



# SFD Promotion Initiative

## Tikapur Nepal

### Final Report

This SFD Report was created through field-based research by Sandec (the Department of Sanitation, Water and Solid Waste for Development), Eawag

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SFD Report Tikapur, Nepal, 2018

Produced by:

Marius Klinger & Dr. Mingma Sherpa

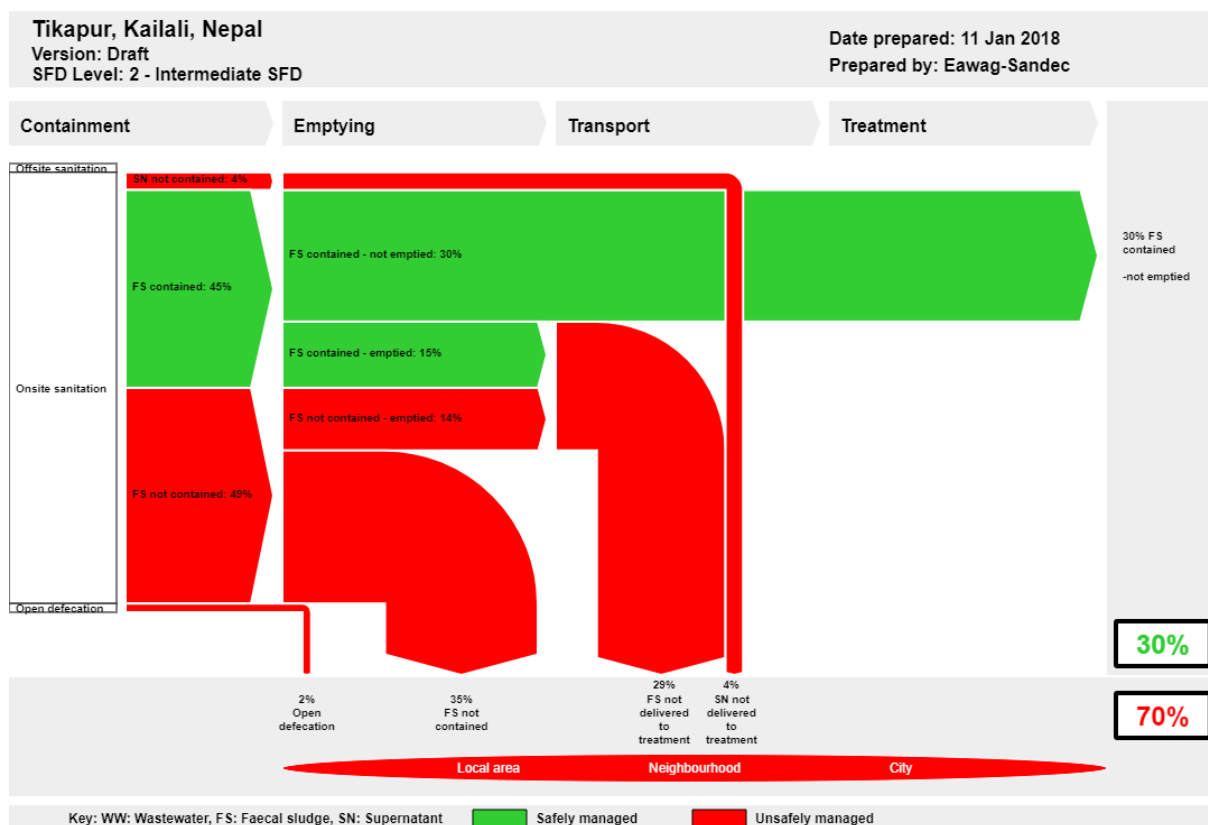
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## 1. The Diagram



## 2. Diagram information

### Desk or field based:

Field based assessment

### Produced by:

This Shit Flow Diagram (SFD) was developed through a field-based research by Sandec (Sanitation, Water and Solid Waste for Development) of Eawag (the Swiss Federal Institute of Aquatic Science and Technology).

### Collaborating partners:

Department of Water Supply and Sewerage, Nepal

500B solutions Pvt. Ltd.

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## 3. General city information

Tikapur is a municipality of over 60,000 inhabitants (56,136, 2011 census), located on the right bank of the Karnali river in the Terai district of Kailali, far western region. It is a “new

town” and was founded about 50 years ago and is composed of four main different socio-economic settings. There is a well-planned core-urban area in Ward 9, which is based on a master plan prepared in 1972, which allocated land for future infrastructure like roads, drinking, storm and waste water, health, education or electricity. In the eastern part of Ward 9 and 8, ex-bounded labourers from Tikapur have been allocated land and now form a dense settlement with access to the road network and electricity. Around this area, there are also illegal settlements of displaced people that have built their homes on municipal and land. They have no access to electricity nor proper sanitation and are in the process of negotiating their relocation. The rest of the municipality are peripheral semi-urban and rural areas which cover Wards 1, 2, 3, 4, 5, 6, and 8. Due to the local political situation, the eastern informal settlements were not taken into account into the main source of information for this field based SFD. Moreover, even though Tikapur is a regional educational, economical and tourist centre, no data was available on institutional, public and restaurants/hotels waste flows, they are therefore not included in this SFD.

#### 4. Service delivery context

At the national level, national policy on water supply and sanitation is guided by two key targets regarding access to WASH services:

- the global SDG targets to guarantee access to all to water and sanitation by the year 2030 and,
- a more ambitious target, formulated under the Rural Water Supply and Sanitation (RWSS) Policy and accompanying strategy (2004) which aims to provide water supply and sanitation coverage to all by the year 2017 (but which is unlikely to be met nationwide).

At the national level, the lead agency for the development and implementation of policy is the Department of Water Supply and Sewerage (DWSS), under the Ministry of Physical Planning and Works (MPPW). As stipulated in the National Guidelines for Sanitation and Hygiene Promotion, 2005 and the Local Self Governance Act, 1997, responsibilities for sanitation provision are to be decentralized, with DWSS retaining only an advisory and enabling role.

Responsibility for implementation lies with Water User and Sanitation Committees (WUSCs). These are linked to Village Development Committees (VDCs), which in turn link upwards to the District Development Committees (DDCs), which are responsible for overall district-level planning. The whole decentralized DDC/VDC/WUSC structure falls under the Ministry of Local Development (MLD) and is supported technically by the District Technical Office (DTO). DTO staff are provided through the Department of Local Infrastructure Development and Agricultural Roads (DoLIDAR). For rural and small-town programs, the policy and overall lead agency function is the responsibility of one ministry (MPPW), while the day-to-day implementation of that policy is carried out by organizations falling under a different ministry (DoLIDAR). In practice, DWSS continues to be involved in the planning and implementation of schemes serving populations of over 1,000 through divisional and sub divisional offices. (WEDC, 2005).

In addition to the above policies, acts and frameworks, a separate National Plan for Small Town Water Supply and Sanitation exists. The Plan provides a 15-year development plan for small town water supply and sanitation. It was endorsed by the Government in January 2000.

At the national level, the implementation of the new constitution might affect the institutional

framework with the redistribution of some department, the restructuring of ministry responsibilities or the creation of entirely new entities. But it is yet not clear on how exactly, these changes will affect the urban environmental sanitation enabling environment in Nepal in the coming years.

#### 5. Service outcomes

In Tikapur, 98% of the residents are using on-site sanitation technologies, which are either pit latrines, septic tanks or biogas digesters. 2% of the population is still practicing open defecation. Tikapur does not have a sewer system.

Moreover, there are no mechanical faecal sludge emptying services available. All the emptying is carried out by informal manual emptying providers. The emptied sludge is disposed either directly into the garden of the house owners, in open drains/irrigation canals or buried in an adjacent pit. No official discharge location or faecal sludge treatment is available.

An assessment of soil type, groundwater table, drinking water sources and the distance between those and latrine technologies have led to the assumption that the risk of groundwater contamination is significant in the core-urban and semi-urban areas. These represent approximately 50% of the municipal area, while the risk in the remaining 50% rural area is assumed to be low. Groundwater is used by 98% of the households as the main drinking water source through tube well and boreholes present at the household level.

#### 6. Overview of stakeholders

In the WASH sector in small towns, the Department of Water Supply and Sewerage (DWSS) is the national leading agency with the financial support from the Asian Development Bank (ADB) through the Small Town Water Supply and Sanitation Sector Project (STWSSSP, third phase).

At the local level, the municipality is, in theory responsible of the water and sanitation infrastructure, but in most cases (as in Tikapur), this responsibility has been handed over to the Water and Sanitation Users Committee (WSUC). In fact, ADB is working directly with the WSUC in the context of the STWSSSP, by-passing the municipality.

