Project Deliverable 6.2

Locating excess water in a small sewer system –

The case of Snogeröd, Höör Municipality, Sweden

This case study forms part of the Interreg-project STEP, South Baltic Program and is based on an internal report compiled by Mittskåne Water

Lead Partner:
West Pomeranian University of Technology, Szczecin
Electrical Engineering Faculty
West University of Technology, Szczecin
Address: ul. Sikorskiego 37
70-313 Szczecin

Contact:assistant professor dr.hab. inż. Marcin Holub
Phone: +487 (258) 60950
E-mail: marcin.holub@zut.edu.pl

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INTRODUCTION

The intrusion of excess water into sewer systems through e.g. cracks or illicit connections is a major problem for wastewater utilities around Sweden. Excess water has been found to e.g., increase pumping costs and have a detrimental impact on the functioning of wastewater treatment plants (WWTP).

Excess water can be further divided into different fractions depending on how it entered the sewer. If the water did not enter directly after a rainfall its origin is most probably groundwater or leaking potable water. It is the localization of groundwater and leaking potable water the work in this report deals with. From now on this fraction will be called Leak And Drainage water (LAD).

In Sweden, several methods have been tested to track the points of entry of LAD. The conventional approach is to measure the flow in the sewer during night hours when wastewater generation among households is minimal. Sections with elevated levels are then internally TV-inspected with a remotely controlled camera trailer. In the inspection protocol the existence of cracks and wrongly connected drainage are noted.

Other methods that have been suggested for the localization of LAD are: (i) To measure the temperature, a relatively cold wastewater would indicate high levels; (ii) To analyse the level of dilution of nutrients, a low concentration would indicate high levels; (iii) To perform a GIS analysis were various layers are combined (e.g. soil properties, groundwater levels etc.) to pin point sewer sections with high levels.

As these methods often are applied separately it is difficult to evaluate how accurate they are. It would therefore be of interest to evaluate them on a representative sewer system with elevated levels of LAD. Snogeröd in Höör municipality is a fitting candidate. The town, surrounded by agricultural areas, has a typical Swedish sewer design which is comprised of a separate wastewater system composed of concrete pipes installed in the late 1960s. The level of excess water reaching the treatment plant has been estimated to about 70 % where most of it is thought to originate from LAD. Levels have been found to be peaking during spring when the groundwater table is high.

AIM

The aim of this study is to evaluate various methods for the localization of sewer sections with elevated levels of LAD in Snogeröd.

AREA DESCRIPTION

The town of Snogeröd is, except for a few smaller workshops and a kindergarten, comprised of households. There are roughly about 80 families that have settled in the town. The total population is estimated to about 200 persons. The sewer system has a separate design. All properties are connected to the wastewater system, however some household lack connection to the storm water network. The sewer system carrying wastewater has a total length of 2 500 meters. No pump stations exist, wastewater is carried by gravity down to the wastewater treatment plant in the northern part of the area. The sewer network of Snogeröd has for the purposes of this study been further divided into 13 different sections (see Figure 1).

