# SFD Lite

# Manaus
# Brazil

The SFD Lite Report was prepared by GFA Consulting Group GmbH.

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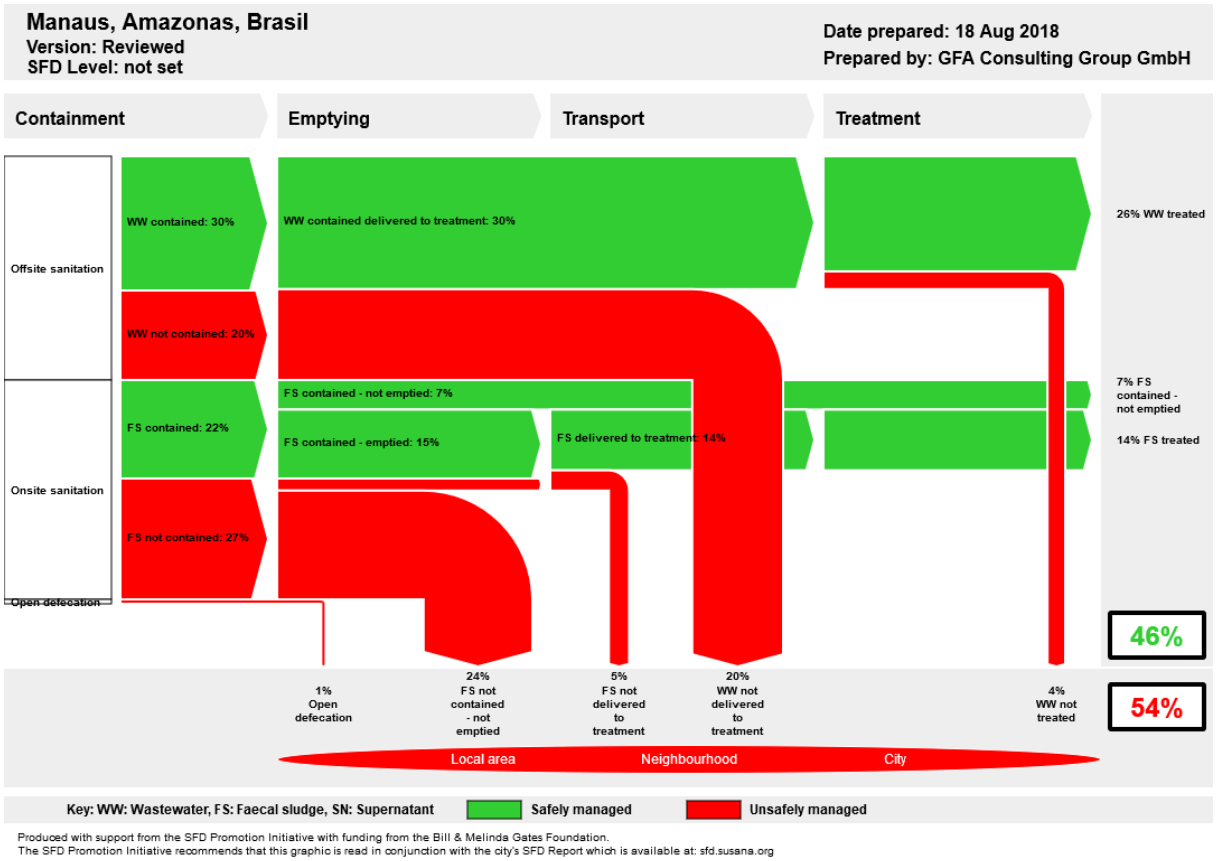
# 1 The SFD Graphic




Produced with support from the SFD Promotion Initiative with funding from the Bill & Melinda Gates Foundation.
The SFD Promotion Initiative recommends that this graphic is read in conjunction with the city's SFD Report which is available at: sfd.susana.org

# 2 SFD Lite information

**Produced by:**

- GFA Consulting Group GmbH.
- This SFD Lite was produced by Giuliana Talamini (main author) with inputs from Alejandra Burchard (all from GFA Consulting Group) in the scope of the project "GIZ Sector Programme Sustainable Sanitation – Production of 10 SFD reports for cities around the world", financed by GIZ.