In Tikapur, the STWSSSP is building a piped drinking water supply system for the municipality. For sanitation, the project co-funded the City Sanitation Plan (CSP) of Tikapur, in collaboration with Eawag-Sandec. The SFD was produced as part of this

structured CSP process. The WSUC is the local leading body concerning these projects.

Ministry of Urban Development Nepal, 2014. Tikapur Initial Environmental Examination.

**Table 1 Key WASH stakeholders in Tikapur (Eawag, 2016)**

Key Stakeholders	Institutions / Organizations /
Public Institutions	DWSS, Tikapur Municipality, Tikapur WSUC
Private Sector	Informal manual emptiers
Development Partners, Donors	ADB, Eawag-Sandec

### 7. Credibility of data

The majority of data used for the SFD matrix come from an environmental sanitation baseline survey carried out in Tikapur during the CSP process with 400 households (Eawag, 2016). Some data, on groundwater contamination, was sourced from the initial Environmental Examination (IEE, 2014). Both studies were produced under the STWSSSP, directed by DWSS.

The two main data sources available were both quite recent (2014 and 2016) and of significant content, therefore the available data can be considered of good quality.

In addition to these two field studies, the data was collected through different workshops and informal meetings as part of the CSP process (launching workshop, expert workshop, meeting with WSUC members, with municipal engineers or with informal manual emptiers). Three focus group discussions were held in Tikapur during the CSP process to validate the findings of the survey and to determine service priorities.

However, quantitative data could not be found for the following parameters: height of the water table; the distances between sanitation systems and groundwater sources; the liquid outlet of the existing water-based sanitation systems, specifically the one of the septic tanks and the bio-digester. This had to be estimated based on local observations and stakeholder interviews.

### 8. Process of SFD development

The SFD was developed as part of the CSP of Tikapur. This process was done in collaboration and with the support of local stakeholders and experts in the field of urban sanitation in Tikapur. A draft SFD was produced and shared with relevant stakeholders at different workshops and meetings during 2016.

### 9. List of data sources

Eawag, 2016. Tikapur Environmental Sanitation Baseline Report.

SFD Tikapur, Nepal, 2018

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## Table of contents

1	City context .....	3
2	Service delivery context description .....	4
2.1	Institutional framework .....	7
2.2	Policy and sector strategy regarding small towns .....	7
2.3	Local body representativeness and future institutional changes .....	8
3	Service Outcomes .....	9
3.1	SFD Matrix .....	9
3.1.1	Risk of groundwater contamination .....	11
3.1.2	Containment Technologies.....	12
3.1.3	Emptying practices .....	14
3.1.4	Conveyance, treatment and end use.....	16
3.2	Discussion of results .....	16
3.3	Discussion on the quality of data.....	18
4	Stakeholder engagement .....	19
4.1	Key Informant Interviews .....	19
4.2	Focus Group Discussions .....	19
4.3	Observation of service providers .....	19
4.4	Expert workshop .....	19
5	References.....	19
6	Appendix .....	20
6.1	Environmental sanitation baseline survey sample design.....	20

## List of Tables

Table 1 summary of demographic data of Tikapur.....	3
Table 2 Relevant Policy and Legal Frameworks for Water and Sanitation. Source: adapted from ADB (2009) .....	4
Table 3 Fraction of the different on-site sanitation systems that are regularly emptied .....	15
Table 4 Final estimations for the SFD matrix calculation of containment systems (based on Eawag, 2016) .....	15
Table 5 Input variables of the FSD matrix.....	16

## List of Figures

Figure 1 Population density at the ward level (2011 Census) .....	3
Figure 2 Legislative framework for water and sanitation. Source: WASH Sector Development Plan (2016), Nepal .....	6
Figure 3 Nepal WASH sector legal and political framework .....	8
Figure 4 SFD of Tikapur, field based assessment .....	9
Figure 5 Map of Tikapur municipality with the survey enumeration blocks, the excluded squatter settlements, the urban-core area delimitation and the surveyed households .....	10
Figure 6 Containment technologies in Tikapur.....	12
Figure 7 Distribution of the containment technologies at ward level.....	13
Figure 8 SFD Selection Grid for Tikapur .....	14
Figure 9 End use/disposal of emptied faecal sludge.....	16

# 1 City context

Tikapur is a municipality of over 60,000 inhabitants (56,136, 2011 census), located on the right bank of the Karnali river in the Terai district of Kailali, far western region. It is a “new town” and was founded about 50 years ago and is composed of four main different socio-economic settings. There is a well-planned core-urban area in Ward 9, which is based on a master plan prepared in 1972, which allocated land for future infrastructure like roads, drinking, storm and waste water, health, education or electricity. In the eastern part of Ward 9 and 8, ex-bounded labourers from Tikapur have been allocated land and now form a dense settlement with access to the road network and electricity. Around this area, there are also illegal settlements of displaced people that have built their homes on municipal and land. They have no access to electricity nor proper sanitation and are in the process of negotiating their relocation. The rest of the municipality are peripheral semi-urban and rural areas which cover Wards 1, 2, 3, 4, 5, 6, and 8. Table 1 outlines a summary of demographic data and Figure 1 shows population density at ward level.

Table 1 summary of demographic data of Tikapur

Total municipal surface	67.2 km <sup>2</sup>
Population of the municipality	56,127 (as per 2011 census)
Population growth rate	2.35% (Ward 9: 6.98%)
Population density	400-1600 persons / km <sup>2</sup>
Residents per household	6.3 (average)

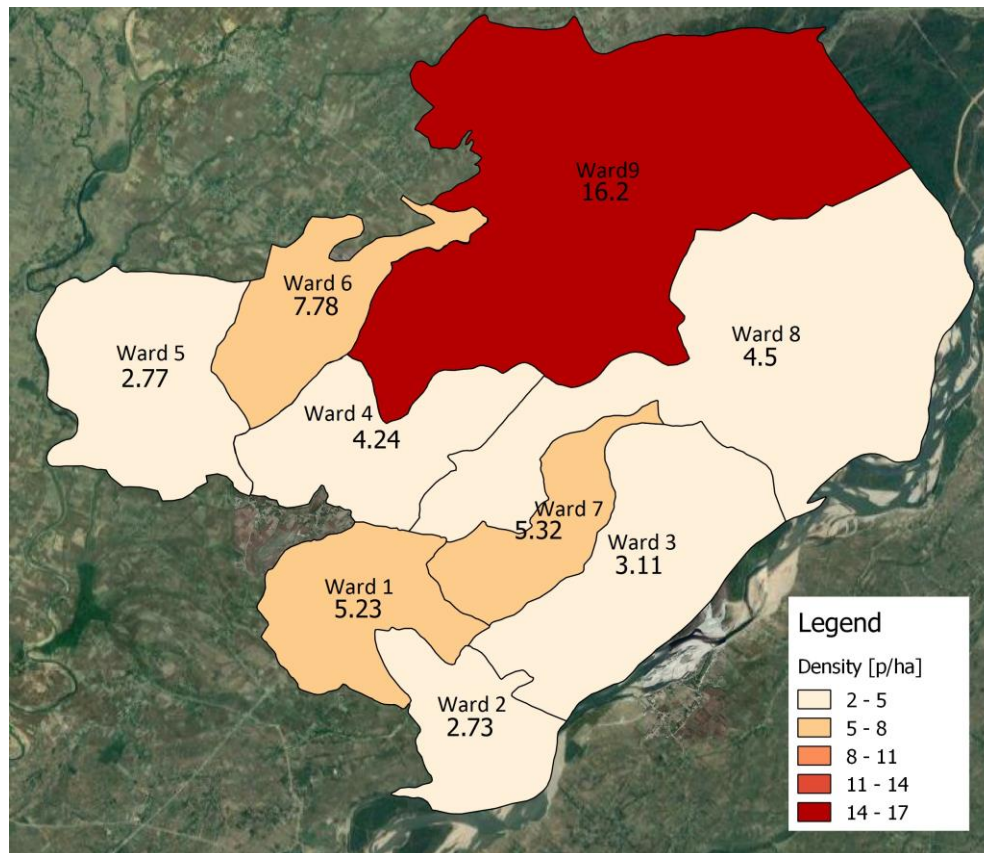


Figure 1 Population density at the ward level (2011 Census)



## 2 Service delivery context description

At the national level, national policy on water supply and sanitation is guided by two key targets regarding access to WASH services:

- the global SDG targets to guarantee access to all to water and sanitation by the year 2030 and,
- a more ambitious target, formulated under the Rural Water Supply and Sanitation (RWSS) Policy and accompanying strategy (2004) which aims to provide water supply and sanitation coverage to all by the year 2017 (but which is unlikely to be met nationwide).

