21%							
Open defecation	0%	0%	100%							
		0%	0%							
		Containment	79%	Emptying	79%	Transport	79%	Treatment	2%	
Unsafe:	**100%**		**21%**		**46%**		**31%**		**1%**	
Affected zones (you can adapt the terms to suit the context)		*Local area and beyond via drains (amount direct to groundwater not identified)*		*Local area (via overflowing latrines or dumped FS)*		*Neighbourhood (via leakage/overflow from sewers or drains)*		*Receiving waters (via sewer outfall/discharge)*		
	(orange)	from household survey								
	(yellow)	from secondary data								
	(grey)	de facto value								

Figure 20 Faecal Waste Flow matrix – slum sample

		Containment		Emptying		Transport		Treatment		Overall
Dhaka - slums		*of which*		*of which*		*of which*		*of which*		**Safe:**
Type of system	*% pop. using*	*contained*	*not contained*	*emptied*	*not emptied*	*transported*	*not transported*	*treated*	*not treated*	**0%**
Sewered (off site centralised or decentralised)	0%	100%	0%	100%	0%	25%	75%	25%	75%	
		0%	0%	0%	0%	0%	0%	0%	0%	**0%**
On-site storage - emptiable	29%	100%	0%	35%	65%	0%	100%	0%	100%	
		29%	0%	10%	19%	0%	10%	0%	0%	**0%**
On-site storage - single-use / pit sealed	0%	100%	0%							
		0%	0%							
On-site non-storage - straight to drain/similar	71%	0%	100%							
		0%	71%							
Open defecation	0%	0%	100%							
		0%	0%							
		Containment	29%	Emptying	29%	Transport	29%	Treatment	0%	
Unsafe:	**100%**		**71%**		**19%**		**10%**		**0%**	
Affected zones (you can adapt the terms to suit the context)		*Local area and beyond via drains (amount direct to groundwater not identified)*		*Local area (via overflowing latrines or dumped FS)*		*Neighbourhood (via leakage/overflow from sewers or drains)*		*Receiving waters (via sewer outfall/discharge)*		
	(orange)	from household survey								
	(yellow)	from secondary data								
	(grey)	de facto value								

Annex C CSDA scoring table criteria

Indicator	Question	Containment	Emptying	Conveyance	Treatment	End-use disposal	Comment
Policy	**Policy:** Is FSM included in an appropriate, acknowledged and available policy document (National/ local or both)?	0.5	0	0	0	0	There is scant mention of FSM in the any of the major sector policy documents in Bangladesh. There are numerous policy documents relating to eradicating open defecation and promoting safe sanitation but little mention of FSM. In Dhaka, till recently, the issue of FSM was almost completely invisible in policies and strategy documents. The recent D-WASA master plan mentions an increasing role for D-WASA in FSM but this requires agreement with the CC's. The recently drafted national water supply & sanitation strategy has a chapter on FSM and a draft FSM Framework has been drafted by BUET for Dhaka with support of the Gates Foundation.
	Institutional roles: Are the institutional roles and responsibilities for FSM service delivery clearly defined and operationalized?	0.5	0	0	0	0	In Bangladesh, the role of managing sanitation is assigned to local governments under the respective City Corporation, Paurashava and Union Parishad Actcs, however FSM is not explicitly identified nor recognized as a responsibility of anyone. While *dejure* the responsibility of FSM was assigned to Dhaka City Corporations (North & South), *defacto* the City Corporation's have been oblivious of the need to manage fecal sludge (or indeed their responsibilities for FSM). A draft FSM framework for Dhaka has been developed by BUET which lays out the roles and responsibilities for the various organizations (DCC, DWASA, RAJUK). This has led to the creation of a Ministry steering committee to oversee the development of a national framework for FSM. Containment is assigned to households but the common practice is to connect to open drains.
	Regulation: Are there national and/or local regulatory mechanisms (i.e. bylaws and means of enforcement) for FSM?	0.5	0	0	0	0	RajUK plays the key role in Dhaka of regulating household behaviour in regards to the creation of assets for the containment of fecal sludge however RaJUK is NOT monitoring 'as built' construction sufficiently to stop households from connecting the black / grey water from new buildings directly to the storm water drains. The City Corporations are responsible for regulating household behaviour in managing on-site sanitation systems and entrepreneur behaviour in managing fecal sludge emptying, transporting & treating processes however they are unaware of this responsibility and have no engagement in this regard. DWASA bylaws forbid the connection of toilets and septic tanks to the storm water drains, however this is not reinforced at all. The Ministry of Environment has dedicated significant resources to regulating industrial effluent with apparently neglible effect. It has not yet focused on the regulation of sewage / fecal sludge discharges.
	Service provision: does the policy, legislative and regulatory framework enable investment and involvement in FSM services by appropriate service providers (private or public)?	0.5	0.5	0	0	0	The existing legal documents do not even recognize the existence of fecal sludge management and therefore there is nothing that either enables or nothing that limits any investments in fecal sludge management practices. In Dhaka, the emptying of pits / septic tanks is undertaken by private sweepers and the emptying of drains is undertaken by government contract sweepers. While trade licenses (issued by the City Corporation) are generally required for those engaged in formal trade, the fully informal nature of fecal sludge management services means that this is not undertaken. D-WASA has given permission for 2 NGOs that operate mechanical emptying systems the permission to discharge the contents of the VacuTug into the intake of 2 of the 30 of the D-WASA sewage pump stations.

