SFD Promotion Initiative

Buffalo City Metropolitan Municipality

Eastern Cape, South Africa

SFD Lite Final Report

This SFD Lite Report was created through desk-based research by Emanti Management and Centre for Science and Environment for a Water Research Commission project and as part of the SFD Promotion Initiative.

Date of production: 26 October 2018

Last update: 26 October 2018

SFD Lite Report

The SFD Promotion Initiative (SFD PI) has developed recommended methods and tools for preparing SFD Graphics and Reports. A full SFD Report consists of the SFD Graphic, the analysis of the service delivery context and enabling environment for service provision in the city for which you are preparing your SFD, and the complete record of data sources used. This analysis allows a systemic understanding of excreta management in the city, with evidence to support it. As a starting point (first step stone) to this (explained in detail in the SFD Manual), the SFD Lite is a simplified reporting template that summarises the key information about the excreta management situation in the city.

SFD Lite Report Buffalo City, South Africa, 2018

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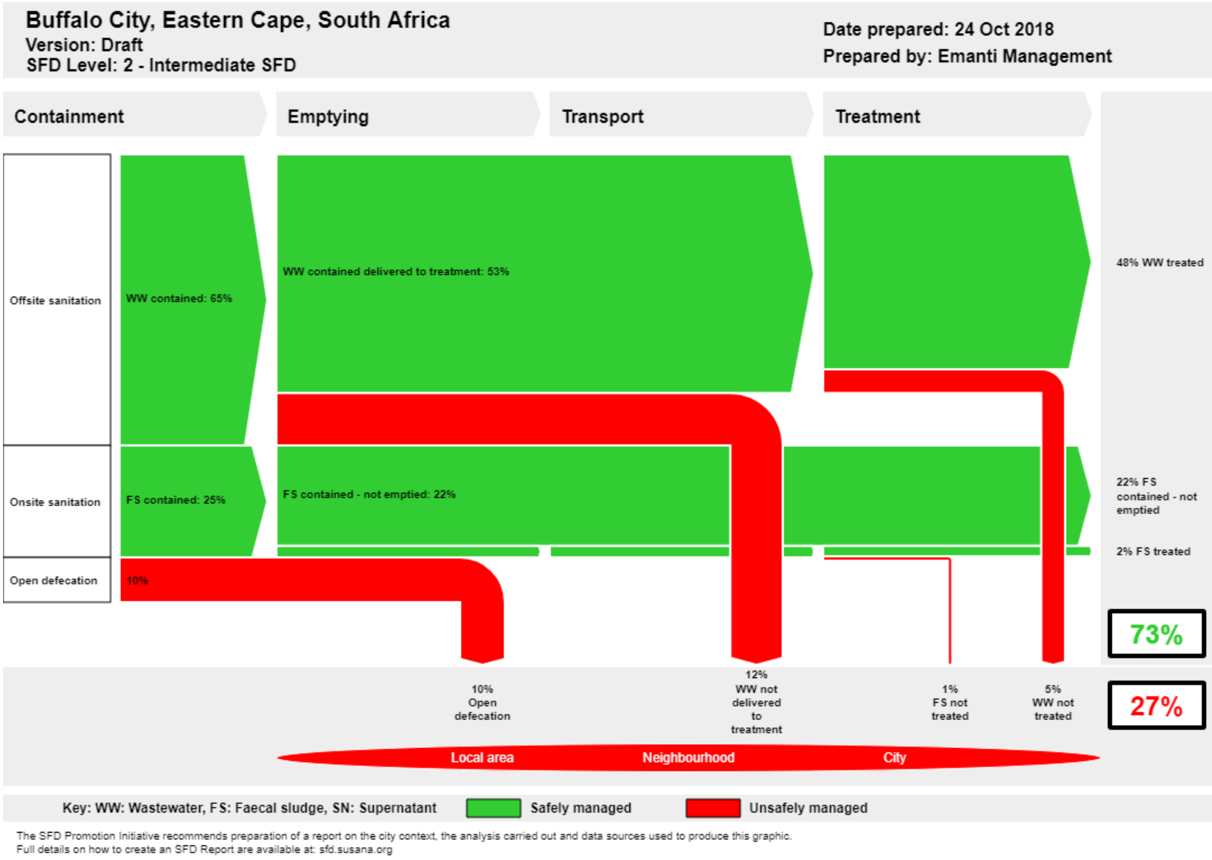
Executive Summary

1. The SFD Graphic



2. Diagram information

Desk or field based:

This is a desk based SFD.

Produced by:

Emanti Management (Pty) Ltd, Stellenbosch, South Africa.

Centre for Science and Environment (CSE), New Delhi, India.

Status:

This is a final SFD.

Date of production:

26 October 2018

3. General City Information

Buffalo City Metropolitan Municipality (BCMM) is a Category "A" Municipality situated on the east coast of Eastern Cape Province, South Africa. The main economic sectors in BCMM are community services, finance, manufacturing, trade, and transport. 60% of BCMM can be considered urban and 40% rural, with an estimated population of 843,997 and number of households of 253,477 (i.e. population density of ~336 persons per km^2 and ~3.3 persons per household). A population growth rate of 2.1% is noted. Buffalo City normally receives about 850 mm of rain per year, with most rainfall occurring mainly during summer. Temperatures for Buffalo City range from an average of 21°C in winter to 28°C in summer.

4. Service outcomes

The following sanitation technologies were noted:

- Toilet discharges directly to a centralised foul / separate sewer – these are flush toilets that are connected directly to the wastewater treatment works.
- Fully lined tank (sealed, no outlet or overflow) – these are buried concrete tanks, both from individual households (flush toilet connected to a conservancy tank) and community ablution blocks (flush toilets connected to a conservancy tank; replaced previous use of chemical toilets in specific areas). Some of these tanks are in poor condition.
- Lined pit with semi-permeable walls and open bottom – these are cement block lined VIPs with an open bottom. Although some VIPs are emptied, an emptying backlog exisits.
- Unlined pits – these are VIPs that are unlined and were mostly installed before 2012. There is limited groundwater potential within BCMM, but some rural areas are, however, currently still using groundwater resources. Although some VIPs are emptied, a backlog exisits.
- Pit (all types) never emptied, but abandoned when full and covered with soil, no overflow or outlet where there is significant/low risk of ground water pollution – these are old pit latrines that are not lined and never emptied. As they are full, BCMM currently categorize these households as not serviced. When full, the top structure is removed and taken to a new pit. It is believed that these pits are covered with soil when abandoned. There is limited groundwater potential within BCMM, but some rural areas are, however, currently still using groundwater resources.
- No toilet, open defeacation – these are rural and informal households that have not been serviced, and do not have a toilet. Their sanitation status is unknown, and it is assumed that open defecation is occuring.

5. SFD development process

Data was collected through secondary sources (reports, plans), and then Buffalo City was visited to conduct interviews with the relevant stakeholders, and subsequent follow-ups to confirm understanding. This information was used to fill in gaps and cross-check data collected. The data was fed into the SFD Graphic Generator to calculate the excreta flow in terms of percentage of the population.

73% of the excreta in Buffalo City is managed safely, while excreta for 27% of Buffalo City is not safely managed safely, as it is either not delivered to treatment (leaking pipes), not treated effectively, or not contained and can pollute groundwater sources and the environment. Furthermore, some customers are not currently serviced, and open defecation is suspected.

NOTE: Excreta being safely managed or not is dependent on the containment of the system, and not on whether the waste is safely handled or not.

