

Sewer TV inspection - a tool to gain more detailed information about sewer infiltration flow from private house connections

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The Problem

A basic problem concerning the rehabilitation of sewerage systems which are affected by extraneous water is unreliable information (especially the missing of discharge data). Without these information a sustainable rehabilitation could not be guaranteed.

In fact the situation after finishing the rehabilitation could be even worse than before. It has been observed that in many cases the repaired and then water-tight sewerage pipeline causes the local groundwater table to rise higher than ever before. Instead of groundwater infiltrating through the public sewer, infiltration will reach the private sewerage systems - most are often more leaking than public sewers are.

Therefore a sustainable rehabilitation with long-term elimination of extraneous water can only be assured by regarding the complete situation within a sewerage system. This means gathering additional information about

- the main infiltration sources and the quantity of infiltration flow,
- house connections delivering an appreciable infiltration flow and
- the actual sources for extraneous water from private house connections (e.g. leaking sewers or drainage systems)

Considering these information, the consequences of a rehabilitation of the public sewer system, could be foreseen before starting rehabilitation-work. A concept for a sustainable rehabilitation of the sewerage system may be planned. As a result of the complete examination this concept may also include the rehabilitation of private house connections delivering extraneous water into the public sewer.

The following article will outline one way to prepare and gather additional information for a sustainable rehabilitation plan with special regards to discharge measurements and TV-inspection. Beside the capabilities of identifying extraneous water, a prospective about the use of new planning-tools like Geographical-Information-Systems (GIS) will be discussed.

Examination – Instruments and Period of Time

Within the examination of the sources and the quantity of extraneous water special regards belong to the instruments and the period of time at which observations should be started. The instruments by which most information about the sources and the quantity of extraneous water may be collected are

- Discharge **measurements** to quantify the sewer infiltration flow and
- sewer **TV-inspections** to locate sewer infiltration sources.

But the gathering of representative data is always closely linked to a well planned time schedule for these investigations. Long- and short-term fluctuations both of the

local groundwater-level and the daily curve of sewerage flow are main factors that have to be considered.

To allow the measurement and location of groundwater-infiltration-flow the groundwater-level has to be well above the average level of the sewage system. Best groundwater-conditions within one year are given from January to April following a period of long and continuous precipitation during winter months (fig. 1). Whereas most of the very intensive summer-precipitation results into runoff and evaporation without feeding the groundwater-body.

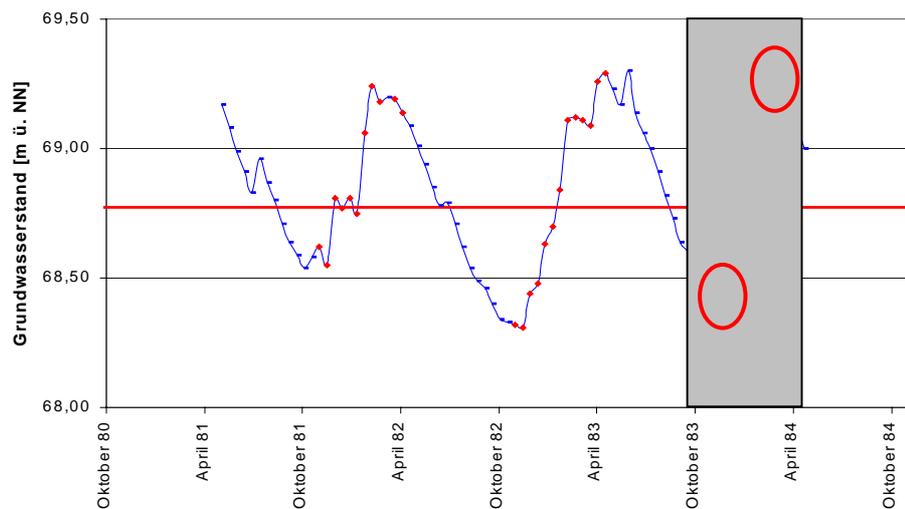


Fig. 1: Short-term fluctuation of the groundwater-level within the year 1983/84 (grey)

In addition to this yearly cycle the change of the groundwater-level is also a subject to long-term fluctuations over tens of years. Fig. 2 shows a long-term monitoring of the local groundwater-level since the year 1961. Obviously extraneous water from groundwater sources was not a problem in 1996 whereas observations in the year 2000 showed an appreciable infiltration problem in the first months. Therefor representative information about the infiltration of extraneous water from groundwater-sources always have to be analysed on the background of a fluctuating groundwater-table.

