Risk-based drinking water safety plan for RBF sites

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INTRODUCTION

Budapest Waterworks operates 756 wells on 15 water source sites along the Danube. The maximum production capacity of the riverbank filtration system is approximately 1,000,000 m3, of which half is needed. The produced water serves about 1.8 million residents with reliable drinking water in Budapest and in the surrounding agglomeration area.
The EU Drinking Water Directive (EU) 2020/2184, has been in force since January 2021. Hungary, as an EU member state, adapted the Directive on 12th January 2023. According to the 5/2023 (I.12.) Hungarian government decree the provider of the drinking water supply system must establish a drinking water safety plan. The drinking water safety plan must be a risk-based approach – including risk and hazard assessment, based on three main aspects, probability, severity and detectability. The riverbank filtration aquifers are vulnerable water sources therefore not only the quality of the riverbank filtrate analysed in production wells but also the quality of groundwater sampled from monitoring wells are of great significance. Hence as a part of developing the water safety plan, additionally to the potential pollutants arriving from the Danube also the range of pollution sources from the background of the production wells were assessed.

METHODS

The following fundamental tasks were necessary for the preparation of the water safety plan:

1. Defining and evaluating potential contaminant sources
2. Identifying the types and indicator parameters of determined pollution sources
3. Review of the annual monitoring plan for monitoring and production wells based on the relevant sources of contamination
   a. To the monitoring plan of the contaminant sources 17 monitoring wells were assigned, of which 11 wells were already part of the monitoring plan prior the review, while 6 were added to the list of regularly sampled monitoring wells starting January, 2026.
4. Assigning monitoring wells to production wells or well groups based on the distance and the direction of the groundwater flow
   a. If there is no monitoring well in between the potential contaminant source and the production well the following steps were required:
      i. new monitoring plan for the affected production well,
      ii. preparation of the plan of the new monitoring well development.
5. Defining an established decision-making process to manage non-compliances in monitoring wells.

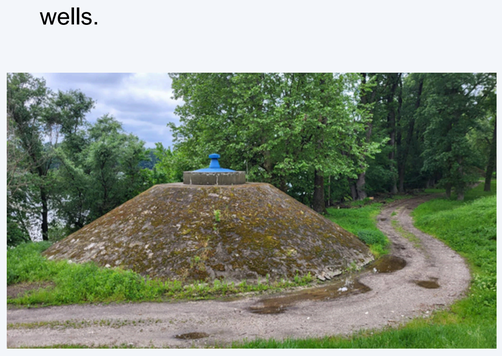

Figure 1. Picture of production well

Figure 2. Picture of monitoring well

RESULTS

The hazard analysis and risk assessment of the water safety plan identified and documented 38 hazards associated with extremely high-risk and high-risk pollution sources.

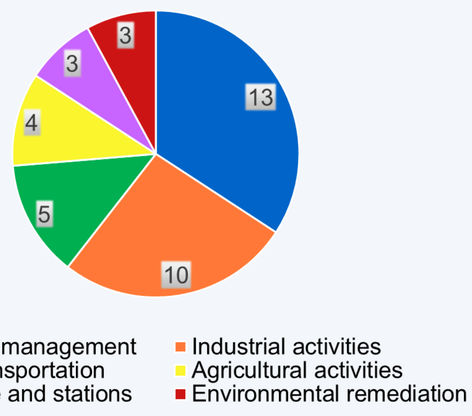

Figure 3. Distribution of various types of pollution sources

Following the identification of potential sources of contamination, the lists of parameters forming the basis of the monitoring plan of the contaminant sources were determined.