6. List of data sources

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

- Published reports: Census 2011, Community Survey 2016
- Unpublished documents: IDP, WSDP
- Key informant interviews: BCMM

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Abbreviations

BCMM	Buffalo City Metropolitan Municipality
DM	District Municipality
DWS	Department of Water and Sanitation
FS	Faecal sludge
GDS	Green Drop System
IAM	Infrastructure Asset Management
ICT	Information and Communications Technology
IDP	Integrated Development Plan
IT	Information Technology
LG	Local Government
LM	Local Municipality
MuSSA	Municipal Strategic Self-Assessment
NRW	Non-Revenue Water
O&M	Operations and Maintenance
RDP	Reconstruction and Development Programme
SALGA	South African Local Government Association
SDBIP	Service Delivery and Budget Implementation Plan
SFD	Shit Flow Diagram
StatsSA	Statistics South Africa
VIP	Ventilated Improved Pit Latrine
W_2RAP	Wastewater Risk Abatement Plan
WCDM	Water Conservation and Demand Management
WRC	Water Research Commission
WSA	Water Services Authority
WSDP	Water Services Development Plan
WSP	Water Service Provider
WTW	Water Treatment Works
WW	Wastewater
WWTW	Wastewater Treatment Works

1. City context

Buffalo City Metropolitan Municipality (BCMM) is a Category "A" Municipality situated on the east coast of Eastern Cape Province, South Africa. It includes the towns of East London, Bhisho and King William's Town, as well as the large townships of Mdantsane and Zwelitsha (IDP, 2018).

BCMM's land area is approximately 2,515 km², with 68 km of coastline. Buffalo City is the key urban center of the eastern part of the Eastern Cape. It consists of a corridor of urban areas, stretching from the "port city" of East London to the east, through to Mdantsane and reaching Dimbaza in the west. The area is characterized by a composite settlement and land use pattern, incorporating urban, peri-urban and rural components, which were previously administered as separate local government entities. King William's Town serves as a secondary node in the BCMM region, and functions as a Regional Service Centre and together with Bhisho, is the Provincial Administrative Hub and contains the seat of the Provincial Government of the Eastern Cape Province. Rural and peri-urban settlements accommodate some 20% of the Municipal population or by land used for intensive and extensive agricultural purposes. The rural settlements are mainly situated to the western and southern parts of BCMM. Commercial farming areas are dominant in the north-eastern and south-western (coastal) sectors of the Municipality and are characterised by extensive land uses, with certain areas making use of intensive farming (irrigation-based) (IDP, 2018). The main economic sectors in BCMM are community services, finance, manufacturing, trade, and transport, and it is world-wide renowned for its developed manufacturing base, with the auto industry playing a major role (ECSECC, 2017).

BCMM is a Water Services Authority (WSA) for its area of jurisdiction in terms of the Water Services Act (Act 108 of 1997, Water Services Act). It therefore has statutory responsibilities and accountability in terms of legislation and policy with respect to the provision of water services. Considering access to basic water and sanitation services, the following is noted (StatsSA, 2016):

- Water (access to piped water in dwelling/yard or within 200m) = 247,655 households (97%)
- Sanitation (flush toilet, septic tank, chemical toilet, VIP) = 238,426 households (94%)

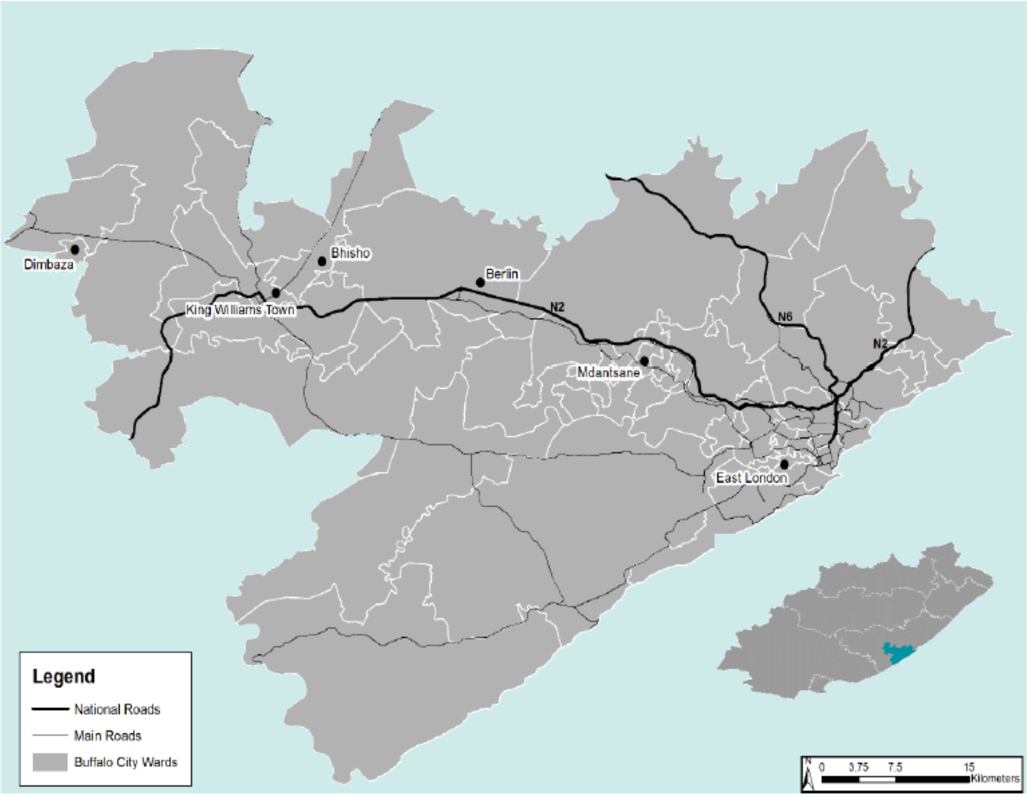
60% of BCMM can be considered urban and 40% rural. The StatsSA Community Survey (2016) estimated the population of BCMM to be 843,997 and number of households to be 253,477 (i.e. population density of ~336 persons per km^2 and ~3.3 persons per household). This indicates a substantial increase in households from 2013 (estimated to be 234,885 households). According to StatsSA out of the 253,477 households, 71% are considered formal, 25% are informal and 4% are traditional households. (StatsSA, 2016; IDP, 2018). In 2015 Buffalo City accounted for 11.7% of the total Eastern Cape population (IDP, 2017). A population growth rate of 2.1% is noted (IDP, 2018).

The climate is subtropical, with winter average day temperatures reaching 21 degrees Celsius and the average summer day temperatures reaching 28 degrees Celsius (IDP, 2018). The climate of BCMM is moderate for most of the year, but with hot spells from December to February, particularly in the inland areas. BCMM normally receives about 850 mm of rain per year (ECSECC, 2017), and rainfall varies from approximately 1000 mm along the coastal belt, gradually decreasing in a westerly direction to 500 mm, while in the north western portion of the region, the mean annual precipitation again increases to 1000 mm to 1500 mm (IDP, 2017). Although the region does receive rainfall all year round, it is primarily a summer rainfall region with the months of June and July generally being the driest months of the year (IDP, 2018).

The BCMM area extends from sea level along the coastal belt increasing in north-westerly direction to a plateau of elevation between 450 m and 850 m above sea level. This plateau extends from Maclean Town and Berlin, through to Dimbaza. The elevation in the most north-westerly portion of the BCMM occurs in the Amatole Mountains and reaches 2,100 m above sea level. The topography of the region is characterized by a number of incised river valleys, which run nearly parallel to each other in a south easterly direction through the municipality and which dissect the municipality at regular intervals. This terrain, which lacks large tracts of flat land, impacts significantly on settlement patterns and the cost of provision of services within the region. The geological strata of the region are typical of the Karoo system and consist mainly of mudstones and sandstones intruded by dolerite dykes and sills. In general the dolerite dykes trend east to west. Much of the geology is of marine origin, giving rise to the high salinity of the ground water in the area. The soils are generally moderate to deep clayey loams and the erodability index of the soils in the region is recorded as being medium to low.