Likewise, the Urban Water supply and Sanitation Policy (draft 2009) which was approved by the Government of Nepal, specifically endorses core principles related to public health, economic growth, social inclusion, protecting and optimizing investments, financial sustainability, environmental protection and development of an efficient, effective and accountable urban water supply and sanitation sector (MPPW, 2009). Sanitation as such is considered as a basic need and a basic right by the different policies. These policies favour a strong collaboration between government agencies and NGOs, donors and the private sector while establishing water and sanitation provisions. In small towns (5000- 10,000 inhabitants), the end users are required to contribute ~20% of the capital costs when setting up community based water supply schemes. Environmental sanitation, which includes human excreta, wastewater and drainage, and solid waste management are included in all water supply projects and considered integral component of urban master plans (MPPW, 2009). Table 2 presents an overview of the relevant policy and legal frameworks that govern the water and sanitation sector in Nepal.

**Table 2 Relevant Policy and Legal Frameworks for Water and Sanitation. Source: adapted from ADB (2009)**

<b>Act or Regulation</b>	<b>Areas Addressed</b>
Water Resources Act 1992	<ul style="list-style-type: none"> <li>• The umbrella act governing water resource management.</li> <li>• Declares the order of priority of water use.</li> <li>• Vests ownership of water in the state.</li> <li>• Provides for the formation of water user associations and establishes a system of licensing.</li> <li>• Prohibits water pollution.</li> <li>• Allows ownership of completed projects to be transferred to users associations.</li> </ul>
National Water Supply Sector Policy 1998	<ul style="list-style-type: none"> <li>• Makes clear the objective of providing safe, convenient, and adequate water supply to all, with sanitation as its integral component.</li> <li>• Decreases direct involvement of the Government in implementation and strengthens institutions for decentralized service delivery.</li> <li>• Sets the target of expanding the national coverage of water supplies to all by 2002 (but the target was not achieved).</li> </ul>
Drinking Water Regulation 1998	<ul style="list-style-type: none"> <li>• Regulates the use of drinking water.</li> <li>• Provides for the formation of drinking water user associations and sets out the procedure for registration.</li> </ul>

	<ul style="list-style-type: none"> <li>• Deals with licensing of use drinking water.</li> <li>• Deals with the control of water pollution and maintenance of quality standards for drinking water.</li> <li>• Sets out the conditions of service utilization by consumers.</li> <li>• Provides for the acquisition of house and land and compensation.</li> <li>• Provides for formation of service fee fixation committee.</li> </ul>
Local Self Governance Act 1999	<ul style="list-style-type: none"> <li>• Establishes a decentralized governance structure.</li> <li>• Sets out the powers, functions, and duties of the VDCs, municipalities, and DDCs in relation to water and sanitation.</li> <li>• Sets out which natural resources are assets of local bodies and empowers local bodies to levy a natural resource tax.</li> <li>• Allows local bodies to transfer assets to consumer groups.</li> </ul>
Local Self Governance Regulation 1999	<ul style="list-style-type: none"> <li>• Sets out the powers, functions, and duties of VDCs, municipalities, and DDCs in relation to water and sanitation.</li> <li>• Establishes the procedure for the formulation of water-related plan and project implementation</li> </ul>
National Drinking Water Quality Standards 2005	<ul style="list-style-type: none"> <li>• Sets standards for water quality.</li> <li>• Service providers responsible for monitoring.</li> <li>• Local offices of the Ministry of Health and Population responsible for surveillance.</li> <li>• Guidelines specify methods and frequency of sampling and testing.</li> </ul>
Water Supply Management Board Act 2006	<ul style="list-style-type: none"> <li>• Establishes WSMBs to manage services in municipal areas.</li> <li>• Authorizes WSMBs to issue licenses and enter into agreements with service providers to collect tariffs.</li> <li>• Constitutes Kathmandu WSMB.</li> </ul>
Water Supply Tariff Fixation Commission Act 2006	<ul style="list-style-type: none"> <li>• Establishes the commission.</li> <li>• Provides for appointments to the commission.</li> <li>• Authorizes the commission to fix tariffs to be charged by service providers.</li> <li>• Authorizes the commission to monitor service providers to ensure compliance with standards.</li> </ul>
National Water Plan 2005 (2002–2027)	<ul style="list-style-type: none"> <li>• Sets national coverage and service level targets for water and sanitation for all by 2017</li> <li>• Aims to provide universal basic service first then focus on upgrading.</li> <li>• Describes need for clearly defined roles and responsibilities, improved coordination, increased resources, improved cost recovery in urban schemes, improved monitoring, and effective regulation.</li> </ul>
Urban Development Strategy (2015)	<ul style="list-style-type: none"> <li>• With respect to WASH considers both networked and non-networked sanitation systems as options for urban areas</li> </ul>
WASH Sector Devpt. Policy, Plan and Act (2015)	<ul style="list-style-type: none"> <li>• Updated WASH sector policy, taking into account recent international and national sector developments</li> </ul>

Figure 2 provides the legislative framework for water supply and sanitation as per the newly drafted WASH Sector Development Plan (2016).

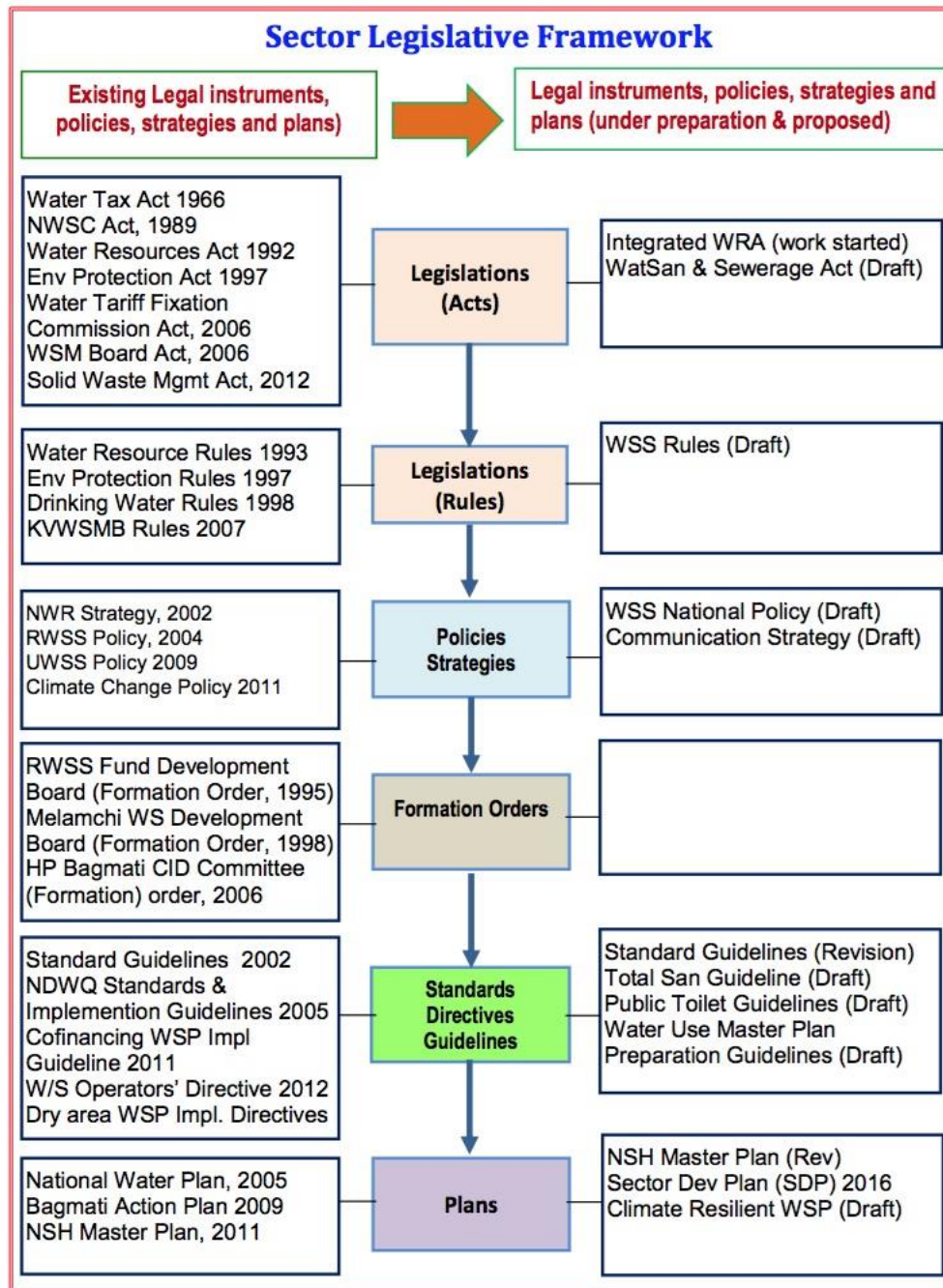


Figure 2 Legislative framework for water and sanitation. Source: WASH Sector Development Plan (2016), Nepal

In addition to the above policies, acts and framework, a separate National Plan for Small Town Water Supply and Sanitation exists. The Plan provides a 15-year development plan for small town water supply and sanitation. It was endorsed by the Government in January 2000. A total of 209 towns with a total population of 2.14 million was defined in the plan. The plan quantified the water supply and sanitation needs of small towns, estimated the cost of providing the improved services, and proposed an improved institutional framework. Small towns are further classified in terms of water supply coverage as good (existing piped water supply coverage

equal to or higher than 75%), satisfactory (between 30% and 75%), and poor (less than 30%). However, in the eight years to 2008, improved water supply services were provided to only 32 towns, out of which 29 were supported by the ADB's STWSSSP, Phase-I. The remaining three towns were supported by a grant from the Government of Japan.