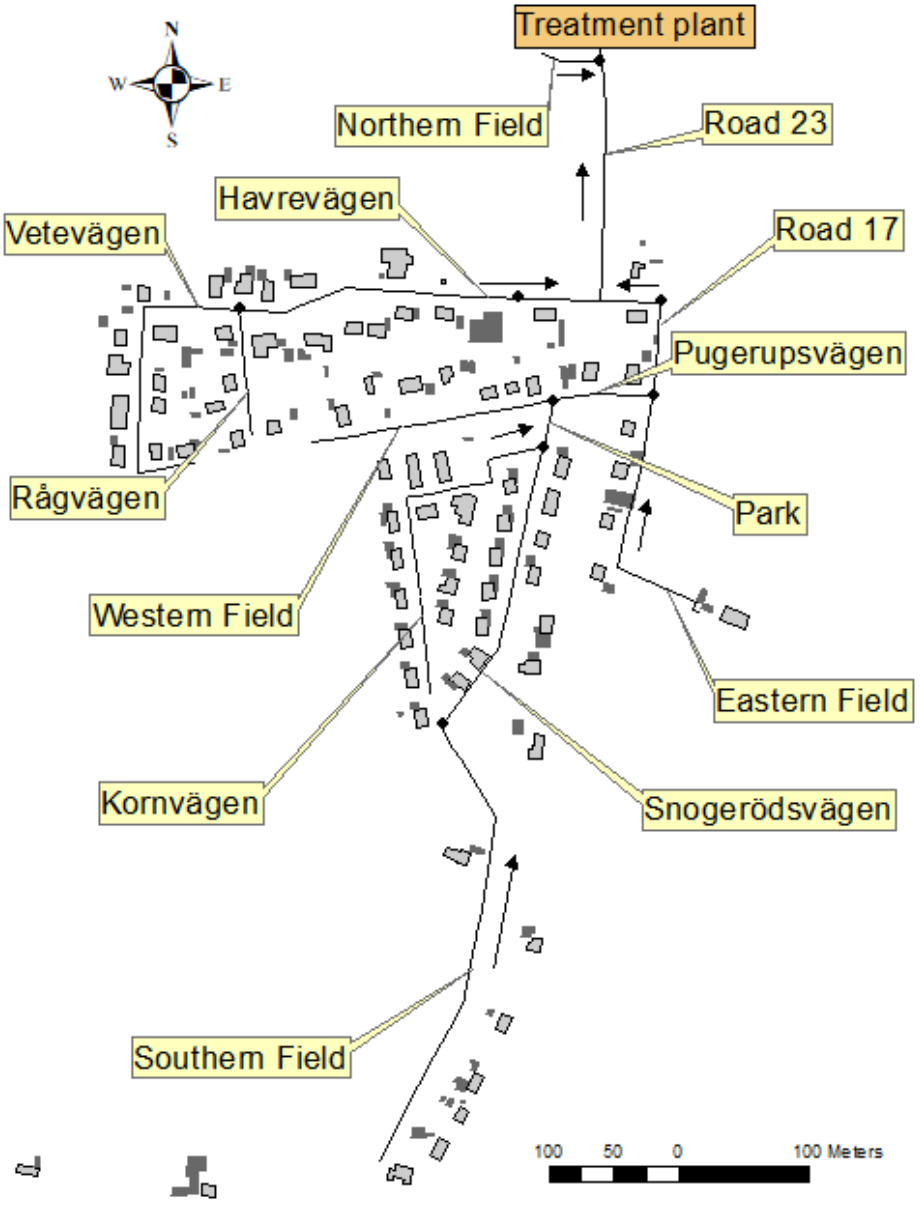

Figure 1. The sewer system in Snogeröd has been divided for the purposes of this study into 13 sections. The arrows show the direction of flow, from south to north. There are no pumping stations in Snogeröd.

METHODS

The methods evaluated by Mittskåne water to locate LAD were GIS-analysis, temperature- and flow measurements, analysis of the level of dilution, and TV-inspection. All these methods were applied during April and May (except for the GIS-analysis which was done before). Since the aim was to localize the inflow of groundwater and leaking drinking water, no investigation was carried out during, or the same day, as rain occurred. A summary of the methods used can be found in Table 1. A detailed description of each method can be found in an internal report (in Swedish) elaborated by Mittskåne water.

Table 1. Methods evaluated to locate LAD.

Name	How?	When?
GIS-analysis	Combining geohydrological layers (e.g. soil and elevation) with layers containing info on sewers (e.g. pipe age) (Figure 2).	Was performed during the winter of 2019.
Temperature measurement	A ”pistol” emitting an infrared signal was pointed toward the wastewater stream from above ground (Figure 3).	Carried out twice during morning hours when the villagers were preparing to go to work (07-09) and a relatively warm wastewater could be expected.
Analysis of the level of dilution	Samples were collected from above ground by holding down a foldable fruit picker fitted with a plastic bag (Figure 4). Analysis of the level of nutrients, (ammonium and phosphate) was done by a certified laboratory. A quick analysis was also tested with test stripes that relied on a colorimetric scale to determine the same concentrations (Figure 5).	Carried out twice during morning hours when the villagers were preparing to go to work (07-09) and a relatively concentrated wastewater could be be expected.
Flow measurement	A weir was inserted into the incoming pipe (Figure 6). Also, an ocular estimation of the flow was performed.	Performed before lunch hour (10-12) when the villagers were expected to have left for work.
TV-inspection	After a preliminary flushing of the sewer the camera trailer documented all cracks or suspicious inflows that could signify illicit connections (Figure 7).	Performed during working hours.

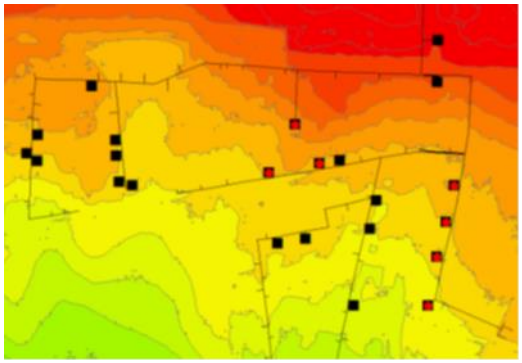

Figure 2. GIS-analysis that combined information on geohydrology with information on the estates in Snogeröd

Figure 3. The temperature pistol was directed against the wastewater stream at the bottom of the well. The temperature was then shown in the display.