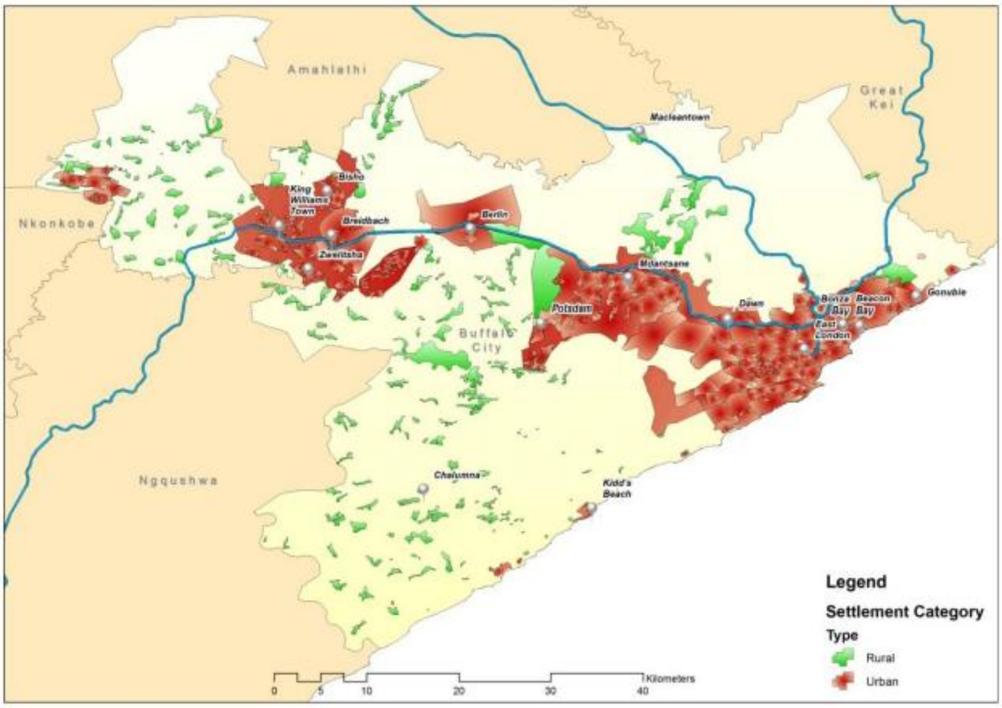
BCMM has 10 major river systems, with 9 of these systems considered “Endangered”, while the Buffalo River system is considered “Vulnerable” (IDP, 2018). In terms of aquatic systems, the National Wetlands Inventory identifies a total of 2064 wetlands areas. The groundwater potential in the region is generally not good, resulting in low borehole yields (generally below 2 L/s) and high salinity waters. The north-western portion of the region has the greater groundwater potential (i.e. Peelton villages), with the potential reducing in a south easterly direction towards the coast.

Figure 1: Location of Buffalo City within South Africa



Source: Urban-Econ GIS Unit (2016)

Figure 2: Location of Buffalo City within Eastern Cape province, South Africa



Source: BCMM GIS UNIT

Figure 3: Buffalo City urban and rural settlements

2. Service outcomes

Service outcome analysis is based on secondary sources. The following key sources of data are used:

- StatsSA Census (2011)
- StatsSA Community Survey (2016)
- Draft Integrated Development Plan Review for Buffalo City (2018/2019)
- Integrated Development Plan Review for Buffalo City (2017/2018)
- ECSECC Socio Economic Review and Outlook for Buffalo City (2017)
- Overview of the BCMM Sanitation Division (2018)
- IWA Water Balance for Buffalo City (2017/2018)
- Buffalo City Tariff Book (2018/2019)

Data on emptying and transport is not currently closely monitored, and is mostly qualitative in nature.

2.1 Overview

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

Table 1: Sanitation technologies and contribution of excreta in terms of percentage of population

No.	Sanitation technologies and systems as defined by:		SFD reference variable	Percentage of population
	Buffalo City	**SFD promotion initiative**		
1	Toilet flushes directly to sewer	Toilet discharges directly to a centralised foul/separate sewer	T1A1C2	64.6%
2	Conservancy tanks (concrete all around)	Fully lined tank (sealed), no outlet or overflow	T1A3C10	2.1%
3	Community ablution blocks (replaced chemical toilets)	Fully lined tank (sealed), no outlet or overflow	T1A3C10	1.4%
4	VIPs – unlined	Unlined pit	T1A6C10 (low risk GW)	6.7%
5	VIPs – lined with cement blocks and open bottom	Lined pit with semi-permeable walls and open bottom	T1A5C10 (low risk GW)	8.9%
6	Pit latrines – unlined (noted as “no service”)	Pit (all types), never emptied but abandoned when full and covered with soil, no outlet or overflow, where there is a ‘significant risk’ of groundwater pollution	T2B7C10 (high risk GW)	6.5%
7	Not serviced (rural and informal)	No toilet, open defecation	T1B7C10	9.7%

2.1.1 Containment

There is an extensive sewerage network of approximately 2,100 km, with the off-site formal waterborne sewer system linked to 15 BCMM wastewater treatment works.

The remaining areas are reliant on on-site sanitation systems. The following on-site containment systems are generally noted:

- Flush toilet connected to a conservancy tank (concrete)
- Community ablution blocks (flush toilets connected to a conservancy tank; replaced previous use of chemical toilets in specific areas)
- VIPs – lined, but open bottom (semi-permeable)
- VIPs – unlined (mostly installed before 2012)
- Old pit latrines – unlined (noted as “no service”)

Conservancy tanks on individual properties appear to have a capacity of 10 m^3. The size of communal conservancy tanks is unknown. It is noted that these conservancy tanks sometimes overflow, thereby spilling wastewater into the environment.

There are parts of BCMM urban and rural areas where communities use VIP toilets. To-date, few of these VIPs have been emptied, and indications are that they are filling rapidly. In rural areas, communities are used to covering up and abandoning a full VIP and relocating the VIP to a new location. In the urban context, limited space could prohibit this practice.

2.1.2 Emptying and Transport

Vacuum tankers are used to empty and transport wastewater from the conservancy tanks (individual and communal) to specified Buffalo City Wastewater Treatment Works. The BCMM is not aware of manual emptying from conservancy tanks occurring within Buffalo City. The municipality aims to empty all conservancy tanks every 3-6 weeks, but sometimes tank overflows are experienced. There is no money exchanged between the emptier/vacuum truck and the household (part of annual charge or pay upfront at the municipal office, and then the service is scheduled and performed). Emptiers are provided with a list of households that they need to service (pre-paid by the household to the municipality before the service is performed).

BCMM currently has a fleet of 12 vacuum trucks, with 10 vacuum trucks for East London (4 trucks are ~10 years old, while 6 trucks are very new) and 2 vacuum trucks for King William’s Town (2 trucks are ~10 years old). All trucks appear to have a capacity of 6 m^3. Considering this, the following is noted:

- Household conservancy tanks
  - 5,437 households are serviced by conservancy tanks.
  - It could be assumed that there are approximately 5,437 conservancy tanks.

- Community Ablution Block conservancy tanks
  - 3,544 households are serviced by community ablution blocks.
  - Assuming 10 households are serviced by a community ablution block, it could be assumed that there are approximately 355 conservancy tanks conservancy tanks.
- Combining the two, we could therefore have approximately 5,800 conservancy tanks.
- If each tank is emptied every 3-6 weeks, it means that all tanks are emptied every 15-30 days (assuming no service on the weekend). This equates to some 193-386 tanks that need to be emptied per day. This implies that for the fleet of 12 vehicles, each vehicle needs to empty approximately 16-32 households per day, or 2-4 per hour for an 8-hour working day. BCMM have indicated that a vacuum truck routinely delivers 8-10 loads per day, this representing 4-5 households for the day. If all 12 trucks are in good working condition, this implies that approximately 48-60 tanks will be emptied in a day (i.e. 15-25% of the required amount). This implies that unless wastewater generation is significantly less than anticipated, regular overflows into the environment could be anticipated.

Vacuum trucks are mostly servicing the urban areas of Buffalo City. Some of the vacuum trucks are municipal owned/run, while it is known that other private operators do exist, and might be servicing the likes of Department of Public Works or Department of Education. Although the BCMM policy states that a municipal vacuum tanker must be used, BCMM do not currently have any control over private tankers, who largely operate in the peri-urban/rural areas of BCMM. Although some private vacuum tanker operators are recorded on the municipal database, the actual number and sizes of vehicles are currently unknown. BCMM have an existing 3-year contract with 5 service providers, who are able to assist with providing a service in an emergency (i.e. supply chain management can mobilize quickly).