Indicator	Question	Containment	Emptying	Conveyance	Treatment	End-use disposal	Comment
Planning	**Targets:** Are there service targets for (each part of) the FSM service chain in the city development plan, or a national development plan that is being adopted at the city level?	0.5	0	0	0	0	There are clear national targets (and successes) in regards to the containment of feces primarily understood as the eradication of open defecation. While open defecation rates in urban areas are very low (even amongst slum dwellers) the quality of the containment of feces is very poor with the majority of fecal matter being discharged into the drainage system. There is no recognition of the need for other components of the fecal sludge management chain of emptying / transporting / treating / reusing fecal sludge and therefore there are no targets in this regard.
	Investment: Is FSM incorporated into an approved and used investment plan (as part of sanitation) - including ensuring adequate human resources and Technical Assistance? (Ideally a medium term plan, but if not, at least an annual plan)	0	0	0	0	0	There are no investment plans determining the public investments necessary to manage fecal sludge by the City Corporation. There are also not any plans directing City Corporation human resources & technical assistance resources to fecal sludge management. A draft WSS Sector Strategy Document does highlight the need to undertake research and develop plans for FSM and the Dhaka WASA Master Plan has proposed to increase the role of the WASA in FSM ... however plans with allocated budgets are still dependent on the clarification of the respective roles of D-WASA and DCC with respect to FSM.
Budget	**Fund flows:** Does government have a process for coordinating FSM investments (domestic or donor, e.g. national grants, state budgets, donor loans and grants etc.)?	0	0	0	0	0	There are no instruments for coordinating public investment or supporting any donor engagement or guiding any NGO investment or prioritising private sector investment in FSM. Through World Bank support D-WASA has prepared sewerage and drainage master plans ... but these are limited to D-WASA investments (and not sector investments). There are some NGO initiated activities on FSM in Dhaka that generally seek some form of approval / collaboration with D-WASA) but these are limited to pilot scale.
	Adequacy & structure: Are the public financial commitments to FSM commensurate with meeting needs/targets for Capex and Opex (over the coming 5 years)?	0	0	0	0	0	Currently there are no public investments by any agency (DCC, D-WASA, Cantonment Board, Ministry of Environment, Ministry of Housing & Public Works) in any part of the fecal sludge management chain of collection, emptying, transporting, treating, re-using fecal sludge. The D-WASA infrastructure Master Plan proposing increased engagement in FSM has not been translated into an infrastructure investment plan..
Expenditure	**Capital funding:** What is Capex expenditure per capita on FSM (3 year average)?	0	0	0	0	0	The current CAPEX / capita (D-WASA + DCCs + RaJUK + Cantonment) = 0 The public sector CAPEX requirements per capita can't be / haven't been calculated as the service level benchmarks for fecal sludge management have also not been established.
Equity	**Choice:** Is there a range of affordable, appropriate, safe and adaptable technologies for FSM services available to meet the needs of the urban poor?	0	0	0	0	0	Containment (safe) = Low (# septic tanks are reducing as most toilets are piped into storm water drains) Emptying (affordable) = VacuTug, sweeper Emptying (safe)= VacuTug Transportation (safe)= nil (all dumped in open drains) Treatment (safe) = nil (WTP is not even treating sewage properly and there is no sludge digesters) Re-use = Nil (1 small scale co-composting pilot using rural fecal matter)

