CASE STUDY 9

Decentralised wastewater treatment system

Makassar,
Indonesia

SNV

UTS Institute for Sustainable Futures

Background

Treatment selection and purpose

Community-managed anaerobic decentralised wastewater treatment systems (DEWATS) offer sanitation solutions in low-income, densely populated urban settlements. There are 147 DEWATS in Makassar registered to UPTD (Unit Pelaksana Teknis Daerah: Regional Technical Implementation Unit), an independent government unit under the Public Works and Housing Office. This unit provides monitoring of these simplified sewer systems. However, the daily operation and maintenance (O&M) of each DEWATS is managed by a local community group. Implementation and construction of DEWATS is supported by the national budget, international and local grants, and international loans. The Abbulo Sibatang DEWATS, which is the focus of this case study, was built through an Asian Development Bank-funded project in 2011.

The Abbulo Sibatang DEWATS technology was chosen based on community demand and limited land availability. Local government primarily constructed the DEWATS at the community's request, due to a lack of adequate sanitation. The community had seen the DEWATS in a neighbouring area and decided it would be suitable for their needs. A densely populated city, limited land availability was another key consideration. As such, a simplified DEWATS sewer system, which is constructed underground, was the preferred option.

Once the community demand was established in Abbulo Sibatang, UPTD and the Public Works and Housing City Office in Makassar assessed the proposal. This was followed by an open procurement process to select an independent vendor to design the facility, the pipe network, and the household connections. This is the standard procurement process followed for all DEWATS in Makassar. and the Head of the Wastewater Management Division in the Public Works and Housing City Office makes the final decisions on the selection of the vendor and the type of DEWATS.

> *We received a programme from the Ministry of Public Works and Housing to build the DEWATS. They gave us the manual and the design for the technology they had decided on. We socialised the technology to the community and they perceive that DEWATS is quite a simple technology and does not need a big area, hence suitable to implement in here.*
>
> **INTERIM SECTION HEAD OF SANITATION AND CLEAN WATER DIVISION, CITY PUBLIC WORKS OFFICE**

Abbulo Sibatang DEWATS

Description of the system

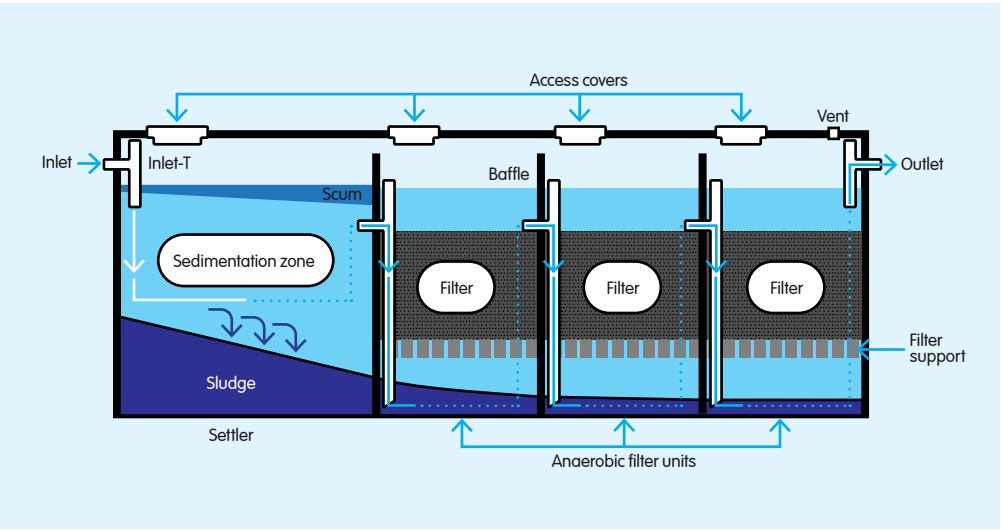
The Abbulo Sibatang DEWATS is a modular passive anaerobic treatment system designed to treat domestic wastewater, including greywater and blackwater. The wastewater comes from approximately 50 households and is delivered to the DEWATS via underground pipes.