There is currently very little monitoring and management of vacuum truck emptying (i.e. don't have a system in place to record arrival of trucks at WWTWs), and monitoring at point of discharge to the WWTWs does not appear to be occurring (i.e. do emptiers actually deliver collected sludge to the designated discharge points?). Despite this, it is noted that from a municipal perspective, as municipal officials operate the vacuum trucks, they assume they do deliver at WWTWs/specific discharge points (e.g. pump station, pond system, inlet works, into sewer at a specified manhole), as these officials will not be turned away at the wastewater treatment works, and therefore have no reason to not discharge correctly at the WWTWs. Furthermore, the distance to travel from conservancy tanks to the discharge point is relatively short (~10 km). However, as emptiers are salaried staff, there does not seem to be an incentive to manage time efficiently.

BCMM inherited between 20,000 and 30,000 VIP's from the Department of Water and Sanitation (DWS) and Amathole District Municipality (ADM) spread throughout the rural areas. All these were installed in the last 10-15 years and are becoming full and need cleaning out. BCMM have appointed private contractors to assist with emptying of VIPs. BCMM vacuum trucks are not used for rural sanitation, and private contractors need to supply their own vehicles as part of their contract of appointment with BCMM. Although necessary checks of vehicle safety (e.g. roadworthy test) are done, monitoring of service provider adherence to safety requirements (e.g. use of PPE) is not really performed. Regarding pit emptying, where sludge is fluid enough, this is sucked up via vacuum truck; where sludge is thicker, fluid is sometimes added, but it is noted that there is always a lot of solids in the pits (e.g. bottles), and that vacuum pipes often block and forks are need to manually unblock these. Solids collected from pit emptying are collected in a bag and taken to landfill for disposal.

The experience gained in clearing out VIP's has shown that it is not an easy operation as all kind of foreign material is deposited into the pits. The content furthermore is normally quite solid and cannot be removed by vacuum tanker unless water is added and then mixed. Even then problems occur as plastic packets or bottles and lumps of newspaper clog the hoses. Disposal nappies appear to be a significant problem, and they are both found in VIPs and from flushing, clogging smaller pipes with the sewer network.

In addition to mechanical emptying of VIPs, some manual VIP emptying is necessary for < 5% of VIPs (i.e. difficult for a truck to reach certain areas). Although there are 11 municipal drivers (10 in East London and 1 for King William’s Town) with 2 assistants per driver (i.e. total of 33 people) that are able to perform manual emptying, there are only 2 utility vehicles (bakkies) for this purpose. BCMM have therefore appointed a service provider to assist with manual VIP emptying. VIP contents are emptied to a bucket (25 L or 50 L containers with closed lids) with transportation via a utility vehicle (bakkie).

The disposal of the content once in the tanker remains a significant challenge. Currently tankers have to drive long distances to wastewater treatment works to empty. Suitable dumping sites will have to be found within close proximity of villages if the clearing of household VIP's are going to be done on a regular basis. Farms may need to be purchased on which pond systems can be established. Town Planning will have to take cognizance of these ponds as no housing development will be allowed within a radius of 800 m of the ultimate treatment works site since these systems do not have active treatment. It has been estimated that the following facilities would be required for enhancing VIP emptying:

- R25 million would be required for the suggested 5 pond systems (R5 million per pond system), and
- R7.5 million would be required for an additional 10 VIP emptying vehicles such as vacuum tankers or tractor/trailer combinations (R0.75 million per vehicle).

It is noted that the VIPs appear to be filling up quickly, and although BCMM are committed to emptying and maintaining VIPs on a 5-year cycle, they are currently behind.

As no site inspection was performed to confirm the aforementioned aspects, it is difficult to further elaborate on the emptying/transport/discharge process. The typical skills/capacity/training of the team, use of safety equipment, etc. is therefore currently unknown.

In addition to the above, the Sanitation Department is responsible for the operation and maintenance of 2,100 km of sewers and 81 Sewer Pump Stations. Sewerage systems in BCMM are well beyond their design lives, are in poor condition and are operating at capacity. In particular, it is noted that the weighted average life of the sewer pipe system is approximately 3 years (Westerberg, 2018). The effect of this situation is that expansion of the city and the housing programme is now severely constrained and the environment is under threat from sewage spills and leakages (IDP, 2018). It is estimated that the deferred maintenance to sewer network / infrastructure is in the region of R15 million per annum (Westerberg, 2018).

2.1.3 Treatment and disposal

The Sanitation Department is responsible for the operation and maintenance of 15 Wastewater Treatment Works (see figure below). The average combined wastewater flow into the 15 WWTWs is approximately 108 ML/day.

No.	Treatment Works	Treatment Type	Capacity (Ml/d)	Flows (Ml/d)	Sludge Treatment	Sludge Dewatering	Sludge Disposal
1	Berlin	Biofilter	1.0	0.7	Anaerobic Digestion	Drying Beds	Agricultural
2	Bisho	Ponds	0.8	2.0	-	-	On-site
3	Breidbach	Ponds	0.8	1.3	-	-	On-site
4	Central	Biofilter	5.0	7.8	Anaerobic Digestion	Drying Beds	On-site
5	Dimbaza	Activated Sludge	7.0	8.1	Sludge Lagoon	Drying Beds	On-site
6	East Bank	Activated Sludge	40.0	35.1	-	-	Sea Outfall
7	Gonubie	Activated Sludge	6.0	6.6	Sludge Lagoon	-	On-site
8	Hood Point	Sea Outfall	40.0	14.3	Screening	-	Sea Outfall
9	Keyzers Beach	Ponds	0.1	0.1	-	-	On-site
10	Kidds Beach	Ponds	0.1	0.1	-	-	On-site
11	Mdantsane	Biofilter	24.0	11.1	Anaerobic Digestion	Drying Beds	On-site
12	Potsdam	Biofilter	9.0	4.8	Anaerobic Digestion	Drying Beds	On-site
13	Reeston	Activated Sludge	2.5	1.1	Sludge Lagoon	-	On-site
14	Schornville	Activated Sludge	5.0	6.7	Anaerobic Digestion	Drying Beds	On-site
15	Zwelitsha	Activated Sludge	9.3	8.0	Anaerobic Digestion	Drying Beds	On-site
	TOTAL		150.6	107.7			

Figure 4: Buffalo City wastewater treatment works

Currently, there is no beneficial use of sludge, and most sludge is either stockpiled on-site at wastewater treatment works, or discharged to sea. Landfill sites are, however, filling up and reuse is becoming necessary. For beneficial re-use, BCMM needs an appropriate viable market for sludge related products. Although farming occurs within BCMM, there is insufficient intensive agriculture for this to be viable. In addition, although incineration is practiced at De Gama, the sludge has a low calorific value and is therefore not ideal for these purposes.

As part of their sludge management strategy, BCMM are investigating various options for advancing sludge management including a coastal regional site for sludge management, use of sludge drying beds, windrow, etc. the ability to implement proposed actions are dependent on the sludge quality (and associated compliance), the acceptability of the sludge for its intended use (marine outfall, agricultural use, etc.), and the sustainability of such operations (e.g. market exists and financially viable).

