The problem of timeworn sewer networks and their impact on the environment

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1 Introduction

In recent years, the problem of wastewater is gaining an increasing role and relevance all over the world. In the process of economic activity, modern society consumes all considerable amounts of water, most of which, as a result, becomes contaminated with a variety of substances. When they enter the environment, the ecology is severely damaged, and therefore they must be cleaned up.
To ensure it properly, it is necessary to use special equipment and technological complexes, with the help of which the established standards for wastewater pollution, defined in the relevant documents, are achieved.
But most of the sewer networks used were built a long time ago, and now the networks are timeworn, hinder the full operation of the sewage system and bring a negative impact on the environment. In order to avoid such problems in the future, it is necessary to design the sewerage network in a more practical way using new combuter technologies.
The design of the sewerage network begins with the division of the city's territory into sewerage basins, the choice of the location of the treatment facilities and the release of treated wastewater into the reservoir. The boundaries of the sewerage basins are drawn on the city plan with horizontals, they are determined by the terrain and the draft of the city's vertical planning. Determine the direction of movement of water and areas where pumping of water is required (if gravity is not possible). Then they begin to trace the external and internal sewerage.
When designing a sewer network, the following tasks are solved: sewerage basins are determined, the route of the network is planned; costs for calculated sections of the network are determined; hydraulic calculation and design of the network is carried out; longitudinal profiles are drawn up; constructions on the sewerage network are being designed.
Wastewater is a colossal problem today, both ecologically and environmentally and economically. From household and industrial effluents, organic substances enter the hydrosphere, which are decomposed by colonies of oxygen-consuming bacteria.
With the necessary air access, aerobic bacteria process wastewater into environmentally friendly substances. With limited access of oxygen to the effluent, the vital activity of aerobic bacteria decreases, as a result of which anaerobic bacteria develop, provoking the process
putrefaction.
Household and industrial effluents that have not been sufficiently deeply treated or have not been subjected to biological treatment may contain pathogenic viruses and bacteria that are dangerous to humans, and if they enter the drinking water, dangerous diseases may develop.
Pesticides, phenols, surfactants (for example, detergents, chemical hazardous substances) also get into the water with sewage from household and industrial effluents. Their decomposition process is extremely slow, some substances practically do not decompose. Through the food chains from the organisms of aquatic animals and fish, these substances enter the human body, negatively affect human health, which in the future can lead to various acute chronic and infectious diseases. Due to the long period of operation in conditions of aggressive drains, a large number of structures, sewer

networks are in an unsatisfactory condition, therefore, they need to be dismantled, repaired, replaced and reconstructed.
Speaking about the prevention of wastewater pollution of water bodies, as well as the protection of surface waters from wastewater pollution, these are the most important tasks facing modern society. Their effective and comprehensive solution is possible only with the use of advanced technologies and modern equipment [1]. Therefore, timeworn sewer pipes are a big problem that should be properly addressed. Indeed, in the event of an accident and the destruction of the outer layer of pipes, water from the sewer can get into the soil and groundwater. To prevent this, problem pipe sections should be replaced before a hazardous situation arises for the environment. One of these methods is the tracing of sewer pipes.

2 Tracing of the sewer network

It is a graphical display of the sewer network, main and main collectors on the plan of the sewage facility. This stage is of fundamental importance for the entire design. The labor intensity, cost and timing of the creation of the sewerage system depend on how the collector lines will be laid over the terrain.
When tracing the sewer network, the following principles should be followed: maximum provision of the service area with a gravity drainage regime; economic rationality of the depths of the pipes and collector channels.
Optimal division of the route into gravity sections with the location of sewage pumping stations (SPS) between them for pumping wastewater. This may be required if the ground conditions are unsatisfactory, the relief is heavily indented, with large differences in elevation and for other reasons.
The final element of the main collector in the schematic diagram of the sewage system of a populated area is a treatment plant with a place where treated effluents are discharged into a reservoir. You should also choose sites for the installation of sewage pumping stations.
Several options for tracing the sewer network should be offered. Of these, the best is selected in terms of technical and economic indicators.
The network routing begins with the two most important collectors, the main and the branch. The possibility of mechanization of construction and installation work should be taken into account to the maximum extent. All geometrical parameters of reservoir filling: depths, slopes, cross-sections of pipes and channels are determined according to the calculated flow rates. The sewerage network is tied to the location of treatment facilities and the release of treated water.
The tracing lines of the main collectors are mainly the embankments of streams and rivers or the thalweg of the valleys. If the terrain is flat, then it is preferable to route the collectors along the centerline of the sewage basin with the device of several treatment plants.
The sewer network will gain greater reliability if it is looped back with a connecting pipeline. At the same time, it will become easier to operate it [2]. This solution must be facilitated by local conditions or specific requirements must be placed on the network.
It is advisable to lay collectors with a large cross-section in places with the least interference for construction and maintenance. These are areas of the territory with minimal underground structures and low development and load of transport lines. The crossing of water channels, railways, tunnels, heating mains and other structures underground by sewer networks increases the cost and complicates both the creation of the sewage system and its future operation.
If there are drinking water supply lines on the tracing line of the sewer network, it is necessary to provide for laying the collector below them at least 0.4 m.This is the minimum distance between the sewage pipes and the water pipes. If it is impossible to withstand it, as well as, if necessary, for technical reasons, laying sewer pipes above water conduits at a vertical distance of less than 40 cm, protective measures should be taken:

- use of steel pipes for water supply,
- use of cast iron for sewage;

- installation for a water pipe of a protective case (the minimum length of the case on each side of the intersection: in filter soils - 10 m, in clayey - 5 m).