Within the framework of the National Urban Policy (2007) small towns have been redefined as follows: (i) population of 5,000–40,000; (ii) located on a road linked to the strategic road network and (iii) having at least one secondary school and a health post in addition to grid electricity, basic telecommunications, and banking. Two hundred and sixty-five towns (153 in the Terai and 112 hill towns), with a total population of 3.6 million, meet these criteria. According to the original plan, only 45% of the population in small towns had access to piped water (irrespective of water quality) and the current coverage is likely to be similar.

## 2.1 Institutional framework

At the national level, the lead agency for the development and implementation of policy is the Department of Water Supply and Sewerage (DWSS), which is under the Ministry of Physical Planning and Works (MPPW) (Figure 3). Under the National Guidelines for Sanitation and Hygiene Promotion, 2005 and the Local Self Governance Act, 1997 relating to decentralization, responsibilities for sanitation provision are to be decentralized, with DWSS retaining an advisory and enabling role.

Responsibility for implementation lies with Water User and Sanitation Committees (WUSCs). These are linked to Village Development Committees (VDCs), which in turn link upwards to the District Development Committees (DDCs), which are responsible for overall district-level planning (Figure 3). The whole decentralized DDC/VDC/WUSC structure falls under the Ministry of Local Development (MLD) and is supported technically by the District Technical Office (DTO). DTO staff are provided through the Department of Local Infrastructure Development and Agricultural Roads (DoLIDAR). For rural and small town programs, the policy and overall lead agency function is the responsibility of one ministry (MPPW), while the day-to-day implementation of that policy is carried out by organizations falling under a different ministry (DoLIDAR). In practice, DWSS continues to be involved in the planning and implementation of schemes serving populations of over 1,000 through divisional and sub divisional offices. (WEDC, 2005).

## 2.2 Policy and sector strategy regarding small towns

The STWSSSP has its Project Management Office (PMO) in Kathmandu within DWSS institutional structure. It is then separated into Regional Project Management Offices (RPMO) for the eastern and western regions of Nepal which are responsible to manage and implement the project at the town levels. At the town level, the WUSC is the local body responsible to support the project implementation, to collect the 15% local participation to the overall project budget and, in the long run to operate and maintain the infrastructures built through the project.

Until recently, STWSSSP has been focusing on the construction of water supply infrastructure, and even though there is a budget allocated for sanitation components, the main action taken till now are the construction of public toilets, providing Output Based Aid (OBA) for toilet construction and the construction of some treatment infrastructures without operation and maintenance plans. Due to this, most of the newly built treatment plants are not working. The STWSSSP is now in the phase of looking for ways to improve sanitation services in small towns. In this process, a letter of understanding has been signed between STWSSSP and Eawag-Sandec for the implementation of a Citywide Sanitation Planning (CSP) procedure for

small towns. If this collaboration proves successful, a scaling up of the process and implementation of CSP in other project towns is foreseen.