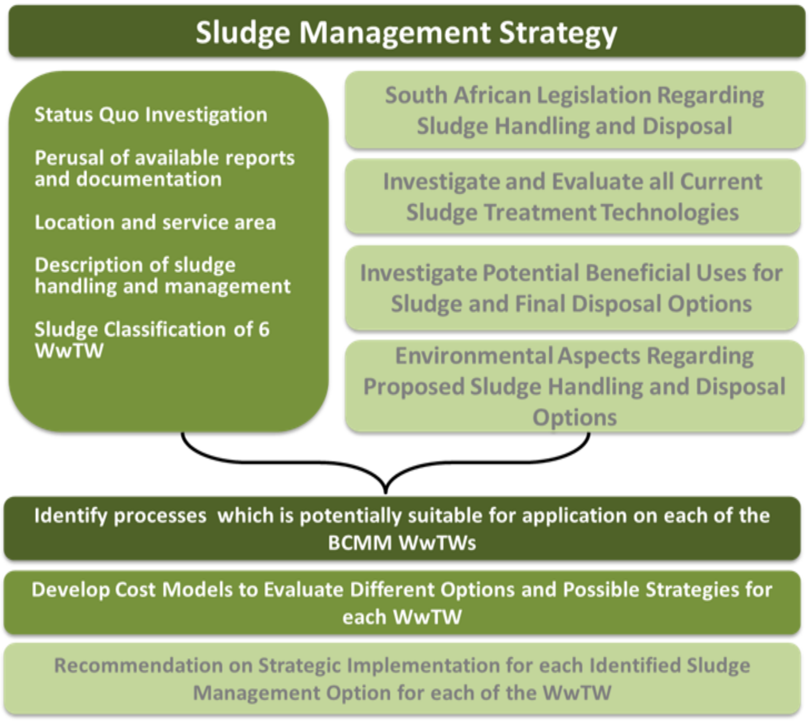


Figure 5: Overview of BCMM sludge management strategy

NO	Treatment Works	Treatment Type	Current Sludge Treatment.	Current Sludge Dewatering	Current Sludge Disposal	Proposed Sludge Treatment.	Proposed Sludge Dewatering	Proposed Sludge Disposal
1	Berlin	Biofilters	Anaerobic Digestion	Drying Beds	Agricultural	Anaerobic Digestion	Drying Beds	Agricultural
2	Bhisho	Ponds	-	-	On-site	Decommissioned	-	-
3	Breidbach	Ponds	-	-	On-site	Decommissioned	-	-
4	Central	Biofilters	Anaerobic Digestion	Drying Beds	On-site	Decommissioned	-	-
5	Dimbaza	Activated Sludge	Sludge Lagoon	Drying Beds	On-site	Sludge Lagoon	Drying Beds	On-site
6	East Bank	Activated Sludge	-	-	Sea outfall	-	-	Sea outfall
7	Gonubie	Activated Sludge	Sludge Lagoon	-	On-site	-	Belt Press	Land Fill
8	Hood Point	Sea Outfall	Screening	-	Sea outfall	Screening	-	Sea outfall
9	Kayzers Beach	Ponds	-	-	On-site	-	-	On-site
10	Kidds Beach	Ponds	-	-	On-site	-	-	On-site
11	Mdantsane	Biofilters	Anaerobic Digestion	Drying Beds	On-site	Anaerobic Digestion	Drying Beds	Land Fill
12	Potsdam	Biofilters	Anaerobic Digestion	Drying Beds	On-site	Anaerobic Digestion	Centrifugation	Agricultural
13	Reeston	Activated Sludge	Sludge Lagoon	-	On-site	Sludge Lagoon	Belt Press	Land Fill
14	Schornville	Activated Sludge	Anaerobic Digestion	Drying Beds	On-site	Decommissioned	-	-
15	Zwelithsa	Activated Sludge	Anaerobic Digestion	Drying Beds	On-site	Anaerobic Digestion	Belt Press	Agricultural

Figure 6: BCMM sludge management – current practices vs. versus proposed practices

As no site inspection was performed to confirm the aforementioned aspects, it is difficult to further elaborate on the status of treatment and disposal.

2.1.4 Human resources

It is noted that within Water and Sanitation services in BCMM, 611 posts are filled, while 258 posts are vacant and/or unfunded (Westerberg, 2018). This could indicate potential gaps with fulfilling all required sanitation services functions/tasks.

2.1.5 Service charges

The following water and sanitation related service charges are noted (Buffalo City, 2018):

- Once-off connection charge
  - Water
    - Varies for new/existing townships, type of metered connection (normal vs. combination meter vs. sprinkler connection), size of connection (e.g. 15 mm and 20 mm connections vs. 25 mm and larger), and number of meters installed.
  - Sewer
    - Varies for size of connection (e.g. 100 mm vs 150 mm)
- Service charges
  - For both water and sewer and is dependent on the required service (e.g. serviceman visit, clearing blocked drain)
- Monthly charges
  - Water (2018/2019, VAT incl.)
    - Domestic (availability): R115,00
    - Normal consumption: Domestic
      - 0-6 kL (indigent): R0 per kL
      - 0-6 kL: R16.36 per kL
      - 7-10 kL: R16.68 per kL
      - 11-20 kL: R23.16 per kL
      - 21-30 kL: R30.03 per kL
      - 31+ kL: R37.68 per kL
    - Punitive tariffs and controls are in place when water availability is scarce.
  - Sewerage (2018/2019, VAT incl.)
    - Residential
      - Small (domestic)
        - Erf 0 – 300 m^2: R1,087 per annum
        - Erf 301 – 400 m^2: R1,726 per annum
      - Medium
        - Erf 401 – 800 m^2: R4,496 per annum
      - Large
        - Erf 801 – 1200 m^2: R4,852 per annum
        - Erf > 1200 m^2: R5,287 per annum

- Varying tariffs are also noted for flats, complexes, etc. and for sea discharge (applicable in certain areas, and varies based on category)
- Conservancy tanks
  - Combined charge: R4,496 per annum
- Removal of conservancy tank effluent, septic tank effluent and pit latrine
  - Clearance of at least once every 3 weeks per 4.5 kL load or part thereof: R5,223 per annum
  - Additional: R432 per load
  - Various tariffs are also noted for emergency services, removal of contents of malfunctioning septic tanks, etc.

2.1.6 Water conservation and demand management

The BCMM water reticulation consists of 1,860 km of pipe, and reservoirs have a total storage capacity of 250 ML. Buffalo City has approximately 120,000 water connections in the urban areas, and approximately 20,000 flat rate consumers in the urban areas. The percentage non-revenue water (NRW) for Buffalo City for 2017/2018 was recorded as 43.7% with water losses 34%, and an Infrastructure Leakage Index (ILI) of 8.7 (Buffalo City, 2018). The average annual consumption of BCMM is 66 million m^3, which equates to approximately 217 litres per person per day (Buffalo City, 2018). This is very similar to the current South African average consumption of 237 litres per person per day under normal conditions (DWS, 2018). BCMM has developed a Water Conservation and Water Demand Management (WC/WDM) Strategy, which focuses primarily on reducing the level of non-revenue water to enhance both the financial viability of and water supply sustainability. The goals set in terms of this Strategy, are the following: (1) reduction of non-revenue water, (2) increased billed metered consumption, (3) reduction of raw water treatment losses, (4) ability to undertake detailed water balances, (5) promotion of water use efficiency, and (6) enhanced WC/WDM institutional capacity.

2.2 SFD matrix

The final SFD for BCMM is presented in **Appendix 6.1**.

2.2.1 SFD matrix explanation

In this report, all sanitation infrastructure is categorised according to their design and functioning as per SFD terms. Below is a description of each of the sanitation technologies in BCMM.

- Toilet discharges directly to a centralised foul / separate sewer – these are flush toilets that are connected directly to the wastewater treatment works.
- Fully lined tank (sealed, no outlet or overflow) – these are buried concrete tanks, both from individual households (flush toilet connected to a conservancy tank) and community ablution

blocks (flush toilets connected to a conservancy tank; replaced previous use of chemical toilets in specific areas). Some of these tanks are not in a good condition.

