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Consolidation of small wastewater treatment plants

1. INTRODUCTION

Due to the growing challenges in the field of municipal wastewater disposal, the issue of consolidating small wastewater treatment plants is increasingly coming into focus. On the one hand, the demands on treatment performance are increasing due to legal requirements such as the EU Water Framework Directive, and on the other hand, the ongoing shortage of skilled workers is making it increasingly difficult to provide comprehensive support for small plants. Added to this is the high energy demand, which many of these decentralized plants cause – often being the largest energy consumer in a municipality.

Small wastewater treatment plants also often reach their technical limits when it comes to complying with discharge limits or recovering resources such as phosphorus. The operation of many small plants requires a large number of operating points, which results in high operating costs. Against this background, the idea of replacing several small wastewater treatment plants with a central treatment plant is not only sensible, but also necessary in many cases. The prerequisite for this, however, is the construction of an efficient pipeline system that transports the wastewater safely and efficiently to the central plant.

This whitepaper highlights the advantages of merging, the technical and legal requirements for the pipe systems required for this, as well as specific practical examples that can serve as orientation for future projects.

2. ADVANTAGES AND FRAMEWORK CONDITIONS

A key argument in favor of merging small wastewater treatment plants is economic efficiency. Wastewater disposal concepts, which are prescribed in many federal states, analyze in advance whether the operation of several small plants is economically viable in the long term.

In many cases, it has been shown that the reduction in operating points not only saves on personnel and maintenance costs, but also reduces energy consumption overall. For example, the city of Bonn has the highest energy consumption[1] for its wastewater treatment plants in the entire city area. Consolidation promises considerable savings potential here. In addition, there are legal requirements, which can no longer be met technically by many existing small wastewater treatment plants. These include stricter limit values for the discharge of wastewater, requirements for the recovery of phosphorus from the year 2029 and – with a view to the future – the introduction of a fourth treatment stage for the removal of trace substances. Compliance with these requirements is often only possible with considerable technical and financial effort, which is no longer economically viable for individual plants. The creation of central structures offers the opportunity to implement modern cleaning processes economically at and to comply with the legal requirements in the long term.

3. TECHNICAL REQUIREMENTS ON PIPELINES

A functioning and future-proof pipeline system is essential for the implementation of a consolidation. This must meet high requirements: It must be durable and resistant to chemicals in order to function reliably over decades. At the same time, it must be absolutely leak-proof in order to ensure the protection of soil and groundwater – especially when crossing water protection areas.

In such sensitive areas, specialized pipe systems are often used, such as the egeSmart: Leak Control 3L safety pipe system, which enables permanent leak monitoring. These systems are able to detect even the smallest leaks at an early stage and trigger corresponding alarm messages. As a result, environmental damage can be prevented and operations can be controlled efficiently.

The type of installation also plays a central role. While open trench installation is the most economical solution in many cases, trenchless methods are also necessary in difficult terrain or when crossing under sensitive zones. The decision on the most suitable method depends on the geological and hydrological conditions on site.

Modern pipe systems also allow the integration of digital monitoring technology and can be controlled and maintained via the internet. Planning must also take into account whether the wastewater can be drained down a free gradient or whether pumping stations are necessary – as was investigated in the Bonn project, for example.

4. PRACTICAL EXAMPLES

4.1 Bonn wastewater treatment plant project – Consolidation

4.1.1. Initial situation and problem definition

The city of Bonn currently operates four wastewater treatment plants, spread across the districts of Bad Godesberg, Beuel, Duisdorf and the centrally located Salierweg. Due to the high energy consumption – the sewage treatment plants are the city's largest energy consumers – and considering the fact that stricter legal requirements are foreseeable, a specialist office was commissioned to prepare a feasibility study. This recommends the decommissioning of the three decentralized plants and the concentration on the Salierweg site.

4.1.2. Legal basis

Requirements for phosphorus recovery from 2029 and the discussion about a fourth treatment stage for the removal of pharmaceutical residues point to stricter environmental regulations in the future.

4.1.3. Solution approach

The planned centralization provides for the expansion of the existing plant on Salierweg with the latest purification and membrane technology. It is also necessary to convert the sewer network in order to transport the wastewater from other districts and the neighboring municipalities of Wachtberg and Alfter to the central plant. It is being examined whether the wastewater can be transported in the free fall or whether pumping stations are required.