Indicator	Question	Containment	Emptying	Conveyance	Treatment	End-use disposal	Comment
	Reducing inequity: Are there specific and adequate funds, plans and measures to ensure FSM serves all users, and specifically the urban poor?	0	0	0	0	0	No funds/systems/procedures for making FSM services available to the urban poor and there is no criteria codified in policy/strategy/ orders/acts for making FSM services available to the rich (let alone the poor). The urban poor are the only ones that really cannot afford to connect their toilets to the deep storm water drains, however for emptying & transportation they engage manual emptiers who will generally dump waste at the closest location thus polluting the same waterways. The proposal to introduce an environmental sanitation tax for FSM (linked to holding tax) could be an opportunity for local management of the externality of FSM to be rewarded by channelling resources back to LIC areas.
Outputs	**Quantity / capacity:** Is the capacity of the FSM chain growing at the pace required to ensure access to FSM meets the needs and targets that protects public & environmental health?	0	0	0	0	0	There appears to be a decline in the fecal sludge emptying part of the service delivery chain as there appears to be fewer septic tanks installed as housing developers prefer to connect the fecal waste directly to the storm water drains. Therefore more and more of the call-outs of sweepers from households are for the clearing of blockages rather than emptying. There are no demands at all on the hygienic FSM service delivery chain to meet either the existing needs/demands nor any future targets to protect public and environmental health.
	Quality: Is the quality of FSM sufficient to ensure functioning facilities and services that protect against risk through the service chain?	0	0	0	0	0	There is high risk throughout the whole of the FSM service delivery chain. Most of the high health risks occur in the containment/emptying part of the FSM chain with most toilets (& septic tanks) being directly connected to the storm water drains. Given that these connections are to deep drains the proximate health risk is low but the environmental health risk is high. Emptying is high hazard with removal of the sludge primarily undertaken by manual sweepers. Transport of FSM is vulnerable to dumping directly into open drains by manual sweepers or carting by VacuTugs before dumping into the open drains. There is no treatment or re-use of fecal sludge except potentially on the outskirts of the city where there are pit latrines and the sludge is buried.
	Reporting: Are there procedures and processes applied on a regular basis to monitor FSM access and the quality of services and is the information disseminated?	0	0	0	0	0	There are no systems for reporting on the levels of access to FSM services or on the quality of the FSM services. There is some recognition of the need to regulate infrastructure creation by developers however this regulation is 'blind' to the different containment practices and the implications of this on the different FSM services that need to be made available. The systems for reporting on the O&M of FSM are limited to only collection with no systems for tracking the amount of FSM that reaches the DWASA designated drop off locations of which only a very small fraction ends up in the treatment plant.
O&M	**Cost recovery:** Are O&M costs known and fully met by either cost recovery through user fees and/or local revenue or transfers?	0	0	0	0	0	Any O&M costs of the fecal sludge management system are fully borne by users accessing private operators. There are no government provided FSM services however the public cost of poor FSM management is externalised primarily into the storm water drainage system. The public cost is primarily an environmental health cost transported through deep underground storm water drains however the public health cost becomes localised during the frequent blockages / emptying of the sludge from the drains.
	Standards: Are there norms and standards for each part of the FSM service delivery chain that are systematically monitored under a regime of sanctions (penalties)?	0	0	0	0	0	The only part of the fecal sludge management chain that appears to have any form of regulation is the planning authority requirement stipulated by RaJUK to install a septic tank in non-sewered areas. These requirements appear to be side-stepped by housing developers especially in the areas where there are good storm water drains. Even in sewered areas there seems to be a general preference to connect to the storm water drains, which block-up far less often than the sewers. Although the DWASA Act mentions that it is illegal to connect to drains and canals, there are no rules or sanctions regulating this or any other parts of the fecal sludge management chain.