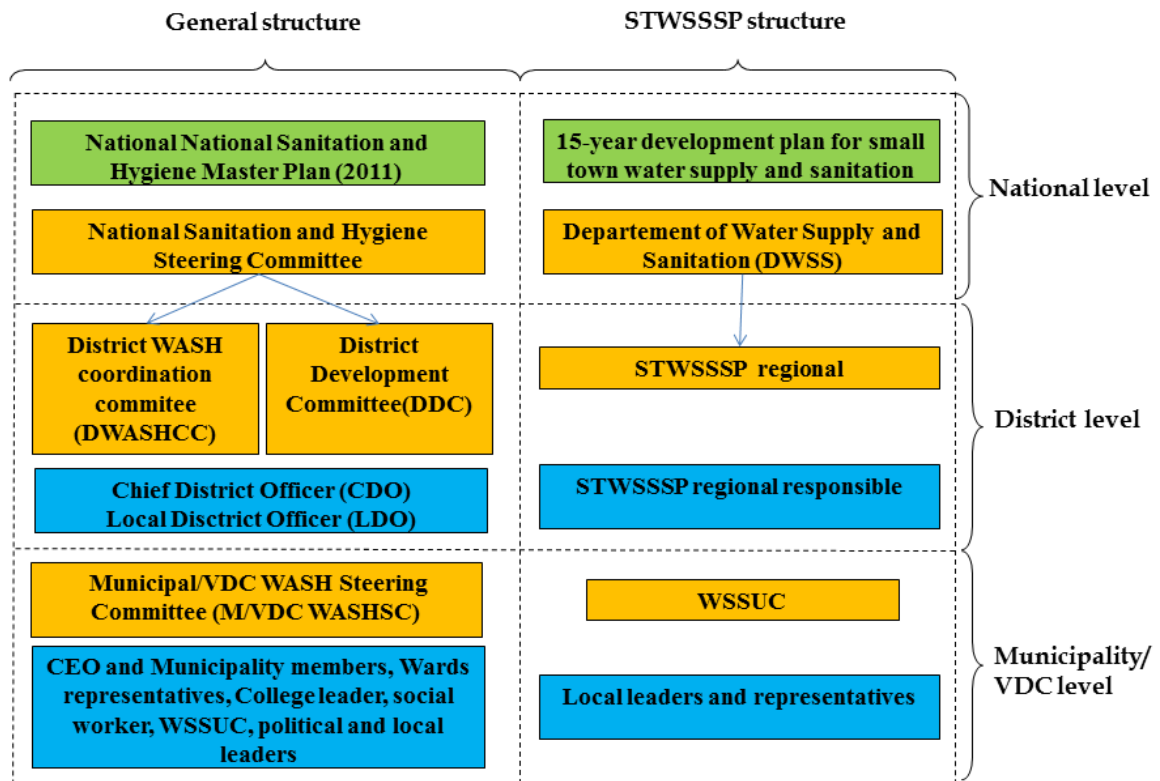


Figure 3 Nepal WASH sector legal and political framework

### 2.3 Local body representativeness and future institutional changes

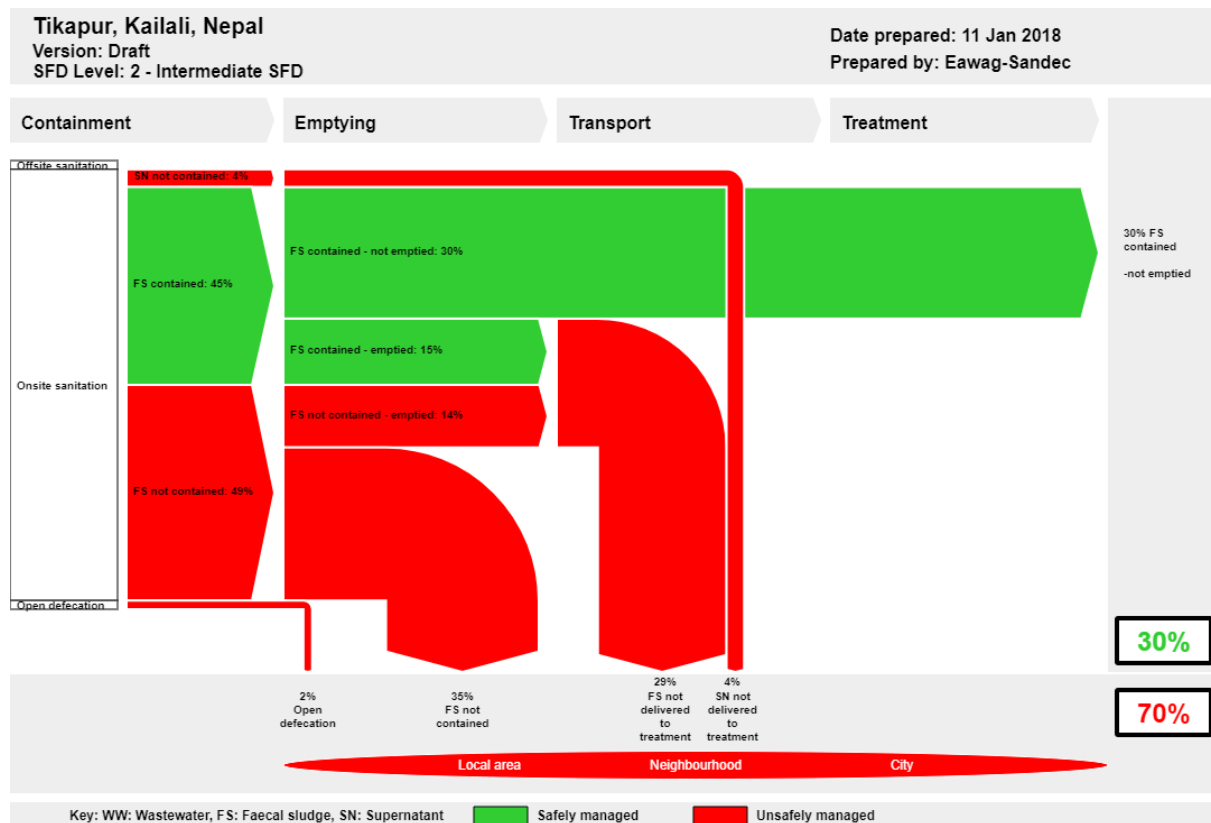
At the local level, the institutional situation is quite complex. Local elections at the municipal and district level have not been held since 1999 (!), leading to a lack of democratic representativeness and in some cases very weak institutions (Municipality, VDC). At the municipal level, the chief executive officer is appointed through consensus between the main political leaders, without democratic election, which leads to a weakened municipal power and decision-making. As a consequence of this, some municipalities have handed over some important tasks and responsibilities to local committees, i.e. Water User and Sanitation Committees or Town Development Committees. They are usually composed of local and political leaders representing part of the population and take responsibility on specific areas such as water supply and water taxes collection or allocation of Municipal land for example. The balance of power and responsibility between the municipalities/VDCs and the local committees varies from town to town and depends on local governance factors. STWSSS has made it compulsory to work directly with the WUSC in each project town. Local elections are planned for the near future, which will probably give more power to the elected body, but the general operating mechanisms at the local level concerning environmental sanitation might not be much affected.

At the national level, the implementation of the new constitution might affect the institutional framework with the redistribution of some department, the restructuring of ministry responsibilities or the creation of entirely new entities. But it is yet not clear on how these changes will affect the urban environmental sanitation enabling environment in Nepal in the coming years.

### 3 Service Outcomes

#### 3.1 SFD Matrix

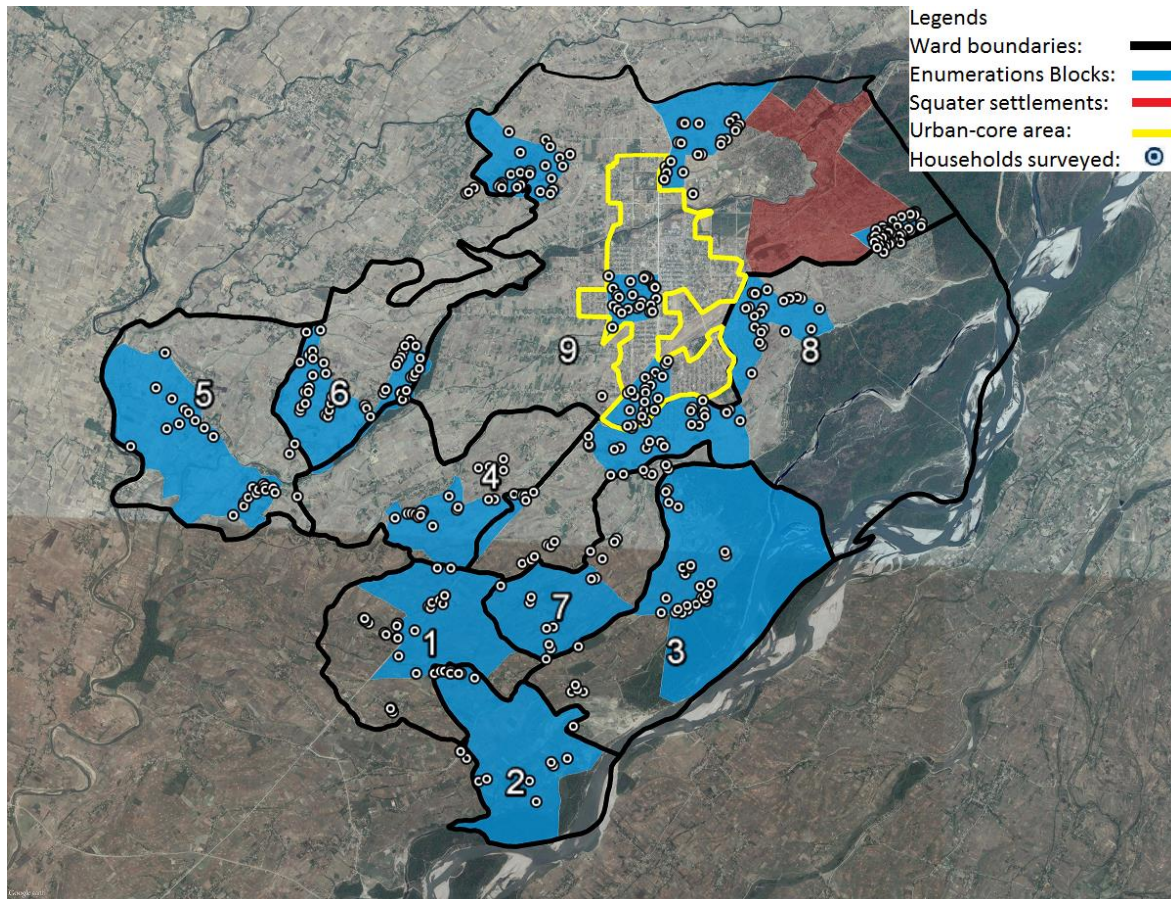
Figure 4 shows the SFD for Tikapur Municipality. A detailed explanation of all assumptions used to estimate the percentages of excreta flows are described in section 3.1.1 to 3.1.4.



**Figure 4 SFD of Tikapur, field based assessment**

Most of the data used for the SFD matrix come from an environmental sanitation baseline survey carried out in Tikapur during the Citywide Sanitation Planning (CSP) process (Eawag, 2016). Some data, on groundwater contamination, was sourced from the initial Environmental Examination (IEE, 2014). Both studies were produced under the Small Town Water Supply and Sanitation Sector Project (STWSSSP) directed by the Department of Water Supply and Sewerage (DWSS). The main data source, the environmental sanitation baseline survey (Eawag, 2016), was a random sample survey calculated from the number of households in each Ward. 400 households from 15 enumeration blocks were surveyed throughout all municipal wards of Tikapur. The questionnaire included 140 questions on environmental sanitation. For a complete description of the methodology, see annex 1. This methodology

allowed to have representative results at the Ward level (and also a specific result for the urban core area). These results were then weighted by the population size of each ward to get representative results for the whole municipality. It covers a total population of about 55,000 inhabitants. Figure 5 displays the enumerations blocks as well as the households that were surveyed.



**Figure 5 Map of Tikapur municipality with the survey enumeration blocks, the excluded squatter settlements, the urban-core area delimitation and the surveyed households**

This survey focused on domestic sanitation. Because no data was available on institutional, public or restaurants/hotel waste flows, they are not included in this SFD. But it is important to note that Tikapur is a regional educational, economic and tourist centre. This implies the presence of institutions, restaurants and hotels in the municipality. They are not connected to any piped sewers and mostly have septic tanks that also require regular emptying. The contribution of the tourist activities was considered to remain limited as compared to the overall population (two hotels and two restaurants were spotted during the field visits). The main tourist attraction is the Tikapur park which attract mainly daily visitors during the weekend. Concerning the educational institutions, about 20 schools and 3 colleges/universities, they are mainly located in the core urban area of the town. The exclusion of the educational buildings from this SFD, might have underestimated the actual share of septic tank from the overall faecal sludge and wastewater production. But as none of the institution have a proper treatment system for their faecal wastes, its exclusion should not affect too much the overall outputs and conclusions of this SFD. In any case, the tourist and education sector should be taken into account for any

potential future sanitation intervention and a proper estimation of their contribution should be carried out.