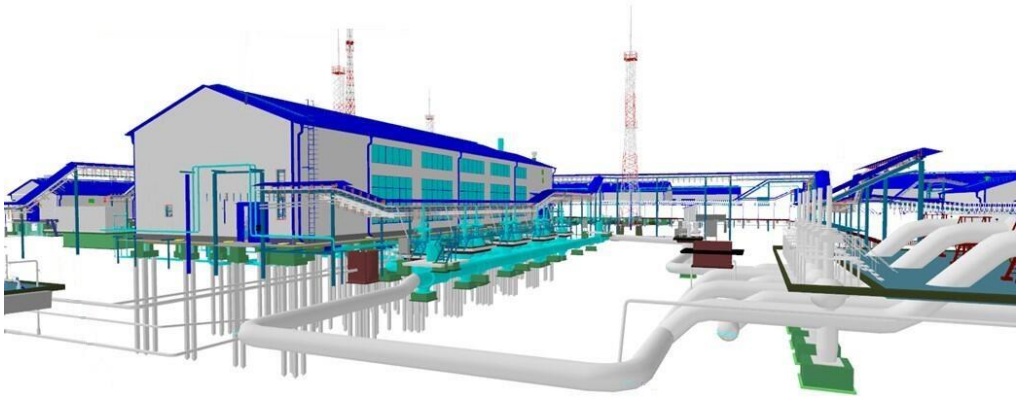

Figure 1. External network tracing [3].

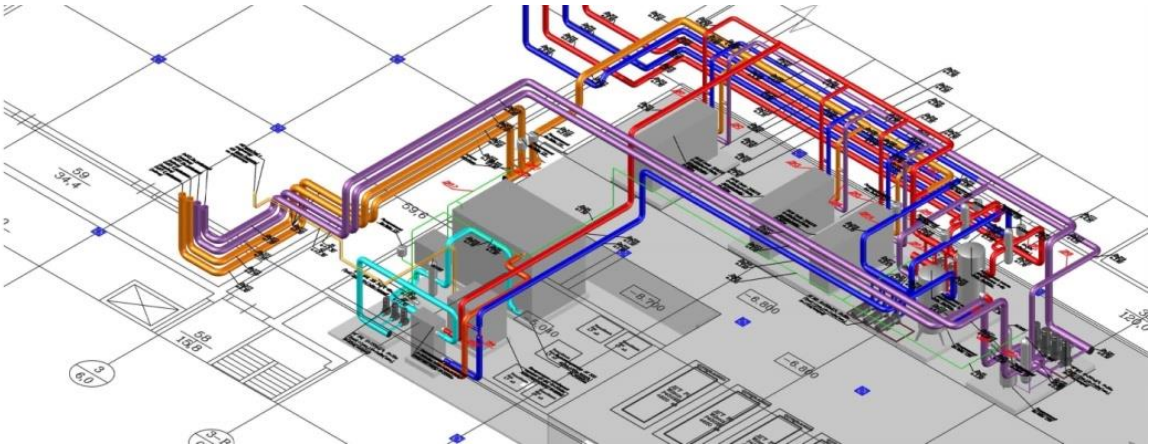

Figure 2. Internal network tracing [3].

Sewerage and water supply lines at the point of intersection must be strictly perpendicular to each other.

In residential areas, it is prohibited to make above-ground or above-ground laying of sewer pipelines. Open-type sewerage canals with gravity flow of treated wastewater can be installed only outside the boundaries of a populated area. The local conditions must always be taken into account.

It is also important to trace the sewerage system inside buildings in order to ensure high-quality and correct output of the internal network to the external network.

The scheme of sewer networks is the relative position in terms of the main elements of the external sewage system, the cost and quality of the network as a whole depends on their correct solution. The choice of the scheme is influenced by many factors, the decisive factor is the relief [3].

The types of circuits are as follows:

- with a smooth lowering of the relief - a crossed pattern;
- in the absence of reverse slopes - perpendicular;

- with a sharp slope of the terrain to the reservoir - parallel;
- in case of complex - radial;
- in case of uneven - zonal.

The perpendicular scheme is used only to drain clean atmospheric precipitation into the river. It is envisaged that sewer pool collectors are routed along the shortest distance to the reservoir, perpendicular to it.

The intersected scheme, the sewer pool collectors going to the reservoir are intercepted by the main one, which transports the wastewater to the pumping station, from where it is fed to the treatment plant via the pressure line. The main collector is laid parallel to the reservoir. This scheme is used for perpendicular reconstruction.