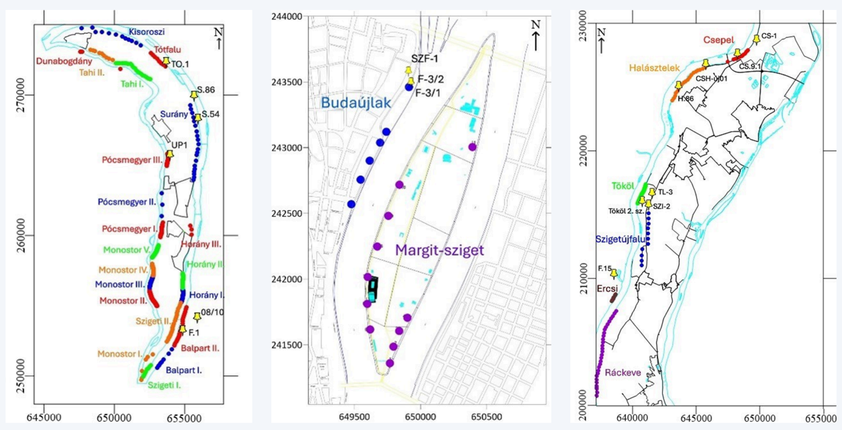

Figure 4. Production well groups and monitoring wells at different water production sites at Budapest Waterworks Ltd, related to the watershed risk assessment activity.

References:
Hungarian Government Decree No. 5/2023 (I.12.) on the quality requirements of drinking water and the order of monitoring, Hungary
Joint Decree No. 6/2009 (IV.14.) of the Ministries of Environment, Health and Agriculture on the protection of groundwater, Hungary
Directive (EU) 2020/2184 of the European Parliament and of the Council on the quality of water intended for human consumption

DISCUSSION

The first step of the risk assessment was to identify the prioritized extremely high-, and high-risk pollution sources that are part of the water safety plan. The method was the following.

For the risk assessment of pollution sources, four main factors were identified as main assessment parameters:

- hazardousness of pollution source,
- severity of potential pollution,
- probability of pollution incidence,
- detectability of the contamination.

The hazardousness of the pollution source is based on the affected protection zone and activity restrictions.

Protection zone	Travel time	Factor
Inner protection zone	20 days	4
Outer protection zone	6 months	3
Hydrogeological „A” portection zone	5 years	2
Hydrogeological „B” portection zone	50 years	1

Table 1. Risk factors determined based on the protection zone classifications

The methodology of the hazard analysis was developed primarily based on the requirements of the ISO 22000 standard and Guideline No. 2-1/1969 of the Hungarian Food Code (Guidelines for the Hazard Analysis and Critical Control Points (HACCP) System and Its Application) and the 5/2023 (I.12.) Hungarian government decree.

The hazards are determined by the risk value (K):

K = probability * severity * detectability

If the risk value is <8, then the hazard is automatically PRP, if the risk value is >8, according to the decision tree, a hazard can be:

- CCP: critical control point – monitoring of measurable critical thresholds
- OPRP: operational pre-requisite program – the effectiveness of monitoring is determined by measured or observed intervention criteria
- PRP: pre-requisite program in case of insignificant risks

Level	Probability	Severity	Detectability
1	Low (yearly occurance)	Insignificant (no effect)	Detectable (regularly measured), intervention is possible
2	Medium (monthly occurance)	Lightly severe (harmless to health)	Detectable (event-driven), intervention is possible
3	High (weekly occurance)	Moderately severe (may be harmful to health)	Detectable, intervention is not possible
4	Extremely high (daily occurance)	Highly severe (harmful to health)	Not controlled

Table 2. Risk value classifications of the hazard analysis

CONCLUSIONS

The results of this work were implemented in the operating system of Budapest Waterworks Ltd., and is applied from 2026 May. The new approach posed improved processes, such as revised monitoring well sampling plan, optimal monitoring well distribution, and holistic risk assessment approach including the background areas of the production wells.

Given that the review of pollution sources and risk assessment are conducted on an annual basis, further changes to the current system are anticipated and will be followed up continuously.

It is definitely important to further develop and implement in the short-term additional fine-tuning of the decision-making process for monitoring wells. The refinement of trend analyses and the range of interventions are yet to be defined thoroughly, thus requiring more intensive data analysis.

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