### *3.1.1 Risk of groundwater contamination*

Tikapur is situated in the Terai region of Nepal, which is part of the Gangetic Plain. The Terai is a flat alluvial sediment plain composed mainly of gravel, silt and clay (IEE, 2014). Tikapur is situated on the bank of the Karnali River, 30 km north of the Indian border. From interviews with local leaders and engineers, it was determined that the groundwater table level can vary between 2 to 15 m below the ground level, depending on the season (dry/rainy season). The water table can be lower than 10 m during the dry season and higher than 5 m during the rainy season. Therefore, we assumed that on average, it lies between 5 and 10 m. Flooding events occur in several parts of the Municipality during the rainy season. Affected on-site sanitation systems can fill up with infiltrated water and leakage from the pits to the environment can occur (Eawag, 2016).

No information about the distance between sanitation facilities and groundwater sources was available. However, two different settings were defined, the first one being the core-urban area of the municipality. Due to the housing density, combined with the high level of hand pump water supply (96% of the population relies on hand pumps as its main source of drinking water, (IEE, 2014), it was estimated that in this setting, more than 25% of the sanitation facilities are within a 10m radius of the next groundwater source. The rest of the municipality can be considered as peri-urban to rural. 100% of the population in these areas rely on household hand pumps for their drinking water supply. No minimum distance was observed when constructing the pumps and sanitation facilities. In some cases, the distance was less than 10 m between the sanitation facility and the groundwater source. Without any quantitative data, the assumption was made that in 50% of the total rural settlement area, less than 25% of the houses failed to respect the 10 m distance limit. In the other areas (peri-urban and core-urban), more than 25% of the houses failed to respect the 10 m distance.

For drinking water, most of Tikapur's residents (96%) rely on shallow tube-wells and hand pumps, installed at their household, without a sanitary sealing. The water is tapped from shallow aquifers ranging from 4-12 m depth (IEE, 2014). It is therefore assumed that people are relying on unprotected boreholes within the entire municipality.

To conclude, these parameters lead to two different scenarios. The first half of the total area, the core urban and part of the peripheral area, is considered to have a significant risk of groundwater contamination. The other half of the municipality, as peripheral area is considered to have a low risk of groundwater contamination.



### 3.1.2 Containment Technologies

Tikapur features on-site sanitation systems only, as no sewer network exists. Based on the environmental sanitation baseline survey (Eawag, 2016), the repartition of the different containment technologies present in Tikapur is presented in Figure 6.

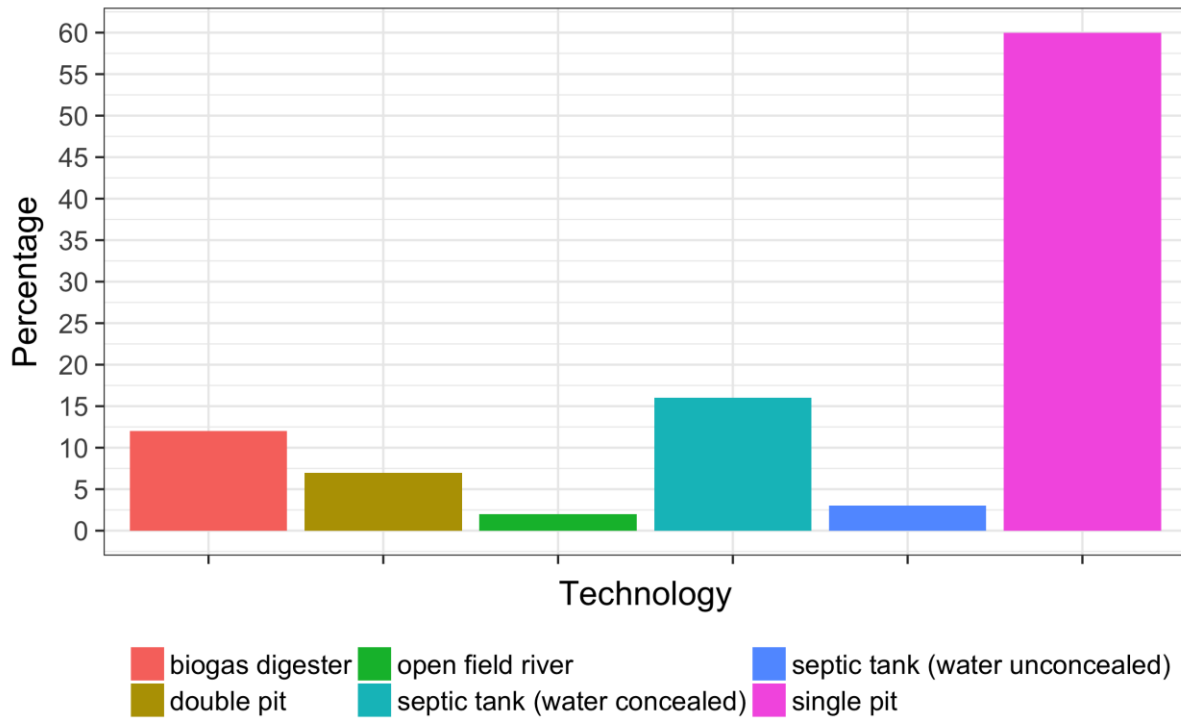
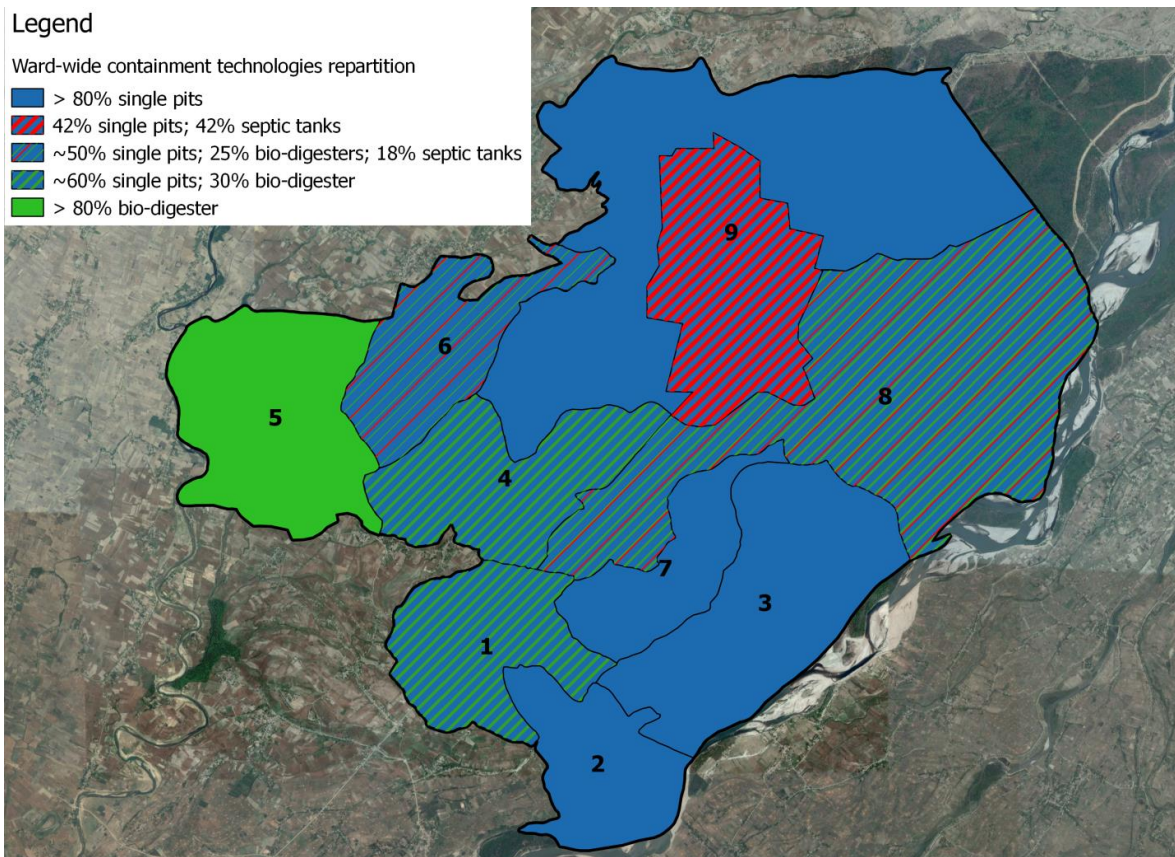


Figure 6 Containment technologies in Tikapur

However, the repartition of these containment technologies is not homogeneous within the municipality, with variations between the peripheral areas of the municipality featuring mainly single pits (71%) and biogas digesters (18%) and the core-urban part with septic tanks (42%) and single pits (42%) (Eawag, 2016). Figure 7 shows the distribution of containment technologies at ward level (with the core-urban area in the middle).