Parallel circuit. Basin collectors are laid parallel or with a slight slope in the direction of water movement in the river and are intercepted by the main collector, which diverts wastewater to the treatment plant.

The zone scheme (belt) provides for the presence of 2 main collectors in the upper and lower zones of the city. From the lower zone, the wastewater is pumped by the pumping station into the waste collector.

Radial scheme. The collectors have a radial direction from the center to its periphery. Each district has its own main sewer, sewage treatment plant and pumping station. This scheme is convenient when expanding cities; it does not require rebuilding existing collectors.

Methods for tracing street networks.

Correct routing of street sewer networks is important.

There are types:

- encompassing - networks describe each quarter from 4 sides along the thoroughfares;
- on the lowered side of the quarter - the network only on the lowered sides of the quarter;
- over-the-quarter - is located within the block in a straight line, the length of the network is reduced, but operation becomes more difficult.

Depth of pipe laying. The depth of placement is influenced by the parameters:

- ensuring the reception of wastewater from the intra-quarter networks of buildings;
- protection against mechanical damage;
- freeze protection.

The minimum depth of laying is taken depending on the depth of freezing, taking into account that the temperature of the drains is 10-15 ° C and not less than 0.7 m, which keeps the pipe from mechanical damage [4]:

$$h = H - (0.3\text{-}0.5) \geq 0.7 + D_{pipes} \quad (1)$$

The initial depth of laying is determined by the formula [4]:

$$H_{initial} = h + i\,(L+L_1) - (Z_1-Z_2) + \Delta d, \quad (2)$$

where h - the smallest depth of the network pipes from the ground surface to the pipe chute in the most distant well of the intra-quarter network;

i - slope of the intra-quarter network;

$L+L_1$ - the length of the intra-block network from the most distant well to the place of its connection to the street network;

Z_1; Z_2 - marks of the ground surface at the most distant well and at the place of connection to the street network;

Δ d - the difference in the diameters of the pipelines of the street and intra-quarter network at the junction.

The maximum laying depth depends on the way they are laid. With an open method of work, the depth of the collectors is 10-15m – in dry soils; 5-7 m in wet soil. With closed methods, usually up to 20 m.

It is recommended to lay the network within the carriageway and in areas of green spaces. At the intersection with railways, near unique buildings, subway routes, duplicate lines with cameras for communication are provided [5].
It is rational to provide for laying pipelines for various purposes together. Laying is carried out parallel to the red building line or the axis of the road. When crossing sewer pipes with water pipes, the first ones are laid below, with a clear distance between the pipes of at least 0.4 m, or the water supply system is enclosed in a casing with a length of at least 5 m, in filter soils - 10 meters on both sides of the intersection.

3 Conclusion

The issue of sewage leakage appears to be quite real and of considerable interest in the scientific field. In particular, its environmental and management repercussions make it a central topic in technical literature. The absence of extended data and contextual in-depth studies on the topic does not allow us to know with certainty the variables that directly contribute to influencing the number of losses that are recorded in a sewer system.
The absence of detailed information on the age of any single pipe subjected to effective intervention does not permit us to completely exclude aging as a factor in causing the high frequency of exfiltration due to both obstructions and rupture.

4 References

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Acknowledgment

This work was supported by the Scientific Grant Agency of the Ministry of Education, Youth and Sports of the Slovak Republic and the Slovak Academy of Sciences within the project VEGA 1/0574/19 and 1/0727/20.

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Abstract

Today water is an important part of human life all over the world. Before entering a person, water goes a long way, and then it goes through sewer pipes to a treatment plant for cleaning and disinfection, so that after that the water could be dumped into water resources.
In addition, cases of destruction of sewer networks are inevitable, this occurs due to aging of pipes from a long time or from other external factors, for example, pollution of pipes with a large accumulation of debris.
At the time of maximum wear, you should find the problem area in time and replace it, or in general, you should completely replace the large line.
One of such methods is pipe routing and their replacement by pulling a new pipe made of modern technological material inside the old timeworn or old one.
The network routing begins with the two most important collectors, the main and the branch. The possibility of mechanization of construction and installation work should be taken into account to the maximum extent. All geometrical parameters of reservoir filling: depths, slopes, cross-sections of pipes and channels are determined according to the calculated flow rates. The sewerage network is tied to the location of treatment facilities and the release of treated water.
Using such technologies, it is possible to achieve a positive result and reduce the impact of wastewater on the environment. After all, the danger lies in the fact that wastewater from timeworn sewer pipes may well get out and get into the groundwater. Thus, the process of groundwater contamination and soil poisoning occurs, which has a detrimental effect on both human life and the flora and fauna of the biosphere.
The issue of sewage leakage appears to be quite real and of considerable interest in the scientific field. In particular, its environmental and management repercussions make it a central topic in technical literature.
In conclusion, we can make the assertion that the timely replacement or repair of timeworn sewer networks reduces the fact of the impact on the environment.