Figure 4. The fruit picker with the attached plastic bag. The plastic bag was inserted into the wastewater stream to collect samples.

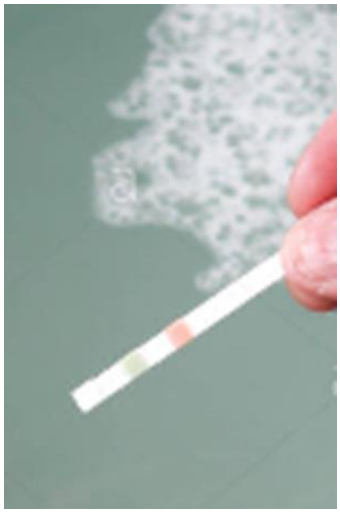

Figure 5. A quick analysis of the concentrations of ammonium and phosphate was carried out with test stripes.

Figure 6. The measuring of flow using weirs.

Figure 7. A TV-inspection was performed for the whole sewer network in Snogeröd

RESULT AND DISCUSSION

The outcome from the application of the various methods can be seen in Figure 8. There, the three sewer sections expected to have the highest level of LAD has been ranked for each method.

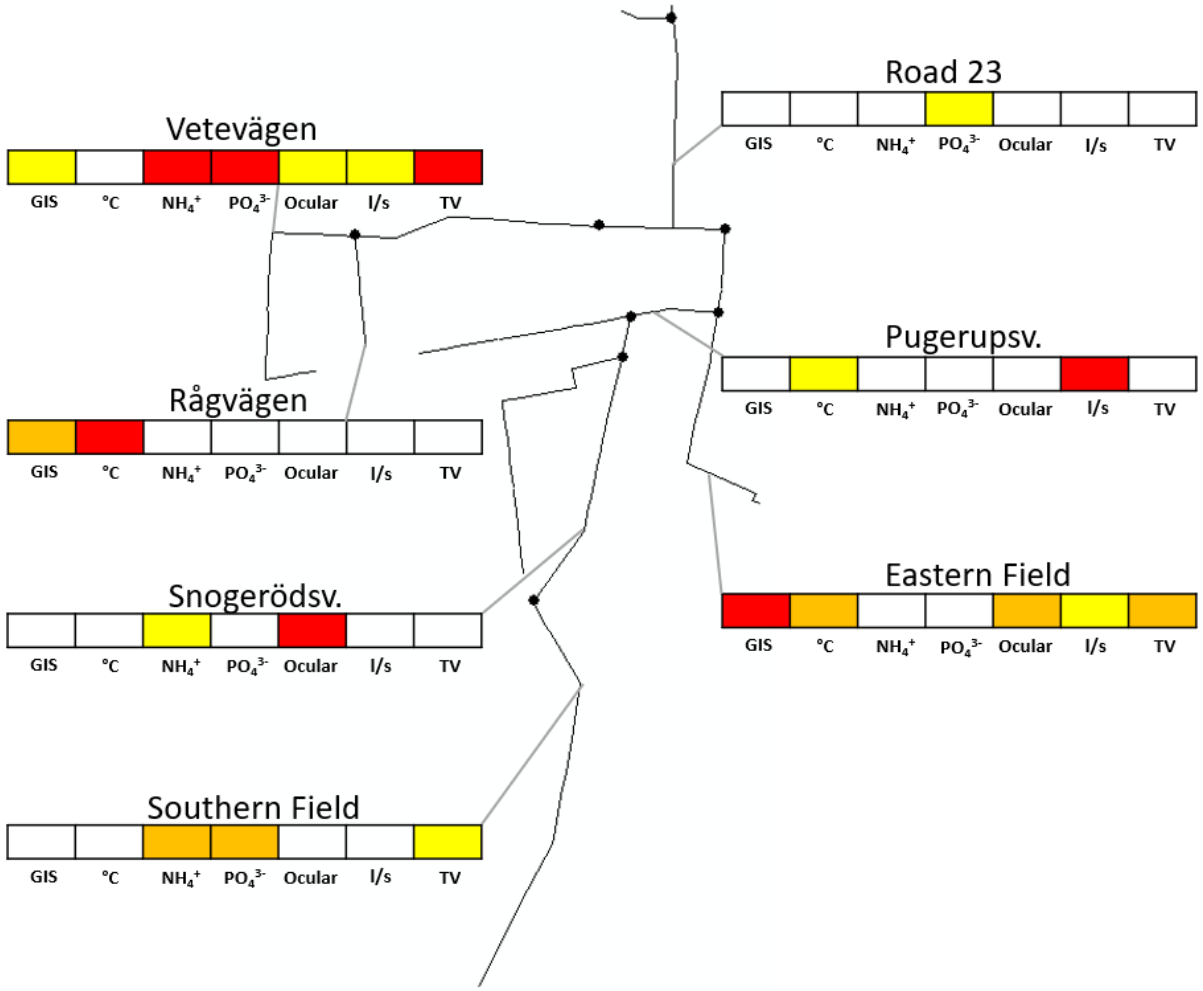

Figure 8. A summary of the outcome from the various methods. The top three sewer sections with the highest level of LAD have been labelled in the following way: Red colour – Top ranked, orange colour – second highest, yellow colour – third highest. The sections which were not flagged by any of the methods have not been given a marker. GIS – GIS-analysis; °C = Temperature measurement; NH_4^+ = Ammonium analysis; PO_4^{3-} = phosphate analysis; Ocular – ocular inspection; l/s = flow measurement with weir; TV = TV-inspection.

SECTIONS WITH ELEVATED LEVELS OF LAD

At the sewer section 'Southern Field', the measured concentrations of ammonium and phosphate were observed to be low and thus would indicate the existence of LAD. This was verified during the TV-inspection when cracks where groundwater entered were documented. However, the actual inflow was relatively minor and consisted mostly of dripping water. That the inflow was not larger than that was confirmed during flow measurements which recorded the flow to less than 0,1 l/s.

'Snogerödsvägen' exhibited a discrepancy between the ocular inspection of the flow compared to the measurement done with a weir. The ocular inspection ranked this pipe section as the one with the highest addition of LAD. However, this was most likely caused by a constructed drop in the well. This drop caused the water to splash and tricked the inspector to over-estimate the flow since the drop was not visible from above ground.