Indicator	Question	Containment	Emptying	Conveyance	Treatment	End-use disposal	Comment
Expansion	**Demand:** Has government (national or city authority) developed any policies and procedures, or planned and undertaken programs to stimulate demand of FSM services and behaviours by households?	0	0	0	0	0	The government has not developed any policies and procedures, nor has it planned or undertaken any programs to stimulate demand of FSM services nor has it promoted hygienic FSM behaviours by households. Recent notices issued by D-WASA have reminded households of their obligations to build a septic tank and a soak pit in the unsewered areas but the management of the fecal sludge beyond this has not been raised publically. The FSM chapter of the national WSS strategy commits to the development of guidelines, pilot projects and the drafting of by-laws / regulations for Local government institutions.
	Sector development: does the government have ongoing programs and measures to strengthen the role of service providers (private or public) in the provision of FSM services, in urban or peri-urban areas?	0	0	0	0	0	FSM service providers for cleaning blockages are expanding but FSM emptying is contracting. The emptying of septic tanks is primarily undertaken by the government employed cleaners (or publically housed sweepers) that offer a small scale, disorganized and unhygienic private emptying service to households. The government has not yet developed any measures to strengthen the role of these privately engaged public sector workers to improve the quality of FSM services but WSUP are working on capacity development with emptiers.. In terms of the liason with other public sector agencies (i.e. NGOs), DWASA is giving permission to DSK / PSTC operarors to discharge fecal sludge from their VacuTugs at pre-designated areas (as a pre-cursor to a potential future role of the private sector), WSUP is starting operations of a VacuTug for D-WASA and UNICEF has provided VacuTugs to D-WASA.
Service outcomes	**Public Health:** What is the magnitude of public health risk associated with the current FS flows (through the stages of the FS service chain)?	0.5	0	0	0	0	Although the management of fecal sludge in Dhaka has been grossly neglected, the connection of fecal sludge systems into the deep storm water drainage system means that the local health risk is low while the larger environmental health risk is excessive. The generally low health risk is compounded by short periods of high health risk when the deep stormwater drainage system blocks up or fails to deal with overloading during flooding.
	Quantity: Percentage of total FS generated by the city that is managed effectively, within each part of the service chain	0	0	0	0	0	Percentage figures will only be ESTIMATES rather than absolute values. Multiplying-up results from HH survey frame is possible, but dependent on assumptions that must be explicitly stated for each context. Volumes can be more accurately measured downstream of containment (from collection through to end-use). Less than 50% of fecal sludge is safely contained, emptied, transported, treated, re-used. Details to be confirmed after the household survey.
	Equity: To what extent do the city's FSM systems serve low-income communities? (Containment, Emptying and Transport services only)	0.5	0	0	0	0	The FSM services of containment, emptying and transport serve low-income communities - Containment: Open defecation rates within low income communities is extremely low. Low income communities tend to contain fecal sludge as they do not have the capacity to connect to deep storm water drains and they do not tend to connect to the open drains because of their proximate location to the house. - Emptying: Manual emptying services are readily available within low income communities as there are often some emptiers living / working within the LICs. - Transportation: Is available via manual carts that are filled / emptied in the middle of the night & then dumped into canals or drains

Annex D Public health risk assessment: scoring used

Observations: To standardise this process, a number of pre-set questions are answered by the observer at each stage of the process, with the observer selecting the most appropriate response from a pre-selected list (including Other and Don't Know options) in each case. Each set of responses is ranged to indicate a High / Medium and Low risk activity, with a score allocated to each response High risk = 3, Medium risk = 2, Low risk = 1. Other or Don't know responses had to be considered separately and an appropriate score allocated depending on additional information provided (photographs, notes, etc.).

- For example, one transport stage question was "During the transport of faecal sludge, does sludge spill into the surrounding environment?" Response categories were: Sludge spillage occurs along the route at various times (scores 3 = High risk); Slight sludge spillage occurs at specific times, e.g. going down slopes or over rough ground (scores 2 = Medium risk); No spillage occurs – equipment contains all of the sludge during transport (scores 1 = Low risk).

Tables showing the full set of observation questions and the rating values of responses are available from the links in **Error! Reference source not found.**.

For each stage of the service chain, a collated score was put into a risk category based on scoring ranges (again, High / Medium / Low ranges). These scoring ranges were based on experience of approaches for assessing risk to water supplies and from sanitation facilities in other studies. In some cases, the **highest** risk score would be considered as the most relevant to identify – particularly in relation to contact between fecal sludge and drinking water supplies or human directly (through hands, feet, etc.).

Table 35 Risk scores along the service chain

Stage of the service chain	Max risk score per stage	Score range for risk level		
		Low	Med	High
Containment	27	9-14	15-21	22-27
Emptying	9	1-4	5-7	8-9
Transportation	9	1-4	5-7	8-9
Treatment	15	1-8	9-11	12-15
Disposal	18	1-9*	10-14*	15-18*
End use	12	1-6	7-9	10-12

*** Note relating to Disposal scores:**
If Qn1 scores 2 or 3, and Qn2 or Qn3 score 2 or 3, this implies medium (no scores of 3) or high (one or more scores of 3) risk
If Qn1 scores 2 or 3, and Qn4 and Qn5 both score 2 or 3, this implies medium (no scores of 3) or high (one or more scores of 3) risk

Using the rating and scoring process during observations of emptying practices, a summary of identified risks is shown in Table 36. The observations only followed the practice to the disposal point, as treatment / end-use of fecal sludge is not practiced in Dhaka. Given the small number of observations carried out, these results cannot be taken as representative of the vast number of emptying practices (most notably those done by manual emptiers) occuring on a daily basis in Dhaka.