The treatment process consists of four main steps beginning with sedimentation in a septic tank, labelled as Zona Pengendapan (sedimentation zone; step one) in Figure 1. Step two involves anaerobic digestion in anaerobic baffled reactors, where the removal of easily degradable organic solids is achieved by forcing the wastewater to flow through a series of chambers separated by baffles. The baffles provide resistance to the flow, thereby increasing contact time between the wastewater and the active biomass (sludge). The third step involves anaerobic decomposition and filtration through anaerobic filters, which dislodges degradable solids that are more difficult to remove. These chambers are filled with bioballs: plastic balls whose jagged shapes create increased surface contact between the organic pollutants and the organisms in the active sludge, resulting in organic digestion. The main function of the bioballs is not filtration, but rather to provide maximum surface contact. Because the bioballs are packed within the chamber (like a fixed-bed filter), they provide additional resistance to the particles containing organic matter and hence they also serve a filtration function. The fourth treatment step involves post-sedimentation and filtration. Here, the removal of digested solids and active bacteria mass occurs. Some DEWATS in Makassar use horizontal gravel filters for this process.

Installation of DEWATS technology

Comparison of concrete and lightweight iron cover for inspection chamber cover

Figure 1. Standard DEWATS treatment flow diagram,[1] adapted by SNV



[1] E. Tilley, L. Ulrich, C. Lüthi, Ph. Reymond, R. Schertenleib and C. Zurbrügg, *Compendium of sanitation systems and technologies*, 2nd revised edition, Dübendorf, eawag, 2014, p. 78.

The disposal of treated effluent and sludge is the final step in the treatment system. Treated wastewater moves to the filtration chamber, from where it is pumped via the outlet to the main city drainage. These open channels, which do not separate the sewerage and stormwater, flow to a nearby river downstream. The sludge generated from the DEWATS is removed and paid for by UPTD every three months and disposed of at the Makassar FSTP. Some of the treated effluent from the Abbulo Sibatang DEWATS is stored in local holding tanks and reused to water plants in the neighbourhood. However this is done without additional filtration or disinfection. Inspection chambers/manholes along the path of the treatment systems allow for access to perform bacteria seeding, repairs, desludging, and inspection of the DEWATS underground.

Table 1. Abbulo Sibatang DEWATS

	Abbulo Sibatang DEWATS
Design capacity	20 m^3/ day of greywater and blackwater
Operating capacity	9 m^3/ day of greywater and blackwater
Operating costs	US$ 2,090 per year (estimated at 5% of capital expenditure)

Regulatory environment and compliance

The UPTD ensures effluent quality is checked regularly, following the national Ministry of Environment and Forestry Effluent Standard (PermenLHK No. 68, year 2016). Due to the significant number of DEWATS in Makassar and budget limitations, effluent quality checks are conducted for approximately 60 of the 147 DEWATS in a year, resulting in each DEWAT being checked approximately every two years. Table 2 shows effluent quality for the Abbulo Sibatang DEWATS in 2019.

Generally, the waste input is quite homogenous as it comes from domestic households. However, there have been cases of home industries draining their contaminated wastewater into the DEWATS, which results in the treatment process breaking down. In this situation the UPTD requests these households not to drain their industrial or commercial wastewater into the DEWATS or the household connection is cut. No influent quality checks are conducted by UPTD as to the type and quality of wastewater from households (mostly kitchen, bathroom, and toilet). Furthermore, UPTD considers effluent quality checks to be more crucial, and UPTD's limited budget means both effluent and influent quality checks are not possible.

Table 2. Effluent quality for the Abbulo Sibatang DEWATS in 2019 as compared to quality standard

Parameter	Effluent quality	Standard (No. 68/2016)[2]
pH	7.3 pH	6-9 pH
Total suspended solids, TSS	24 mg/L	30 mg/L
Ammonia	2.0 mg/L	10 mg/L
Biochemical oxygen demand, BOD5	48 mg/L	30 mg/L
Chemical oxygen demand, COD	148 mg/L	100 mg/L
Grease and oil (mg/L)	<0.9 mg/L	5 mg/L
Total coliform (MPN/100 ml sample)	>160	3,000

The waste input to the DEWATS is almost consistent since it comes from domestic household. But sometimes there is a home industry that discharges their wastewater to the DEWATS, which causes the DEWATS to not work properly. We can tell that from the unpleasant smell coming from the DEWATS' effluent.