At 'Pugerupsvägen' the highest flow was measured with the weir (0,1 l/s) but no obvious inflow of LAD could be seen during TV-inspection. An explanation could be that some activity in the households (e.g. a washing machine or a dishwasher) generated the flow which, in turn, was wrongly registered as LAD.

'Eastern Field' was ranked top-three by five of the methods. No complete TV-inspection could be carried out but from what could be seen, a clear stream of water was coming from a section where few households were connected. This most likely represented the LAD for this section. According to the flow measurement that was done, this addition seemed to be in the vicinity of 0,1 l/s. The GIS-analysis concluded that the section is located in the lowest area of Snogeröd and also lacked municipal storm water pipes. A logical conclusion would be that the LAD is originating from groundwater drainage pipes.

'Vetevägen' was ranked highest by three of the methods. Both the ammonium and phosphate concentrations were found to be the lowest. Here the source of the inflow is thought to be a wrongly connected, or damaged, lateral which was seen during TV-inspection. The inflow of groundwater was estimated to be roughly about 0,1 – 0,2 l/s.

According to the GIS-analysis the probability of elevated levels at 'Rågvägen' was high since it was situated in a low area of Snogeröd and had a relatively large share of old lateral pipes connected to it. Indeed, the temperature of the wastewater was found to be the lowest here. However, during inspection no obvious inflow of groundwater was spotted. Due to the fact that there was sag noted on the pipe were the temperature was measured, it could be that the water had been stagnant there and cooled off before it was measured.

For the overall assessment of LAD, it is worth remembering that the night flow into the WWTP was registered to 0,4 l/s. It is the judgement that the inflow of LAD is occurring here (Figure 9):

- 'Vetevägen' – addition of LAD roughly about 0,1-0,2 l/s. Most likely due to a damaged lateral.
- 'Eastern Field' – addition of LAD about 0,1 l/s. Likely due to connected drainage pipes.
- 'Eastern Field'-'Snogerödsvägen'-'Pugerupsvägen' – Along this network a more diffuse inflow seemed to be occurring. A likely range: 0,1 – 0,2 l/s.

Other sections were adding a negligible inflow of LAD (< 0,1 l/s).