**Figure 7 Distribution of the containment technologies at ward level**

Based on this data, it was assumed that single and twin pits were present on the entire territory (50/50% 'significant risk'/'no significant risk' of the groundwater contamination), the septic tanks only in the urban and peri-urban setting (100% of 'significant risk' of groundwater contamination) and that the bio-digesters were only present in the rural area (100% of 'non-significant risk' of groundwater contamination).

To determine if the septic tanks were watertight, the enumerators were trained on the differences between septic tanks that are watertight and ones that are not. But even with this training, the risk that the respondent doesn't actually know how the septic tank was built was evident. Observations and interviews showed that the outlet of septic tanks, when watertight, were either directly connected to the open storm water drains or irrigation canals or connected to a soak pit. Without proper quantitative data on the fraction, it was estimated that half of the liquid outlets were connected to the drains and the other half to a soak pit. These types of septic tanks are mainly to be found in the core-urban area; where there is a 'significant risk' of groundwater pollution. The unsealed septic tanks, the biogas-digesters and the single and twin pits were considered to have no outlet nor overflow. The proportion of respondents practicing open defecation is 2% at the municipal level (Eawag, 2016).

Combining the previous assumptions, Figure 8 shows the selection grid of the containment technologies for Tikapur municipality.

List A: Where does the toilet discharge to? (i.e. what type of containment technology, if any?)	List B: What is the containment technology connected to? (i.e. where does the outlet or overflow discharge to, if anything?)									
	to centralised combined sewer	to centralised foul/separate sewer	to decentralised combined sewer	to decentralised foul/separate sewer	to soakpit	to open drain or storm sewer	to water body	to open ground	to 'don't know where'	no outlet or overflow
No onsite container. Toilet discharges directly to destination given in List B					Significant risk of GW pollution Low risk of GW pollution					Not Applicable
Septic tank					Significant risk of GW pollution Low risk of GW pollution					Not Applicable
Fully lined tank (sealed)					T2A3C5 Low risk of GW pollution	T1A3C6				T1A3C10
Lined tank with impermeable walls and open bottom	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution					T2A4C10 Low risk of GW pollution
Lined pit with semi-permeable walls and open bottom	Not Applicable									T2A5C10 T1A5C10
Unlined pit										Significant risk of GW pollution Low risk of GW pollution
Pit (all types), never emptied but abandoned when full and covered with soil										Significant risk of GW pollution Low risk of GW pollution
Pit (all types), never emptied, abandoned when full but NOT adequately covered with soil										Significant risk of GW pollution Low risk of GW pollution
User interface failed, damaged, collapsed or flooded										
Containment (septic tank or tank or pit latrine) failed, damaged, collapsed or flooded										
No toilet. Open defecation	Not Applicable						T1B11 C7 TO C9			Not Applicable

Figure 8 SFD Selection Grid for Tikapur

### 3.1.3 Emptying practices

The baseline survey (Eawag, 2016) showed that in the absence of mechanical emptying infrastructure in Tikapur, all faecal sludge is manually emptied either by a family member (38%) of the household or by a hired manual emptier (62%). A large portion of septic tanks or pits have never been emptied yet (44%). When the results are analysed in more detail, it can be seen that there are technologies and geographical differences with a bigger fraction of single pits being emptied more often than septic tanks or bio-digesters. The poor emptying fraction of septic tanks and bio-digesters can probably be explained by a lack of awareness on the proper design, operation and maintenance requirements of these technologies. The percentage of containment systems that have been emptied at least once varied greatly between the systems. Table 3 presents the differences of the fraction of the technologies that are emptied.

**Table 3 Fraction of the different on-site sanitation systems that are regularly emptied**

Technology (% presence at municipality level)	Single pit (60%)	Septic tank (20%)	Bio-digester (12%)	Twin pit (7%)
Fraction of the population that is using the system with emptying	68%	28%	32%	45%

These fractions were used as input for the “Proportion of population using this system with emptying” in the SFD matrix (Table 4). This Table 4 also shows the proportion of each type of system that is emptied and/or delivered to treatment and is treated.

**Table 4 Final estimations for the SFD matrix calculation of containment systems (based on Eawag, 2016)**

**Tikapur, Kailali, Nepal, 11 Jan 2018. SFD Level: 2 - Intermediate SFD**

**Population: 56136**

**Proportion of tanks: septic tanks: 50%, fully lined tanks: 50%, lined, open bottom tanks: 50%**

System label	Pop	F3	F4	F5	S4e	S5e
System description	Proportion of population using this type of system	Proportion of this type of system from which faecal sludge is emptied	Proportion of faecal sludge emptied, which is delivered to treatment plants	Proportion of faecal sludge delivered to treatment plants, which is treated	Proportion of supernatant in open drain or storm sewer system, which is delivered to treatment plants	Proportion of supernatant in open drain or storm sewer system that is delivered to treatment plants, which is treated
<b>T2A3C5</b> Fully lined tank (sealed) connected to a soak pit, where there is a 'significant risk' of groundwater pollution	8.0	28.0	0.0	0.0		
<b>T1A3C6</b> Fully lined tank (sealed) connected to an open drain or storm sewer	8.0	28.0	0.0	0.0	0.0	0.0
<b>T1A3C10</b> Fully lined tank (sealed), no outlet or overflow	12.0	32.0	0.0	0.0		
<b>T2A4C10</b> Lined tank with semi-permeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	3.0	28.0	0.0	0.0		
<b>T2A5C10</b> Lined pit with semi-permeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	34.0	68.0	0.0	0.0		
<b>T1A5C10</b> Lined pit with semi-permeable walls and open bottom, no outlet or overflow	33.0	68.0	0.0	0.0		
<b>T1B11 C7 TO C9</b> Open defecation	2.0					

Concerning the emptying frequency, it varied between once every three months and once in three years.

### 3.1.4 Conveyance, treatment and end use

The absence of any kind of formal treatment infrastructure leads to a high fraction of sludge that is dumped directly into the environment. The results of the disposal of faecal sludge from the household survey are presented in Figure 9 (Eawag, 2016). The emptied sludge is nearly always discharged directly into the environment (86%) without any further treatment, the rest being put into an alternative pit (14%). This last fraction has not been considered as a safe treatment option. This decision was based on the “significant risk” of groundwater pollution in a large area of the municipality and on the fact that this practice is not regulated and no information were available on the safety of this practice.

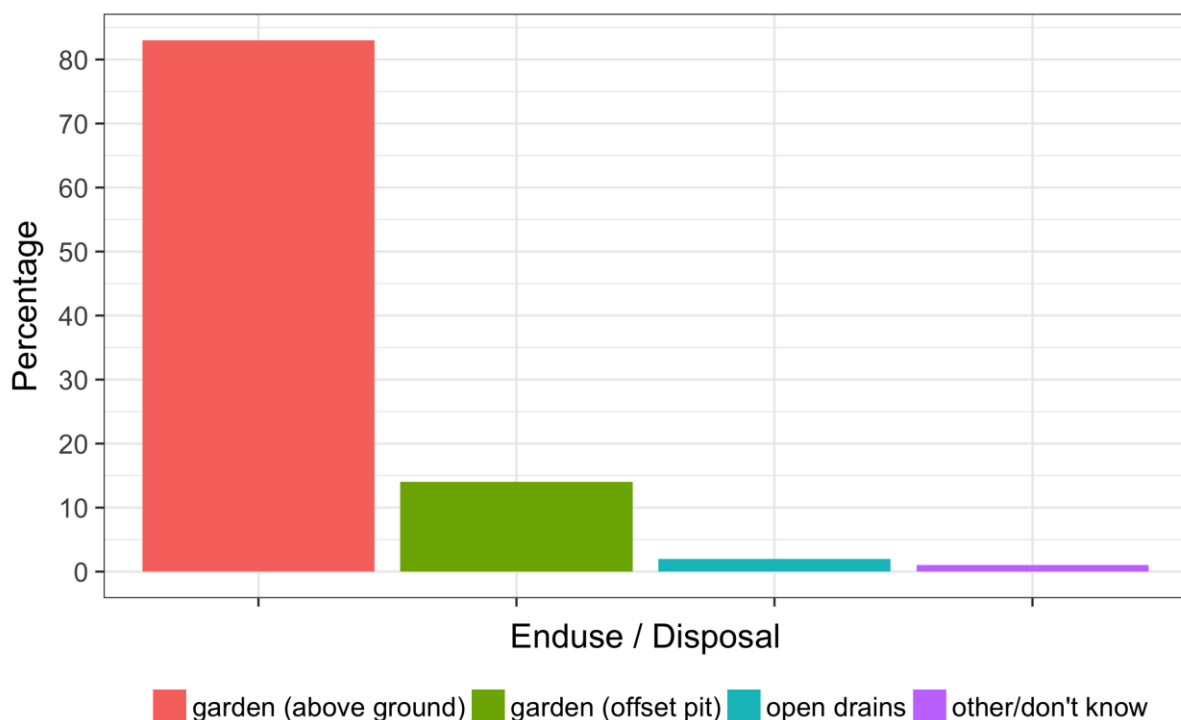


Figure 9 End use/disposal of emptied faecal sludge

This leads to the definition of variable F4: “FS delivered to treatment plants” as 0% and variable F5: “FS treated” as 0%. Because of the absence of any sewer or any treatment option for the wastewater, the variable W5a and W4 (“WW treated at centralized treatment plants” and “WW not contained, delivered to centralized treatment plants”) were set as 0. Table 5 summarises the input variables of the SFD matrix for treatment (Table 4).