CHIEF OF THE UPTD, MAKASSAR'S WASTEWATER UPTD

[2] *Regulation of Ministry of Environment and Forestry of the Government of Indonesia* (2016) Permen LHK No. 68/2016

Operation and maintenance: realities and challenges

Realities of operation and maintenance

Financing mechanism

Household payments and the local city-allocated sanitation budget are used to operate and maintain the DEWATS. Operating costs and minor repairs are covered by the monthly household payments of US$ 1 per household, with collection and disbursements of the payments managed by the community committee treasurer. The exact amount charged is based on the agreement of all households.

Examples of continuous operating costs include monthly electricity bills, incentives for temporary technicians, and regular cleaning. Minor repairs cover the replacement of manholes or fixing broken pipes.

UPTD is responsible for major repairs, such as replacing any damaged infrastructure or flushing clogged pipes, with funding coming from the 2% of Makassar city's budget that is reserved for sanitation.

Community beneficiary group responsibilities and UPTD support

Each DEWATS location has a community management group with a working committee that is supported by UPTD to ensure the construction and continued O&M of the DEWATS. Each community management committee comprises a chief, secretary, treasurer, technician, and a campaigner (to socialise DEWATS related activities with the beneficiary group). In constructing the DEWATS, the community groups provide the labour, while the government provides all materials, expert technicians, and additional construction workers. While the community groups provide the labour, each community decides whether payment is provided or not. In the Abbulo Sibatang case, labour was paid for from the collected fees.

For the continued O&M of the DEWATS, the community technician is trained by UPTD. The UPTD receives support from IUWASH PLUS, a USAID-funded sanitation development project, in developing the training modules. Training covers the Standard Operating Procedures (SOPs) of the DEWATS, the Occupational Health and Safety (OHS) measures required, and sensitisation on the need to keep the DEWATS pipe network and manholes free of garbage, grease, and oil. The OHS measures include advice that personal protective clothing such as safety vests, gloves, hard helmets, hard boots, and masks should be worn. However, in reality the community group technician and workers do not follow this advice, perhaps because of discomfort due to hot weather conditions.

Inlet of the DEWATS

DEWATS tap for reused water in Abbulo Sibatang

The UPTD receives regular capacity development training from the Ministry of Public Works and Housing and the IUWASH PLUS expert team. This training includes comparative visits to other wastewater facilities and programmes. The training UPTD receives is then passed on to community groups.

Bi-monthly monitoring and evaluation of the DEWATS is also conducted by UPTD, with key activities including monitoring the condition of the manhole, the inspection chamber, and the physical quality of the wastewater input and output (colour, turbidity, smell, etc.).

> *The UPTD gives training to the community beneficiary group once a year, to every group in Makassar. The training encourages the group to maintain the DEWATS by not disposing any garbage to the manhole or disposing grease and oil to the sink that leads to the DEWATS. We advise them to put a grease trap in the inspection chamber.*
>
> **CHIEF OF THE UPTD, MAKASSAR'S WASTEWATER UPTD**

Challenges of operation and maintenance

Construction process objections and challenges

Community reservations about installing a DEWATS in their neighbourhood led to delays in construction and underutilisation of the Abbulo Sibatang DEWATS. Part-way through construction, community group members who had initially supported DEWATS connection decided against it. This is a common issue faced in constructing DEWATS, as many community members fear that the DEWATS will impede their access roads and that their houses may get damaged. As such, the Abbulo Sibatang DEWATS is only operating at 45% of its intended design capacity due to the significant number of households who pulled out after construction had begun.

Blockages and contaminated systems

Clogged manholes, pipes, and screens are some of the key maintenance challenges faced by the Abbulo Sibatang DEWATS. Clogging of manholes is a minor issue that many of the community groups are able to fix themselves. When they lack the technical skills needed, they call on the UPTD for support. Usually, community groups can also take the first steps in attempting to flush out clogged pipes. When this does not work, UPTD staff support is required to operate more sophisticated equipment. Clogged pipes are also often related to the iron bar screens becoming corroded and broken, which then allows solid waste to flow into the system.