Table 36 Risk of immediate human exposure with FS, at each step of the process

Nº	Equipment (man/mech)	Access for equipment type	Containment	Emptying	Conveyance	Disposal	*Disposal Point*
1	Manual	Small mechanical	Low	Med	Direct discharge	High	*Ditch (open)*
2	Manual	Hand-carried only	Low	Med	Direct discharge	High	*Pond*
3	Manual	Hand-carried only	Low	Low	Direct discharge	Medium*	*Drain (covered)*
4	Mechanical	Medium/large	Med	Low	Low	Medium*	*Drain (shallow)*
5	Mechanical	Medium/large	Med	Low	Low	Medium*	*Drain (covered)*

*** See comments in other sections about likely risks from the method of disposal into drains**

Transect walks: Participants used a standard reporting format to allocate scores to help represent a qualitative assessment of the relative impact from physical and environmental conditions on being able to achieve effective and safe FSM services in that locality.

Categories included in the conditions that were recorded included: drainage infrastructure and use (noting the presence of storm water, greywater and/or blackwater); evidence of open defecation, dumped fecal sludge or solid waste; public latrine coverage; access to water points; housing density; conditions of roads and paths. Each category was pre-allocated 5 observed responses, ranging from very poor conditions (scoring 5) through to very good conditions or no evidence found (scoring 1). Scores of 1 therefore represent the lowest impact and 5 the highest impact on FSM services. Results from the 40 transect walks (10 in subsample A PSUs and 10 in subsample B PSUs) are shown in Table 37.

For certain categories relating to FSM (for example evidence of open defecation, fecal sludge, blackwater in drains) that scored 3 or more, participants identified the location of the observation, how often the particular risk occurred in the area, by asking members of the community for information, and the mechanism for human contact and contamination route (through people walking in bare feet, entering drains, blackwater in drains overflowing near to homes, etc.).

Tables showing the format for scoring conditions in the PSUs during the Transect Walks and for collecting further details where high risks were seen, are available from the links in Annex E.

Table 37 Transect Walk results of scored observations

Note: 5 = highest observed risk level, 1 = lowest observed risk level

Category of observation / PSU	1. Drainage (storm water and greywater)	2. Drainage (blackwater)	3. Access to water points	4. Evidence of solid wastes	5a. Evidence of human fecal materials – through open defecation	5b. Evidence of human fecal materials – through dumped	6. Evidence of animal fecal materials	7. Household latrine coverage	8. Public latrine coverage	9. Presence of wastewater and/or fecal sludge treatment facilities	10. Housing density	11. Paths	12. Roads
Sub-sample A													
PSU 1 Rajlaxmi	3	1	1	1	1	1	1	1	1	1	1	1	1
PSU 2 Mirpur Section 11	1	4	1	3	1	1	1	1	1	1	2	3	2
PSU 3 Block C Section 11	2	1	1	4	1	1	1	1	1	1	3	2	2
PSU 4 Block A Section 11 Mirpur	1	4	1	4	1	1	1	1	1	1	3	1	1
PSU 5 North Bishil	2	5	1	5	1	1	1	1	1	1	3	1	1
PSU 6 Golartek	1	1	1	1	1	1	1	1	1	1	3	2	2
PSU 7 Gabtali Jamidarbari	1	1	1	3	1	1	1	1	1	1	3	1	1
PSU 8 Paikpara	1	1	1	4	1	1	1	1	1	1	3	1	1
PSU 9 Monipur	1	1	1	4	1	1	4	1	1	1	2	1	1
PSU 10 Sheora Para	1	1	1	3	1	1	1	1	1	1	3	2	2
PSU 11 Balughat	1	1	1	3	1	1	1	1	1	1	3	2	4
PSU 12 Joarsahara	4	4	1	1	1	1	3	1	1	1	3	2	3
PSU 13 BADC Staff Quarter	4	4	1	3	1	1	1	2	1	1	2	4	5
PSU 14 Mohakhali	2	4	1	4	1	1	1	1	1	1	4	4	4
PSU 15 Middle Badda	2	2	1	4	1	1	3	1	1	1	3	2	2
PSU 16 Shaheed Bagh	1	1	1	1	1	1	1	1	1	1	3	1	3
PSU 17 Purana Paltan Lane	1	1	1	4	1	1	1	1	1	1	3	1	2
PSU 18 Kafrul Taltala Staff Quarter	2	3	1	3	1	1	3	1	1	1	3	2	3
PSU 19 Dhanmondi R/A	3	1	1	1	1	1	1	1	1	1	2	2	3
PSU 20 Rajnarayn Dhar Road	1	2	1	4	1	1	1	1	1	1	4	1	2
PSU 21 Lalbagh Road	1	3	1	3	1	1	1	1	1	1	2	1	1
PSU 22 Nabab Bagicha	2	4	1	3	1	1	1	1	1	1	1	2	2
PSU 23 Water Works Road	3	3	1	4	1	1	1	1	1	1	5	1	2
PSU 24 Rabin Bose Street	2	1	1	3	1	1	1	1	1	1	4	1	5
PSU 25 Syed Hasan Ali Lane	3	4	1	1	1	1	1	1	1	1	5	1	5
PSU 26 Agamasi Lane	2	3	1	4	1	1	1	1	1	1	4	1	4
PSU 27 Raj Chandra Musi Lane	1	3	1	1	1	1	1	1	1	1	5	1	3
PSU 28 Dholpur	2	2	1	4	1	1	1	1	1	1	2	2	2