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# 3 General city information

The Municipality of Manaus is the capital of the Amazonas State and is located in the Northern Region of Brazil. The Hydrographic Region is called Amazonian and occupies 45% of the national territory. It has an extensive network of rivers with a great abundance of water, such as the most known: Amazonas, Xingu, Solimões, Madeira and Negro rivers. The population density is 10 times lower than the national average. However, the region concentrates 81% of the country's surface water availability. About 85% of the area of the Amazon Basin remains with native vegetation coverage (ANA, 2014).

Manaus is the largest city in the Amazon and the seventh largest city in Brazil, located on the left bank of the Rio Negro, at the confluence of the aforementioned river and with the Solimões River occupying an area of approximately 500km². However, its municipal territory is still 11,401 km² and has an estimated population of 2,130,264 in 2017, according to IBGE, with a concentration of 99.5% in the urban area and a population growth between 2016 and 2017 of 1.71%. However, due to the stimulation of the creation of the Manaus Free Economic Zone in 1957, the municipality grew in an intense and largely disordered way, creating a great liability for the municipality that remains to this day. Currently the population density is 158 hab/km².


**Figure 1: Manaus Map, Amazonas State, Brazil (Google Maps, 05/09/2018)**

The territory of Manaus presents a slightly wavy physiography, with altitudes varying from 25 to 100 meters. The climate of Manaus is classified as hot and humid equatorial, with an average temperature for the coldest month always higher than 18ºC. Manaus has rainfall occurrences throughout the year, above 60 mm during the driest month. The average rainfall over the city is about 2,300 mm/year (ROVERE et al., 2002).

Manaus is cut by several "igarapés" which signifies watercourses of the Amazon region characterized by shallow and long rivers or channels. The natural network of these waterways determined the layout of the neighbourhoods, and even the marking of the streets of Manaus.

The main challenges facing Manaus in relation to sanitation services are irregular territorial occupations intensified by the high rate of population growth combined with a high rate of urbanization. In addition, the low adhesion of the population to the public system sewer collecting network leads to the existing very low level of service. The presence of the “igarapés” in the city also brings about technical and planning challenges for the construction of the sewer collecting network and the treatment stations infrastructure.

# 4 Service outcomes

**Table 1: Manaus, Amazonas, Brazil SFD Matrix**

Manaus, Amazonas, Brasil, 18 Aug 2018. SFD Level: not set
Population: 2130264
Proportion of tanks: septic tanks: 100%, fully lined tanks: 100%, lined, open bottom tanks: 100%

| System label | Pop | W4a | W5a | W4b | W5b | W4c | W5c | 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 wastewater in sewer system, which is delivered to decentralised treatment plants | Proportion of wastewater delivered to decentralised treatment plants, which is treated | Proportion of wastewater in open sewer or storm drain system, which is delivered to treatment plants | Proportion of wastewater delivered to 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<br>Toilet discharges directly to a centralised foul/separate sewer | 10.0 | 99.0 | 100.0 | | | | | | | |
| T1A1C4<br>Toilet discharges directly to a decentralised foul/separate sewer | 20.0 | | | 99.0 | 80.0 | | | | | |
| T1A1C6<br>Toilet discharges directly to open drain or storm sewer | 12.0 | | | | | 0.0 | 0.0 | | | |
| T1A1C7<br>Toilet discharges directly to water body | 5.0 | | | | | | | | | |
| T1A1C8<br>Toilet discharges directly to open ground | 2.0 | | | | | | | | | |
| T1A1C9<br>Toilet discharges directly to 'don't know where' | 1.0 | | | | | | | | | |
| T1A2C5<br>Septic tank connected to soak pit | 22.0 | | | | | | | 70.0 | 75.0 | 100.0 |
| T1B11 C7 TO C9<br>Open defecation | 1.0 | | | | | | | | | |
| T2A6C10<br>Unlined pit, no outlet or overflow, where there is a 'significant risk' of groundwater pollution | 27.0 | | | | | | | 10.0 | 75.0 | 100.0 |

The city of Manaus has many irregular occupation areas that are concentrated, mainly in the banks of the “igarapés” in the central area of the municipality and on native vegetation in the peripheral areas. These areas lack management tools and capacities to offer public services capable of guaranteeing the sustainability of the territory, resulting in the population’s search for individualized alternatives for solutions to the needs in water supply and sanitation without complying with norms and legal requirements, due to its inexistence or lack of supervision.