4.1.4. Implementation

Implementation is planned for the long term and is to take place between 2032 and 2043 – in parallel with the complete depreciation of the existing facilities. The investment sum is estimated at around 150 million euros. In addition, it is planned to transport the sewage sludge to Cologne by ship in the future in order to comply with the legal requirements for phosphorus recovery[2]. A fourth treatment stage to remove pharmaceutical residues is also being discussed.

4.2 Liedertswil project (Switzerland)

4.2.1. Initial situation & problem definition

In Liedertswil, a municipality in the canton of Basel-Landschaft, a renovation of the outdated decentralized wastewater treatment plant from 1968 also proved to be no longer economical. The decision was therefore made to connect to a centralized plant. A key challenge was that the planned connecting sewer to the regional sewage treatment plant in Niederdorf had to cross two water protection areas – a sensitive project with high requirements in terms of planning, technology and environmental protection.

4.2.2. Legal basis

In Switzerland, the Water Protection Act (GSchG) together with the Water Protection Ordinance (GSchV) regulate the requirements for the protection of surface waters and groundwater. Water protection zones are divided into three zones:

- Zone S1 (catchment area)
- Zone S2 (narrower protection zone)
- Zone S3 (further protection zone)

In the narrower protection zone S2, strict requirements apply to construction projects and the use of land. Projects such as the construction of a sewer may only be carried out with an exceptional permit, provided there is no risk to the use of drinking water. Special technical measures must be taken such as double-walled pipes, leak monitoring and protective measures against the ingress of pollutants.

4.2.3. Solution approach

Instead of a renovation, the construction of a connecting sewer around 1.7 kilometers long to the regional sewage treatment plant in Villabassa was planned. In order to ensure the protection of the water protection zones, state-of-the-art technology with a high level of operational safety and environmental compatibility was used.

4.2.4. Implementation

A 3L Leak Control safety pipe system with an outer diameter of 315 mm was used. This pipe system offers permanent leak monitoring and automatically triggers an alarm in the event of damage – with direct reporting to the control center or to the smartphone. Remote maintenance and monitoring ensure additional operational safety. Thanks to the technology used, the project could be realized despite the sensitive routing. According to a profitability calculation, the connection to the central system was around 40 percent cheaper than renovating the existing system.

5. CONCLUSION AND RECOMMENDATIONS FOR ACTION

The consolidation of small wastewater treatment plants not only offers economic advantages, but also represents a necessary measure in order to meet future legal requirements and ensure long-term operation. Centralized wastewater treatment plants enable the use of state-of-the-art treatment processes and at the same time significantly reduce personnel and maintenance costs. However, a prerequisite for successful implementation is the forward-looking planning of a suitable pipeline system that meets the requirements for environmental, soil and water protection.

Municipalities should also keep an eye on long-term developments such as mandatory phosphorus recovery, demographic change and digitalization. The experience gained from projects such as those in Liedertswil and Bonn can serve as a valuable reference.

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Sources:

[1] Königs, P. (2023). Wastewater in Bonn: City considers merging sewage treatment plants, from: https://ga.de/bonn/stadt-bonn/abwasser-in-bonn-stadt-plant-zusammenlegung-von-klaeranlagen_aid-104187489 [retrieved May 13, 2025]

[2] Phosphorus recovery from sewage sludge is a key component of sustainable wastewater management and resource conservation. Phosphorus is a vital nutrient for plants and indispensable in agriculture – at the same time, it is a finite resource. For this reason, phosphorus recovery aims to recover phosphorus from waste streams such as sewage sludge and make it usable again as a fertilizer.

ABOUT EGEPLAST

Safety with tested pipe systems from egeplast

Pipes are the backbone of modern infrastructures – and at the same time one of the most valuable assets of municipal and industrial network operators. Particularly with trenchless installation methods, for where subsequent visual inspections are not possible, quality must be at the forefront.

egeplast offers pipe systems with integrated protection and testing functions, which already ensure documented safety during installation and also during operation. This gives planners, engineering offices and network operators the certainty that their investment will deliver what it promises in the long term – for over 100 years.

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