Table 5 Input variables of the FSD matrix

Variable	Percentage	Description
F4	0%	FS delivered to treatment plants
F5	0%	FS treated
W5a	0%	WW treated at centralised treatment plants
W4c	0%	WW not contained, delivered to centralised treatment plants

## 3.2 Discussion of results

This field-based SFD was produced as part of the City Sanitation Plan of Tikapur which allowed to gather reliable and detailed information on sanitation practices at sub-municipal (ward) level. Based on this data, it was possible to build an evidence-based SFD even though some information was still missing. In the following section, different assumptions made will be discussed.

One of the remarkable facts in Tikapur is the total absence of FSM management (emptying, conveyance and treatment). Tikapur is quite representative of most small towns in Nepal, in the sense that there is a high toilet coverage due to successful national Open Defecation Free (ODF) campaigns. The consequence of these campaigns is a high toilet coverage without the corresponding infrastructure to empty, handle and treat the sludge. This is especially an issue in the small towns where the density is too high to handle the faecal sludge as in the rural areas and there is no infrastructure available as in bigger cities. This leads to a difficult situation where the population is either not emptying their tank/pit or dumping the sludge directly into the environment, resulting in very unhygienic urban environments. The positive side of this situation is that within the STWSSSP third phase, there is the will at the national level to take action to find appropriate solutions. The CSP piloted in Tikapur was one of these measures.

The SFD of Tikapur shows that 30% of the sludge is currently safely handled, this may raise some questions as there is no treatment infrastructure available. This is due to the large portion of containment technologies that have never been emptied, especially the biogas digesters and the single pit latrines in the rural areas. But at some point, the sludge will have to be emptied and the existence of treatment infrastructures will be essential even for the current “safely” handled sludge (contained, but not emptied).

The practice of transferring the sludge into an alternative pit, even though it is the safest option in absence of formalised emptying services, has not been considered as a satisfactory treatment option. This decision was based on the lack of information on how these alternative pits were built and to not send a wrong message to residents of Tikapur. This said, in the rural part, this option might still be the best option to deal with faecal sludge if sufficient land is available and the risk of groundwater contamination is low. Overall, there is a lack of awareness on how to safely operate and maintain sanitation systems.

The future outlook concerning Tikapur and other small towns in Nepal are positive. In Tikapur, the CSP is in the final phase of completion and funding for its implementation is nearly secured, especially for the faecal sludge management part. City Sanitation Plans are now planned for 5 other small towns in Nepal, based on the Tikapur experience.

### 3.3 Discussion on the quality of data

The two main data sources available are both quite recent (2014 and 2016) and of significant content, therefore the available data can be considered of good quality.

However, quantitative data could not be found for the following parameters:

- height of the water table;
- the distances between sanitation systems and groundwater sources;
- the liquid outlet of the sanitation systems, specifically for septic tanks and bio-digesters

This had to be estimated based on local observations and stakeholder interviews.

## 4 Stakeholder engagement

### 4.1 Key Informant Interviews

The development of the excreta flow diagram was part of the City Sanitation Planning process in Tikapur. All the stakeholders, national as well as local, were engaged in the process. Several events (launching workshop, household environmental sanitation survey, focus group discussion, expert workshop) were organised to involve the different stakeholders and to develop ownership of the process. The Water and Sanitation Users Committee (WSUC), the local body responsible for water and sanitation services, has been leading the CSP process locally. Alongside with the environmental survey, interviews and discussions were held with the WSUC members, municipal staff, local engineers as well as with informal manual pit emptier entrepreneurs.

### 4.2 Focus Group Discussions

Three focus group discussions were held in Tikapur during the CSP process to validate the findings of the survey and to determine priorities in the field of environmental sanitation. Concerning the SFD, these discussions allowed to validate the findings of the environmental sanitation survey. They also tapped local knowledge about faecal emptying practices, frequency and understanding the point of view of the population regarding these practices.

### 4.3 Observation of service providers

Information of service providers came from the environmental sanitation baseline survey (Eawag, 2016) and from the meeting with one of the informal manual emptiers which is the only service provision available in Tikapur. From time to time, the municipality calls an emptying truck from the nearest bigger town (two hours' drive away) to empty the public toilet septic tank.

### 4.4 Expert workshop

The SFD was used and presented during two occasions: (i) when presenting the findings of the environmental sanitation baseline survey at local level to the WSUC, and (ii) during the expert workshop in Kathmandu. It was well accepted, understood and it helped in sensitising the different stakeholders on the importance in addressing FSM in Tikapur.

## 5 References

- Eawag, 2016. Tikapur Environmental Sanitation Baseline Report.
- Ministry of Urban Development Nepal, 2014. Tikapur Initial Environmental Examination (IEE).



## 6 Appendix

### 6.1 Environmental sanitation baseline survey sample design

A two-stage stratified random sample design was adopted for this survey in order to achieve the objective. The households of the municipal wards are not uniformly distributed it varies from 180 to 11'630 households according to the national population census of 2011. These kind of household distributions are difficult to survey and can lead to a low representation of parts of the Municipality. In order to solve these kinds of problems, wards were split into adequate numbers of enumeration blocks while constructing the sample frame.

The first stage selection of enumeration block in each ward was done by using probability proportional to size (PPS) with the number of households as the measure unit of the size. In final stage, the required number of households was selected in each enumeration block by using equal probability systematic sampling.

#### *Sample size:*

The estimation of minimum sample size based on proportion of own toilet users was considered,

$$n = \frac{z_{\alpha/2}^2 \times p(1-p)}{\delta^2}$$

Where n is minimum sample size,  $Z_{\alpha/2}$  is 1.96 at 95% confidence level, p is proportion of own toilet users in Tikapur Municipality (around 65%) as target population estimated from National Population Census 2011 and  $\delta$  is margin of error to be tolerated, set at 5%.

From above assumptions and non-response adjustment, the minimum sample size (n) was 400 households.

#### *Sample allocation:*

The number of Enumeration blocks allocated for each ward was determined on the basis of compromise power allocation at 0.5 of total number of households in the ward.

$$n_w \propto (x_w)^{0.5}$$

Where  $n_w$  is number of selected enumeration blocks from a ward and  $x_w$  is the number of households in the ward.

#### *Selection of Enumeration Block as Primary Sampling Units (PSUs):*

The wards of the municipality were arranged according to their enumeration block number with household numbers. The selection procedure of the required number of enumeration blocks for the corresponding ward was done using Probability Proportion to Size (PPS) sampling, by measuring the number of households. All together 16 enumeration blocks were used for this survey.

*Selection of household as Ultimate Sampling Units (USUs):*

Selection of households was carried out in the field. The selection was done by using equal probability linear systematic sampling. However, before the selection of 25 households from each selected enumeration block, a list of all households by their family size were arranged in ascending order to make a representative sample of the enumeration bloc population.

*Modification based on field circumstances:*

In Tikapur, Ward 9 features informal settlements housing displaced people on municipal land. Initially, these settlements were supposed to be taken into account in the environmental sanitation survey but, under the pressure of local authorities and leaders (politics!) they were removed from the survey. This led to a total of approximately 1400 households. We had then to readjust the weight of the different regions inside Ward 9 (core-urban vs. peripheral) and with regard to the other Wards. The density of the core-urban area was extrapolated from the density found in the core-urban enumeration blocks surveyed. The density of the peripheral area was extrapolated from the density found in the peripheral enumeration blocks surveyed. Then the surface of both areas (core-urban and peripheral) were estimated from satellite imagery of the municipality. Finally, the population of each area was extrapolated using this information (density\*surface= number of inhabitants) and corrected to fit the total population of the 2011 census for the Ward 9. The results of the environmental sanitation survey for Ward 9 were calculated according to the population of the core-urban area (weight of 0.566) and the peripheral area (weight of 0.434). The weight of each Ward was calculated according to the population found in the 2011 population census. Using this methodology, we produced a survey that is representative of the whole population of Tikapur municipality, excluding the population of the eastern squatter settlements.

*Kathmandu/Tikapur, Nov. 2016*