Category of observation / PSU	1. Drainage (storm water and greywater)	2. Drainage (blackwater)	3. Access to water points	4. Evidence of solid wastes	5a. Evidence of human fecal materials – through open defecation	5b. Evidence of human fecal materials – through dumped	6. Evidence of animal fecal materials	7. Household latrine coverage	8. Public latrine coverage	9. Presence of wastewater and/or fecal sludge treatment facilities	10. Housing density	11. Paths	12. Roads
PSU 29 Muradpur	4	3	1	5	1	1	4	1	1	1	5	4	4
PSU 30 New Jurain Alambag	5	4	1	4	1	1	1	1	1	1	5	4	4
Sub-sample B													
PSU 33 East Kurmitola Camp	3	3	1	5	1	1	3	1	1	1	5	4	5
PSU 34 Baganbari Slum	1	3	1	3	1	1	1	2	1	1	5	5	5
PSU 38 Shohid Bag	1	3	2	2	2	2	2	1	1	1	5	4	5
PSU 43 No. 8 Slum	1	3	1	5	1	1	1	2	1	1	5	5	5
PSU 47 Railline Slum		4	3	3	1	1	1	5	1	1	5	5	5
PSU 51 Karail	1	1	1	4	1	1	1	2	1	1	5	4	5
PSU 55 Kopikhet Bastee	1	2	2	4	1		1	2	2	1	4	4	5
PSU 41 Khalpar/Balurmath Slum	No drain	No drain	1	3	1	1	1	2	1	1	3	3	4
PSU 49 Shikderbari	No drain	No drain	1	3	1	1	1	2	1	1	1	4	5
PSU 50 Ahlia	No drain	No drain	1	3	1	1	3	2	1	1	3	4	3

Annex E Economic analysis tables

		Onsite	Extraction and conveyance	Treatment	Disposal & reuse	Total
FSM	Capital	15207	8827	8706	0	32740
	Annualized	1786	1037	959	0	3782
	Capital maintenance	845	2433	925	0	4203
	Annualized	99	286	102	0	487
	Recurrent	0	1962	13	0	1975
	Total annualized financial cost	**1885**	**3285**	**1074**	**0**	**6244**
SBS	Capital	14569	12995	27919	0	55482
	Annualized	1711	1347	2895	0	5954
	Capital maintenance	824	433	928	0	2185
	Annualized	97	45	96	0	238
	Recurrent	0	227	433	0	661
	Total annualized financial cost	**1808**	**1620**	**3424**	**0**	**6852**
SBS ABR	Capital	14569	21534	13959	0	50061
	Annualized	1711	2233	1447	0	5391
	Capital maintenance	824	615	141	0	1580
	Annualized	97	64	15	0	175
	Recurrent	0	313	182	0	494
	Total annualized financial cost	1808	2609	1644	0	6061

Nb. no suitable cost data was found for disposal and reuse