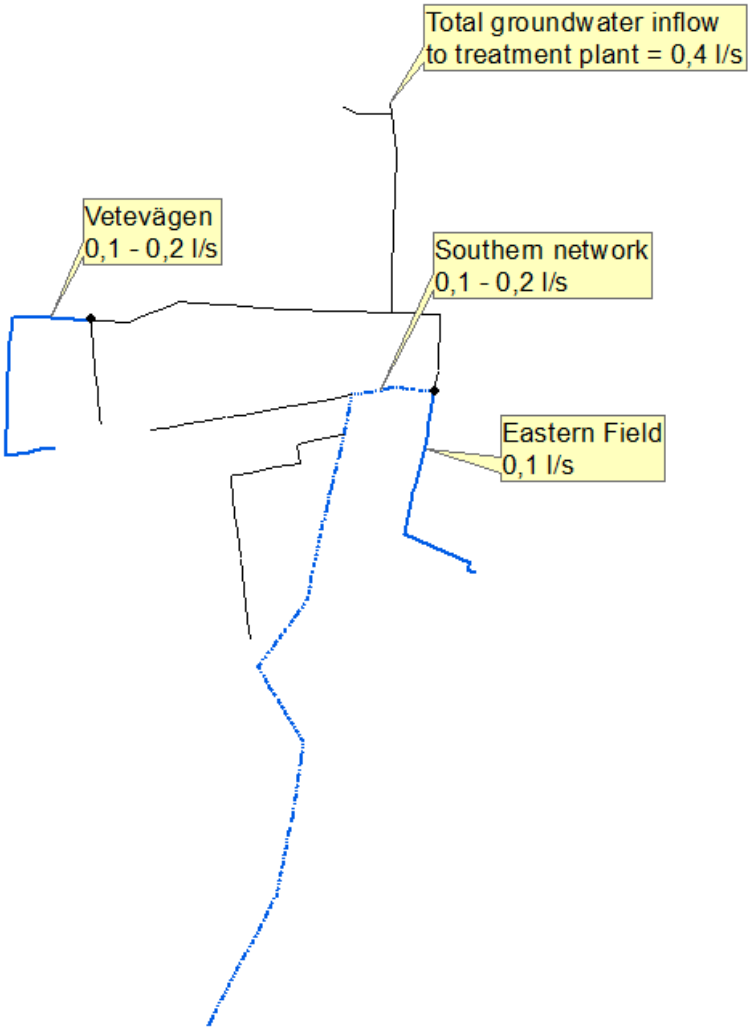

Figure 9. Overall assessment of where LAD is entering the sewer system in Snogeröd.

WHICH METHOD TO CHOOSE?

A GIS-analysis provides a fast option to get an overall picture of LAD-inflow. 'Vetevägen' and 'Southern Field' were both ranked high and these were also found to have elevated levels of LAD. However, since the analysis is lacking substantial field data it should only be used to screen areas for investigation, and always followed by a more detailed study.

The temperature measurements were found to be highly erratic and the outcome hard to draw any conclusions from. This can probably be explained by the fact that the sewer system in Snogeröd is rather small and dictated to a relatively large extent by single household activities. Temperature in the flowing wastewater will thus be the subject of fast changes due to the highly intermittent conditions. The "pistol" could perhaps come to better use in a larger sewer network with stabile flow patterns.

To analyse the level of dilution could be used to localize sections with inflow of LAD. However, since it was hard to draw any sort of conclusion on the volume of the inflow there is a danger of focusing on pipes that are less exposed. This problem might be overcome by

screening areas through a GIS-analysis. If ammonium is to be sampled for a small sewer network, the importance of duplicated sampling needs to be stressed.

The result from this study underlined the dangers in relying solely on ocular inspection. There are various ways to be fooled by flow, especially if one does not climb down into the wells. One should, at least, use a weir. However, even with this method there are dangers. As has been noted before, a small network has a highly irregular flow pattern and it could be enough with one wastewater-generating appliance to affect the results. Therefore, flow measurements on a town like Snogeröd should be carried out during night.

TV-inspection would seem like the most reliable method. However, it is costly. To perform similar inspections like the one carried out in this project are usually not feasible.

CONCLUSIONS

In this study several methods have been evaluated to locate excess water (LAD) in the sewer system of Snogeröd. The total LAD-flow was estimated to 0,4 l/s through observing the incoming volumes during night.

The overall assessment from this study concluded that the sources for the incoming LAD were primarily two sections of the sewer network: ’Eastern Field’ and ’Vetevägen’. A more diffuse type of inflow was occurring along the southern section of the network where many smaller cracks were visible.

To measure ammonium seemed to be a relatively cheap method that could identify most of the sections with elevated levels of LAD. The method can probably be even more effective if it is combined with a preliminary screening using GIS. However, it should be noted that small sewer systems, like the one investigated, will always be the subject of highly irregular flow patterns. If ammonium is to be sampled, the importance of duplicated sampling needs to be stressed.