> *Sometimes, the community groups ask UPTD to support the maintenance of clogged pipes, which requires us to use heavy equipment. We often faced difficulties in accessing the reported DEWATS when it is located in a narrow alley.*
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> **UPTD STAFF**

Another key issue which can contaminate the system is breakage of the piped connections to the DEWATS. In several cases households who no longer wanted to be connected to the DEWATS due to clogging and perceptions of bad odours, decided to cut the pipes connecting their household to the sewer system. They did so without informing the community group or UPTD. This led to the DEWATS being contaminated with city drainage waste, as the inlet pipes were left exposed, resulting in a disruption to the DEWATS treatment process.

Personal protective equipment worn by UPTD workers when conducting field visits

DEWATS vs. household septic tanks

In some cases, operators felt that household septic tanks were a more effective sanitation solution in Makassar than DEWATS. Due to the densely populated urban setting of Makassar, finding sufficient land area to build DEWATS is challenging. In many cases the DEWATS are built underground (often under the road) to respond to this challenge. However, this type of construction is difficult as there are many other utilities underground, which need to be left undisturbed. Furthermore, if the reinstatement of the road after the DEWATS construction is deemed unsatisfactory by the local community, it leads to a public outcry with households sometimes cutting off their connection to the DEWATS or refusing to connect to the system due to a breakdown in communication and trust. In such cases, some operators have thought that until city-scale sewerage systems can be implemented, individual septic tanks could be a more cost-effective interim solution than a DEWATS.

Informed choice considerations	Abbulo Sibatang DEWATS, Indonesia (UPTD)
Operating & design capacity	Design capacity = 2,500 m^3/day of greywater and blackwater Operating capacity = 250-500 m^3/day of greywater and blackwater
Costs and revenue	Capital expenditure, CAPEX = US$ 41,870 Operational expenditure, OPEX = US$ 2,090
Energy requirements	Passive system (using minimal to no energy) that uses gravity for the wastewater to flow through the system; some DEWATS require a pump if they are unable to use gravity and they need to pump some wastewater through the system
Output characteristics	Effluent liquid quality (Effluent limit as per environmental compliance standard PermenLHK No. 68 year 2016): pH = 7.3 (6-9); TSS 24 mg/L (*30 mg/L*); BOD 48.32 mg/L (*30 mg/L*); COD 148.06 mg/L (*100 mg/L*); Total Coliform >160 MPN/100ml (*3000 MPN/100ml*)
Land requirement	Land area was a constraint so they chose the DEWATS technology, which can be constructed underground, with total above-ground land area for 50 households: approximately 21 m^2
Reuse	Minimal reuse of treated water for facility gardening purposes only
Skills & human resources requirements	Each DEWATS daily O&M is assured by the community management group (total of 15 people, including chief, secretary, treasurer and technician) and more extensive O&M, as well as monitoring of the DEWATS, provided by UPTD (10 staff)
Technology/material local availability	All equipment and materials locally available (in Makassar City or within Indonesia)

References

Regulation of Ministry of Environment and Forestry of the Government of Indonesia (2016) Permen LHK No. 68/2016

Tilley, E., Ulrich, L., Lüthi, C., Reymond, Ph., Schertenleib, R. and Zurbrügg, C., *Compendium of sanitation systems and technologies, 2nd revised edition*, Dübendorf, eawag, 2014.

This paper is a chapter in a publication of nine case studies presenting real-life faecal sludge and wastewater treatment practices. The stories were narrated by plant owners, operators, SNV staff, and partners in Indonesia, Bangladesh, Kenya, Zambia, Malaysia, India, South Africa, and Benin. The full publication was reviewed by Antoinette Kome and Rajeev Munankami, and available for download at: https://snv.org/cms/sites/default/files/explore/download/2021-treatment-technologies-in-practice-snvisf-uts-full-publication.pdf.

Citation: ISF-UTS and SNV, *Treatment technologies in practice: On-the-ground experiences of faecal sludge and wastewater treatment*, The Hague, SNV Netherlands Development Organisation, 2021.

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