**Figure 2: Examples of irregular occupations in Manaus (Folha de São Paulo,02/03/ 2018; Google Maps, 01/09/2018; ACritica, 28/03/2018)**

In the regular areas, the collective water supply and sewage services of the Municipality of Manaus are currently under the responsibility of the Concessionaire Manaus Ambiental SA and the sanitation company “Companhia de Saneamento do Amazonas”. These are responsible for the abstraction, treatment and raw water treatment and treated water transportation to the reservoirs in the area of “Complexo Programa Água para Manaus (PROAMA)”.

### 4.1 Sanitation services

Manaus has a centralized sewage collection and treatment system that covers the city centre and parts of adjacent neighbourhoods. The efficiency adopted for this process is only 30% of BOD removal. However, this efficiency is considered regular due to the large absorption capacity (flow rate) of the receiving body, the Negro River. The connection to the sewage collection system is mandatory. However, it is known that there is no efficient inspection to ensure that the population makes the connection. The reason for this is that in addition to paying the tariff, the costs related to the installation of the connection from the internal water installation to the public network is borne by the owner of the land.

The other solutions considered appropriate for sanitary sewage are the small sewage collection and treatment systems at the collective level and septic tanks at the individual level. Manaus has these two types of solutions. In 2007, Law N°1,192 was promulgated in the municipality, which created the Program for the Treatment and Rational Use of Water in Buildings - PRO-ÁGUAS. According to this law, new enterprises, private or public, with number of users of more than 40 (forty) people a day, in the urban and transition area devoid of public sewage system, are obliged to install a domestic sewage treatment system. Existing buildings also require a system that meets minimum standards of treatment efficiency. In these cases, the use of septic tanks is very common. According to the concessionaire “Manaus Ambiental” and enterprise “Sanear Limpa Fossas”, compliance with this legislation is heavily audited (KII 1, 2018, KII 2, 2018).

Thus, some entrepreneurs building residential complexes, residential condominiums and/or subdivisions, inserted into their projects sewage collection and treatment systems, which were later transferred to the concessionaire. According to concessionaire “Manaus Ambiental”, currently it operates 47 isolated systems, arranged throughout the city.

The use of septic tanks is very common in the municipality due to the low availability of network collection from the centralized system. The other solutions adopted for the destination of excreta are considered inadequate. Among these, we could identify the so-called "rudimentary pits" or black pits. According to IBGE, a rudimentary septic tank is defined as *"a device destined for the disposal of sewage in the soil, coated or not, but that allows liquid infiltration into the soil without separation of the solid part. The rudimentary pits are intended to receive, accumulate and dispose of sewage from sinks, toilets, showers, tanks, etc., and are usually characterized as sinks where septic tanks have not been installed upstream*.”

In addition, trenches that discharge the sewage coming from toilets directly into the soil are identified, and flow to the nearest water body, then discharges directly into the river. This is observed mainly in the irregular occupations located on the banks of the streams and in a small percentage of the population practicing open defecation.

### 4.2 Groundwater contamination

Among the water resources used by the collective water distribution system in Manaus, 80% come from surface waters of the Negro River and 20% from groundwater from the Alter do Chão Aquifer (ANA, 2010). Considering that only 88% of the population has access to the collective distribution system, it is estimated that the remaining approximately 12% use individual solutions such as wells for water supply. Thus, approximately 32% of the population of Manaus consumes water from an underground source. The Alter do Chão Aquifer in Manaus is mostly free and occupies the entire area of the city, which is about 500 $km^2$. The average thickness is 160 meters of saturated area and the average depth of the water level is approximately 30 meters (CPRM, 2012). The soils are described as clayey, sandy-clayey, and sandy and Arenito Manaus, consisting of fine-grained to medium sandstones with effective porosity estimated at 18%.

The indiscriminate use of wells and the absence of effective regulation leads to poor construction quality and the lack of sanitary sewage services, which make the availability of this groundwater source more and more compromised, both in quantitative and qualitative terms. Conclusively, considering that 12% of the population uses wells for consumption, the analysis of the risks of groundwater contamination in Manaus is considered high.