- Lined pit with semi-permeable walls and open bottom – these are cement block lined VIPs with an open bottom. Although some VIPs are emptied, a emptying backlog exisits.
- Unlined pits – these are VIPs that are unlined and were mostly installed before 2012. There is limited groundwater potential within BCMM. Although some rural areas that BCMM inherited from Amathole District Municipality are still using groundwater resources, BCMM is phasing this out (i.e. move to piped water supply). It is unknown if these unlined pits are within areas reliant on groundwater sources. Although some VIPs are emptied, a emptying backlog exisits.
- Pit (all types) never emptied, but abandoned when full and covered with soil, no overflow or outlet where there is significant/low risk of ground water pollution – these are old pit latrines that are not lined and never emptied. As they are full, BCMM currently categorize these households as not serviced. When full, the top structure is removed and taken to a new pit. It is believed that these pits are covered with soil when abandoned. There is limited groundwater potential within BCMM. Although some rural areas that BCMM inherited from Amathole District Municipality are still using groundwater resources, BCMM is phasing this out (i.e. move to piped water supply). It is unknown if these pits are within areas reliant on groundwater sources.
- No toilet, open defeacation – these are rural and informal households that have not been serviced, and do not have a toilet. Their sanitation status is unknown, and it is assumed that open defecation is occuring.

Considering the above, the following is noted:

Off-site

According to municipal records, 65% of the population are serviced via off-site sanitation. This wastewater is transported to the 15 BCMM WWTWs.

In order to determine the proportion of wastewater in sewer system that is actually delivered to centralised wastewater treatment works, it needs to be noted that the existing sewer systems in BCMM are well beyond their design lives and in poor condition, with a weighted average life remaining of approximately 3 years. It is therefore anticipated that leakage will occur. Considering the IWA Water Balance for BCMM, the System Input Volume (SIV) is approximately 66 million kl/annum (or ~180 ML/day). If we assume that 70% of the water supply will enter the sewerage system (i.e. ~126 ML/day), and if there was no leakage, we would expect the same quantity at the WWTWs (i.e. ~126 ML/day). Currently, the BCMM 15 WWTWs are receiving and treating ~107 ML/day. The calculated leakage within the sewer network is therefore approximately 18% ((126-107) / 107 = 18%), and this proportion of wastewater is therefore not delivered to the wastewater treatment works. We therefore assume that 82% is delivered to the centralised WWTWs for treatment.

Overall, for the 65% of the population serviced via off-site sanitation, this means that 53% of wastewater is contained and delivered for treatment, while 12% is not delivered to treatment. Once the wastewater reaches the WWTWs, it is treated to meet specified requirements. Considering the various flows per WWTW and associated overall effluent compliance per WWTW, an overall flow weighted compliance of 90% is noted (see table below). This implies that a small proportion of the wastewater is not treated effectively, and can pollute the environment. Overall, considering the 53% of wastewater that is contained and delivered for treatment, 48% of the wastewater is treated effectively, while 5% of the wastewater is not treated.

Table 2: Compliance for BCMM WWTWs

No.	Wastewater Treatment Works (WWTW)	Flow (Ml/day)	Overall Effluent compliance (%)
1	East Bank Sea Discharge	40.0	99%
2	Gonubie	18.0	84%
3	West Bank	40.0	95%
4	Central	5.0	77%
5	Reeston	12.5	93%
6	Mdantsane	24.0	79%
7	Potsdam	9.0	82%
8	Berlin	1.0	84%
9	Zwelitsha	9.3	80%
10	Dimbaza	7.0	90%
11	Scornville	6.0	86%
12	Breidbach	0.8	73%
13	Bhisho	0.8	76%
	Total	**173.4**	**90%**

NOTE: Information to be still verified

- Results only obtained for 13 WWTWs
  - Keysers Beach – do the ponds have no discharge/not monitored?
  - Kidds Beach – do the ponds have no discharge/not monitored?
  - Does Hood Point = West Bank?
- Seems to be design capacities and not actual flows?
- Capacities for some differ from that previously provided?
  - Gonubie – 6 vs 18 ML/day
  - Reeston – 2.5 vs 12.5 ML/day
  - Schornville – 5 vs 6 ML/day

Sludge compliance still needs to be determined.

- **Sludge compliance**
  - Information for all 15 WWTWs
  - According to categorisation of sludge – How do we categorise?
    - Acceptable for "intended use without further treatment/action"?
      - Marine outfall – ok as is, and can continue (what proportion of total is categorised as such)
      - Agricultural use – need to treat before beneficial use of sludge (what proportion of total is categorised as such)
      - Etc.
- We would aim to compile a table as below:

Plant	**Sludge quantity (kg/day)**	**Acceptable for "intended use without further treatment/action"?**	**Sludge quantity that is acceptable (kg/day)**	**"Compliance" (%)**
A	10	Yes	10	100%
B	5	Yes	5	100%
C	20	No	0	0%
Total	**35**		**15**	**Sludge mass weighted compliance** **= 15 / 35 = 43%**

On-site

Of the 5,437 conservancy tanks (concrete, sealed, fully lined), 80% (4,350) are considered to be in good condition (i.e. sealed, not leaking), while 20% (1,087) are considered to be in poor condition (i.e. possibly leaking to environment, but don't know where). Chemical toilets (3,544) as noted by StatsSA (2016) have been replaced my communal ablution blocks connected to a conservancy tank. As these structures are relatively new, it is assumed that 100% (3,544) are in good condition (i.e. sealed, not leaking). Therefore, a total of 4,350 + 3,544 = 7,894 (3.1% of total households) are considered to be in good condition, while 1,087 (0.4% of total households) are considered to be in poor condition. NOTE: As this percentage is less than 1% it is ignored within the SFD calculations. It is therefore assumed that all 8,981 (3.5% of total) conservancy tanks are in good condition. It is assumed that 50% of the faecal sludge is emptied from conservancy tanks by vacuum trucks (i.e. 4,490). It is assumed that 100% of the faecal sludge emptied from these conservancy tanks is delivered to the wastewater treatment works.

Of the total 39,536 VIPs, 17,000 are unlined (pre-2012), while 22,536 are lined with cement blocks and have an open bottom. BCMM have indicated that the intention is to empty VIPs every 5 years. BCMM note that they currently face an emptying backlog related to their VIPs. When VIPs are full, it is noted that households either find other means (e.g. open defecation, sharing facilities) or reuse old pit latrines. It is also estimate that 50% of VIPs are full or close to full. Therefore although BCMM acknowledge that they should be emptying approximately 4,000 VIPs/annum, they are currently only emptying around 500 VIPs/annum. It is therefore assumed that the proportion of this type of system from which faecal sludge is emptied is therefore 12.5% (500/4,000 = 12.5%) Therefore, 12.5% of the 22,536 lined VIPs (with cement blocks and open bottom) and 12.5% of the 17,000 unlined VIPs are emptied (i.e. 4,942 of 253,477 = 1.9%). It is assumed that 100% of the faecal sludge from these VIPs is delivered to the wastewater treatment works.

In addition, there are 16,444 unlined pit latrines in rural communities. As these communities have been self-reliant for many years, and as there should be sufficient space in the rural environment for locating a new pit, it is assumed that 100% (16,444) of these unlined pit latrines are properly covered when the pit is full and moved. As groundwater use is not feasible in large parts of BCMM and therefore not widely utilized, the risk of groundwater contamination is rated as 'low risk'. It is, however, noted that some communities are reliant on groundwater, and this could this is indicated as significant risk. If we know which communities are at risk from groundwater pollution, we can try and proportion the 16,444 pit latrines into GW high risk and GW low risk?

Of the total 39,536 VIPs, 87.5% is therefore contained, and not emptied (34,594). Furthermore, 100% (16,444) of the old and abandoned pit latrines are contained and not emptied. In addition, as it is assumed that 50% of the faecal sludge is emptied from conservancy tanks by vacuum trucks, the other 50% (4,490) remains within the conservancy tank (contained, not emptied). Considering this, faecal sludge for 22% of the total 253,477 households is contained, not emptied (i.e. 13.6% from VIPs, 6.5% from old pit latrines and 1.7% from conservancy tanks or 34,594 + 16,444 + 4,490 = 55, 528, which is 22% of the total 253,477 households). This is considered to be safely managed as it is adequately managed (e.g. covered when full and abandoned), with low groundwater risk.