### 4.3 Positive and negative highlights contributing to the percentages in the SFD Graphic

The SFD graphic of the municipality of Manaus allowed us to make an integral reading of the sanitation situation regarding the disposal of excreta and domestic effluents. It is noteworthy that, of the estimated population that has a safe and adequate solution (46%), most adopt alternative individual and collective solutions. There is much difficulty in finding formal sources of information regarding maintenance services (emptying), transportation and final destination of the waste (sludge). It would be fundamental to increase transparency and improve ease of access to information, as well as integrate databases that are dispersed on different platforms. More than half of the population does not have safe and adequate systems to dispose their sewage (54%). The impact of this service gap is extremely noticeable and high. This is because most of these effluents are concentrated in the location where it was generated, increasing the risk of contact that leads to health problems and several other negative consequences for those living in the neighbourhood. In addition, the presence of the high number of streams that end up being the destination of much of this effluent and waste, affect the environment in general and expose the population to the problem.

In order to advance in the search for a solution, cooperation and integration between the institutions responsible for urban planning seems necessary. Improved construction and implementation of adequate public policies for this municipality are needed together with strong support from monitoring and inspection actions; by the company that plans, builds and operates the collection and treatment systems; and, finally, by the population itself, which must recognize the importance of seeking proper solutions.

## 5 Data and assumptions

This section will provide information on the data sources used and the assumptions adopted in the definitions of percentages of sewage systems and faecal sludge management in Manaus.

### 5.1 Sources of data

The “ATLAS Esgotos”: Depollution of Watersheds published by the National Water Agency (ANA), contemplates the diagnosis of sanitary sewage in Brazil for municipal urban areas exclusively. The 2010 Census - Brazilian Institute of Geography and Statistics (IBGE), is the only integral source of information for population living conditions in all municipalities. The main limitation of this statistical research is the inability to differentiate the part of the population that is connected to the sewerage network from the part that is connected to the drainage network.

The Basic Sanitation Information System coordinated by the Ministry of Cities gathers information provided by water supply and/or waste water treatment services. As there is no audit on the information sent, we note high variations in the indicators that refer to service coverage. The interview with “Manaus Ambiental” and “Sanear Limpa Fossa” resulted in supporting information to predict the approximate percentages in a more current context. Therefore, we use as a reference the year 2017.

### 5.2 Assumptions

The SFD matrix was filled with the following information and assumptions:

- The total population of the municipality in 2017 was 2.130.264. The urbanization rate of the municipality is 99.5% (IBGE).
- In 2013, the total population of the municipality was 1.982.177, such us that 1.972.131 people lived in urban areas and 10.046 people lived in rural areas. This gives a proportion of urban occupation of 99.5% (IBGE, ANA, 2017). According to the latest SNIS information, in 2016, the total population served by collective sewage services (ES001) was equal to the urban population served (ES026), i.e. it is assumed that no sewage collection system is available in the rural area of the municipality of Manaus.
- In 2013, the urban population served by the collective sewage and treatment system was 28.6% (ANA, 2017). Considering the rural population, which do not have access to the collection

network, this proportion decreases to 28.45%. It is estimated that in 2017 this percentage is approximately 30%.

- According to SNIS information, the population served by the centralized system operated by the "Manaus Ambiental" concessionaire ranged from 9% in 2013 to 10% in 2016. In 2017, according to "Manaus Ambiental" concessionaire, we can consider that 10% of the population was connected to the centralized system, although there are collecting networks available to serve 20% of the population. The sewage collection and treatment service in Manaus grows in a coordinated way that the population served by the collective system whose sewage was collected and treated is 100%. However, it is known that it is common in any urban infrastructure system to have for several reasons leaks. Thus, we assume that 99% of the sewage collected is in fact reaching the Waste Water Treatment Plant (WWTP), which, in turn, treats 100% of the raw effluent entering.
- Considering also the isolated or decentralized systems operated by private individuals according to the "Atlas Esgotos", in 2013, there were 74 sewage treatment plants that integrated decentralized systems serving 13% of the total population of the municipality. According to the "Manaus Ambiental" concessionaire, currently, this percentage can reach up to 20% of the population of the municipality. Again, although all systems have their treatment plants, it is estimated that 99% of the sewage collected actually arrives at the WWTP. Regarding the efficiency of the treatment of these WWTP, it is known that there is a strong legal requirement and an active control by the municipality. However, it is not possible to say that 100% of the WWTP are operating efficiently. Therefore, it would be reasonable to adopt a percentage of 80% treatment of raw incoming effluent.
- The urban population served by individual septic tank solutions in 2013 was 22.09% (ANA, 2017). Taking into account the rural population, which according to the 2010 IBGE Census also uses septic tanks in the proportion of 0.1%, the percentage of 22% remains. As there is no more recent information on this solution and considering population growth, it is assumed that this index is still accurate for 2017.
- No databases have been identified regarding emptying, transport and disposal of sewage sludge. However, it is known that the active control of areas and buildings located in regular areas, especially those with commercial and industrial characteristics and with more than 40 people/day, which possibly represent a large part of this percentage, leads to an adequate operation of their septic tanks. Thus, it is estimated that 70% of the population performs the emptying of septic tanks with the frequency necessary for the maintenance of its operation.
- According to the company "Sanear Limpa Fossas" (KII 2, 2018) that performs septic tank maintenance services in Manaus, there are currently 20 companies that empty septic tanks using vacuum trucks, tank trucks, all licensed by environmental agencies (IPAAM and SEMMAS). However, the inspection activity of these agencies is still in the process of implementation, and the process of satellite tracking of sludge transport, which has not yet been completed, has recently begun. This means that not all companies carry out adequate disposal in appropriate treatment plants to receive such waste. It is estimated that 5 out of 20 companies do not empty their sludge to these stations, and can dispose it in the sewerage network of the service provider or directly into the environment. Thus, it is assumed that only 75% of the collected sludge is actually sent to treatment plants and that, due to legal requirements, these plants treat 100% of the sludge they receive.
- In the 2010 Census survey, we have that 27% of the total population of Manaus contained their sewage in rudimentary pits, possibly concentrated in irregular areas. Considering that there is no more recent information on this solution, the increase of the population between 2010 and 2017 and the low growth of the service by collecting networks in the period, it is assumed that this index is still valid in 2017.
- Due to the unclear definition of this system, which goes from a soak-pit-type construction to a simple hole with no coating that can be abandoned when filled, we assume that a small part of this population empties the sludge. In this way, we understand that no more than 10% of the total that uses these systems used services of the clean-pit trucks to discard the sludge in

another location. As explained above, for the transport and treatment of sludge in the municipality of Manaus, it is estimated that 75% of those collected is sent to a licensed WWTP that treats 100% of the waste it receives.

- The 2010 Census survey also differentiated those households whose sewers were open-pit ditches through which open sewage flows into streams or drainage systems, crossing house lots or public roads, corresponding to 2% of the total population; and those whose sewage was discharged directly into the river or watercourse, accounting for 5% of the total population. In addition, 1% of the solutions did not fall into the categories of the study (network, septic tank, rudimentary, trench and water courses); and those who did not have a bathroom, corresponding to 1% of the population. Again, considering that there is no more recent information on this solution, the population increase between 2010 and 2017 and the low growth of the service by collecting networks in the period, it is assumed that these indexes were still valid in 2017.
- Thus, by crosschecking data from the available systems and considering all the points mentioned above, it is estimated that 12% possibly represents the population that is connected to the drainage network of the municipality.

**Table 2: Comparative table of definitions for the SFD methodology**

| | *Type of Containment – Brazil (Portuguese)* | *Type of Containment - SFD* | *Population Proportion (Estimated for 2017)* |
|---|---|---|---|
| ***Offsite Containment*** | Rede coletora de esgoto | T1A1C2 - to centralised foul/separate sewer | 10% |
| | Rede coletora de esgoto | T1A1C4<br>User interface discharges directly to a decentralised foul/separate sewer | 20% |
| | Rede pluvial | T1A1C6 - to open drain or storm sewer | 12% |
| | Valas à céu aberto | T1A1C8 - to open ground | 2% |
| | Córregos e Rios | T1A1C7 - to water body | 5% |
| | Outros/Sem informação | T1A1C9 - to 'don't know where' | 1% |
| ***Onsite* Containment** | Fossa Séptica | T1A2C9 - to 'don't know where' | 22% |
| | Fossa Rudimentar | T2A6C10<br>Unlined pit, no outlet or overflow, where there is a 'significant risk' of groundwater pollution | 27% |
| **Without toilets. Open Defecation** | Sem banheiro | T1B11 C7 TO C9<br>Open defecation | 1% |

# 6 List of data sources

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KII 1, 2018. Interview with the Director of Regulation and Environment of Manaus Ambiental. Phone Interview on 04 of September 2018.

KII 2, 2018. Interview with the Business Development Director of Sanear Limpa Fossas. Phone interview on 16 of August 2018.