Considering this, 22% of the faecal sludge is contained and not emptied, while 3% of faecal sludge is contained and emptied (i.e. (i.e. 1.9% from VIPs and 1.7% from conservancy tanks or 4,942 + 4,490 = 9,432, which is 3.7% of the total 253,477 households). As it is noted that alternative points of discharge do not appear to be feasible, it is assumed that all of the faecal sludge emptied from the conservancy tanks and VIPs is delivered to the wastewater treatment works (i.e. no illegal dumping). Therefore, 100% of the faecal sludge transported actually reaches the wastewater treatment works. Once it reaches the wastewater treatment works, and considering a weighted overall compliance, it is assumed that 90% of the effluent is treated to meet specified requirements. Similarly, sludge compliance is xxx%. The overall combined effluent and sludge compliance is therefore considered to be xxx%. It is therefore noted that of the 3% faecal sludge delivered to the treatment works, that 2% is safely treated, while 1% is not safely treated. **NOTE:** As the SFD Generator only allows input of whole numbers for the percentage breakdown per sanitation technology, treatment efficiency, etc. (i.e. can only enter 13%, and not 12.5%), some rounding issues might be noted.

Open defecation

Currently, 24,718 households are not serviced (i.e. ~10%). This is considered the sanitation backlog, and needs to be addressed. As BCMM do not know the sanitation practices for these households, it is assumed that current sanitation practices are unsafe, and that open defecation is occurring.

Table 3: Description of variables used in SFD

Variable	Description
W4a	WW delivered to centralized treatment plant
W5a	WW treated at centralized treatment plant
F3	FS emptied
F4	FS delivered to treatment plant
F5	FS treated

It can be concluded that excreta of 73% of the population is safely managed, and that 27% of excreta is discharged into the environment untreated. The following figure summarizes the percentages of the population using each sanitation technology and the method along the service chain.

Buffalo City, Eastern Cape, South Africa, 24 Oct 2018. SFD Level: 2 - Intermediate SFD
Population: 253477
Proportion of tanks: septic tanks: 50%, fully lined tanks: 50%, lined, open bottom tanks: 50%

System label	Pop	W4a	W5a	F3	F4	F5
System description	Proportion of population using this type of system	Proportion of wastewater in sewer system, which is delivered to centralised treatment plants	Proportion of wastewater delivered to centralised treatment plants, which is treated	Proportion of this type of system from which faecal sludge is emptied	Proportion of faecal sludge emptied, which is delivered to treatment plants	Proportion of faecal sludge delivered to treatment plants, which is treated
T1A1C2 Toilet discharges directly to a centralised foul/separate sewer	65.0	82.0	90.0			
T1A3C10 Fully lined tank (sealed), no outlet or overflow	3.0			50.0	100.0	90.0
T1A3C9 Fully lined tank (sealed) connected to 'don't know where'	0.0			0.0	100.0	90.0
T1A5C10 Lined pit with semi-permeable walls and open bottom, no outlet or overflow	9.0			13.0	100.0	90.0
T1A6C10 Unlined pit, no outlet or overflow	7.0			13.0	100.0	90.0
T1B11 C7 TO C9 Open defecation	10.0					
T1B7C10 Pit (all types), never emptied but abandoned when full and covered with soil, no outlet or overflow	6.0					

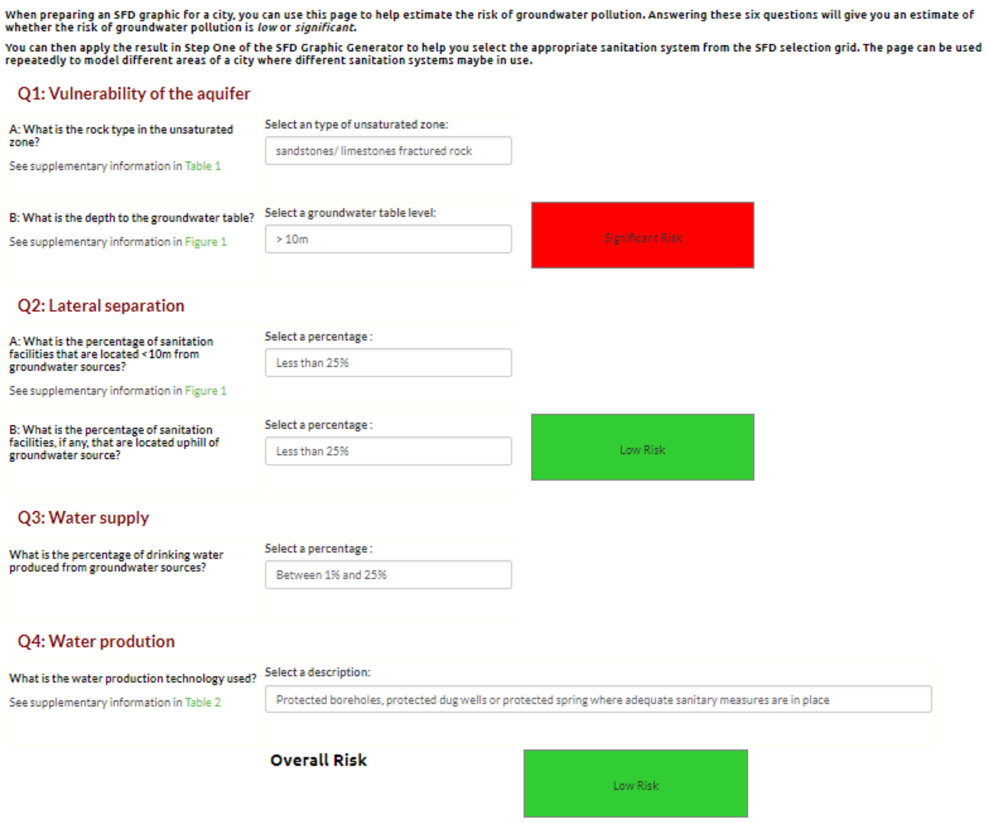
Figure 7: SFD Matrix for Buffalo City (2018)

2.2.2 Risk of groundwater contamination

Water for urban areas of Buffalo City is supplied from either the 2 BCMM owned drinking-water treatment plants or from the Amatola Water Board drinking-water treatment plants. Water is supplied via pipeline to households with the majority of households either receiving water via household taps or yard connections.

The groundwater potential in the region is generally not good, resulting in low borehole yields (generally below 2 L/s) and high salinity waters. Although some rural areas that BCMM inherited from Amathole District Municipality are still using groundwater resources (with little/no treatment and protection), BCMM is phasing this out (i.e. move to piped water supply). Therefore, although groundwater is not presently being used in large parts of BCMM, climate change impacts and the increasing water scarcity facing many parts of South Africa and the Eastern Cape should be considered, and use thereof in the future should not be discarded. As such groundwater should be protected as far as practically possible.

Any sanitation systems that are overflowing (e.g. old, damaged tanks, blocked sewerage lines) and that could pollute the environment (and possibly contaminate drinking-water treatment plant raw water sources and compromise the drinking-water supply) should be rectified soonest. There is a need to create awareness among BCMM citizens about the need to ensure that conservancy tanks are well maintained and that pit latrines/VIPs are adequately sealed when closed/moved/new pit dug, and of the effects of using polluted water.



3. Stakeholder engagement: key interviews

The relevant Buffalo City Metropolitan Municipality staff were contacted through e-mail, letter and telephone call prior to the visit to Buffalo City. The purpose of the SFD study and depth of data required was conveyed through an introductory letter to respective staff. Although a number of stakeholders of government departments were noted, this SFD study aimed to focus on interviews with staff from Buffalo City Metropolitan Municipality.

Interviews were held with the General Manager: Water, Wastewater and Scientific Services and Acting Manager: Sanitation, who were assisted with inputs by other relevant technical staff. As this was a desk-based research process, a site inspection and associated interviews with field-based staff and relevant service providers was were not conducted. Discussions were not held with members of the public (i.e. private citizens) or with focus groups.

A site inspection and associated field-based interviews will assist with verifying data obtained from BCMM published reports (e.g. IDP, WSDP), and help in understanding the existing situation and upcoming developments in the sanitation sector for BCMM.

4. Acknowledgements

This report was compiled for a Water Research Commission project and as part of the SFD Promotion Initiative. We would like to thank Mr. Mark Westerberg, General Manager: Water, Wastewater and Scientific Services and Mr. Mkhuseli Nongogo, Acting Manager: Sanitation and all participating Buffalo City Metropolitan Municipality staff for giving time and necessary information for the assessment. A special thanks to Shantanu Kumar Padhi and Amrita Bhatnagar of CSE for their supervision and guidance during the assessment and report writing.

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6. Appendix

6.1 SFD Matrix

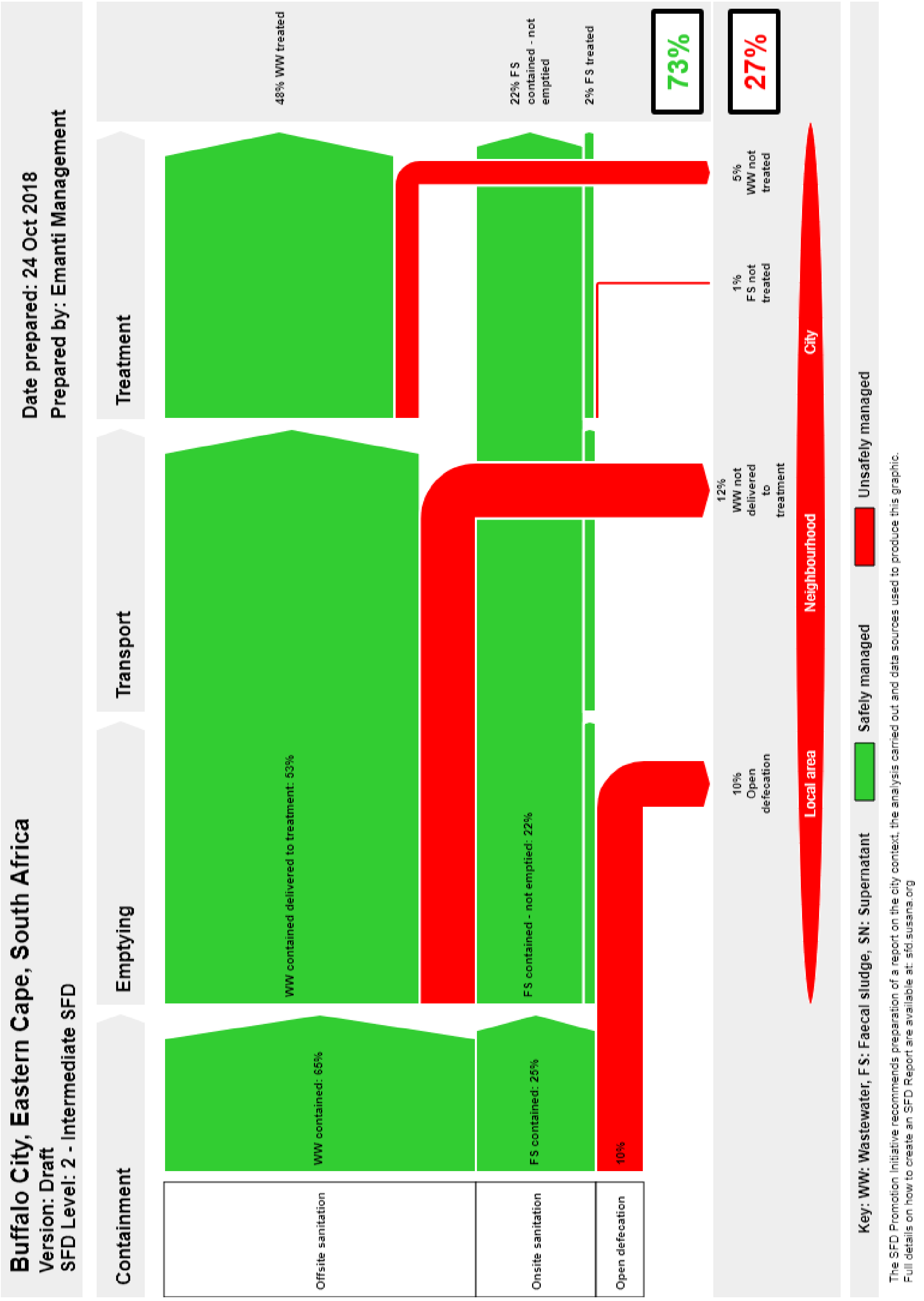

Figure 8: SFD matrix

6.2 Stakeholder identification

Table 4: Stakeholder identification

No.	Stakeholder group	In Buffalo City context
1	City council / Municipal authority / Utility	Water Services Authority (WSA): Buffalo City Metropolitan Municipality Water Services Provider (WSP): Buffalo City Metropolitan Municipality, Amatola Water
2	Ministry in charge of urban sanitation and sewerage	National: Department of Water and Sanitation Provincial: Department of Water and Sanitation (Eastern Cape)
3	Ministry in charge of urban solid waste	National: Department of Environmental Affairs Provincial: Department of Economic Development, Environmental Affairs & Tourism of the Eastern Cape (DEDEAT)
4	Ministry in charge of urban planning, finances and economic development	National: Department of Human Settlements Provincial: Eastern Cape Department of Human Settlements National: National Treasury Provincial: Eastern Cape Provincial Treasury
5	Ministry in charge of environmental protection	National: Department of Environmental Affairs Provincial: Department of Economic Development, Environmental Affairs & Tourism of the Eastern Cape (DEDEAT)
6	Ministry in charge of health	National: Department of Health Provincial: Eastern Cape Department of Health
7	Service provider for construction of on-site sanitation technologies	Various, by tender appointment
8	Service provider for emptying and transport of faecal sludge	Various, by tender appointment
9	Service provider for operation and maintenance of treatment infrastructure	N/A Performed by Buffalo City Metropolitan Municipality
10	Market participants practicing end-use of faecal sludge end products	N/A
11	Service provider for disposal of faecal sludge (sanitary landfill management)	N/A
12	External agencies associated with faecal sludge management services (e.g. NGOs, academic institutions, donors)	N/A

6.3 Tracking of engagement

Table 5: Tracking of stakeholder engagement

Name of organization	**Name of contact person**	**Designation**	**Date of engagement**	**Purpose of engagement**
Buffalo City Metropolitan Municipality	Mark Westerberg	General Manager: Water, Wastewater and Scientific Services	5^{th}, 20^{th} and 24^{th} July 2018, 1^{st} August 2018	Introducing SFD, securing support for project
Buffalo City Metropolitan Municipality	Mkhuseli Nongogo	Acting Manager: Sanitation	24^{th} July 2018, 1^{st} August 2018	Introducing SFD, securing support for project
Buffalo City Metropolitan Municipality	Mark Westerberg	General Manager: Water, Wastewater and Scientific Services	15^{th} August 2018	Data collection, collation, verification and key interviews
Buffalo City Metropolitan Municipality	Mkhuseli Nongogo	Acting Manager: Sanitation	15^{th} August 2018	Data collection, collation, verification and key interviews
Buffalo City Metropolitan Municipality	James Maher	Technician: Information Management	15^{th} August 2018	Data collection, collation, verification and key interviews
Buffalo City Metropolitan Municipality	Dunyiswa Ntsebeza	Engineer: Sanitation	15^{th} August 2018	Data collection, collation, verification and key interviews
Buffalo City Metropolitan Municipality	Tumeka Menjenjalo	Senior Technician: Sanitation	15^{th} August 2018	Data collection, collation, verification and key interviews
Buffalo City Metropolitan Municipality	Mark Westerberg	General Manager: Water, Wastewater and Scientific Services	-	Data gaps, follow-ups
Buffalo City Metropolitan Municipality	Mkhuseli Nongogo	Acting Manager: Sanitation	-	Data gaps, follow-ups
Buffalo City Metropolitan Municipality	Mark Westerberg	General Manager: Water, Wastewater and Scientific Services	-	Draft report review and finalisation
Buffalo City Metropolitan Municipality	Mkhuseli Nongogo	Acting Manager: Sanitation	-	Draft report review and finalisation