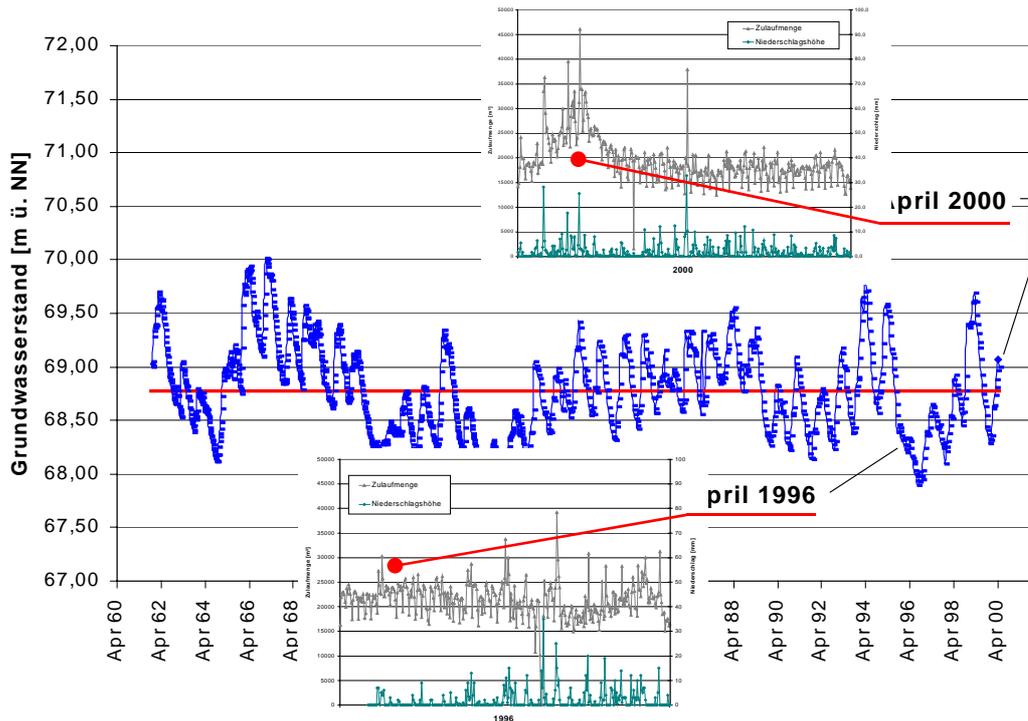


Fig. 2: Long-term fluctuation of the groundwater-level

Beside this groundwater-infiltration can only be measured separately at times without any sewage-flow in the system. Therefore experience shows that the night-time between 2 and 4 h in the morning seems to be the best time to measure and locate extraneous water without any distortion by the normal sewage-flow.

Discharge Measurements

Discharge measurement can be a first tool to locate groundwater-infiltration sources - especially to track down main problem-areas in a sewage system. The discharge measurement should start at the treatment plant at which in most cases the discharge is continuously recorded anyway. From there the main junctions of the sewage system have to be identified in which the discharge could be monitored with purpose to identify main-infiltration-areas. Depending on how many measuring points (usually manholes) are observed the infiltration-sources can be narrowed down to a more or less wide problem-area of the sewage-system. The most detailed information showing the infiltration-flow of this section are granted by measuring the change of discharge between two manholes.

Sewer-TV-Inspection

In many cases the discharge measurement will not provide sufficient information about where to find infiltration-sources. Further information concerning infiltration-sources between two measuring points can only be achieved by the use of Sewer-TV-inspections.

Sewer inspections during the night between 2 and 4 h will help to show whether public or private sources are the main cause of infiltration. Private sources can be detected by a short observation of house connections. For this standard camera-

systems that are used for the inspection of public sewers are very efficient already. For preliminary examinations satellite camera-systems are not needed. To estimate whether a rehabilitation of the public sewer would be effective only a differentiation between the number of public and private sources is important. Less important is any information concerning the source of private infiltration-flow. This means that at first stage there is no need to know whether the leaking of private pipes or a private drainage system is the source of infiltration.

For identifying private infiltration sources within an area mostly affected by extraneous water (discharge measurements), every house connection has to be observed by TV-inspection. For this the standard camera-system is positioned in front of each house connection while a possible inflow of extraneous water from the private house connection is observed and documented. Beside the fact of a present inflow the following subsidiary information may be gathered:

- the position of the house connection (right, left, zenith and distance from the last manhole),
- the source of extraneous water (inflow from private sewer or infiltration through damaged house connection) and
- the approximate quantity of extraneous water (as evaluated by the inspecting operator).

Regarding these information the consequences of a rehabilitation of the public sewer system could roughly be foreseen. Depending on the number of house connections delivering extraneous water into the sewer system a future rehabilitation plan will have to consider both - the public and the private sewerage pipes. Otherwise a simple rehabilitation of the public sewer system would not provide a sustainable solution of the infiltration problem.

Even an actually less affected private sewerage system shall not be left unregarded while rehabilitating the public sewer because of the rising groundwater-level then re-entering the sewerage system by infiltrating through private house connections.

The Results

For further use the results of both investigations can be summarised in the form of two maps of which one

- is achieved by discharge measurements (fig. 3), showing the measured infiltration-flow as well as the main-infiltration areas (much infiltration - red, moderate infiltration - blue, less/none infiltration - green)
- while the other (fig. 4) shows all private house connections at which an infiltration-flow could be proved by the use of sewer-TV-inspections.

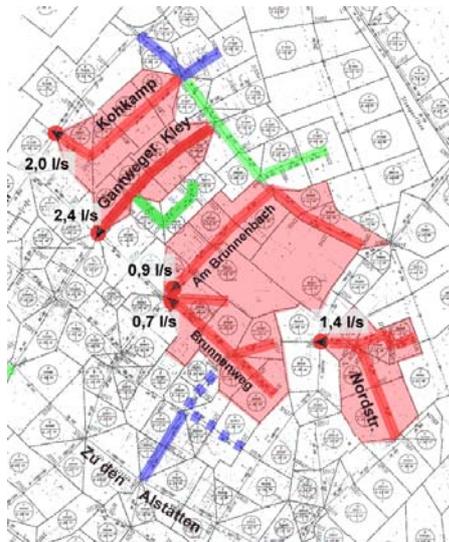


Fig. 3: Main infiltration areas (red)

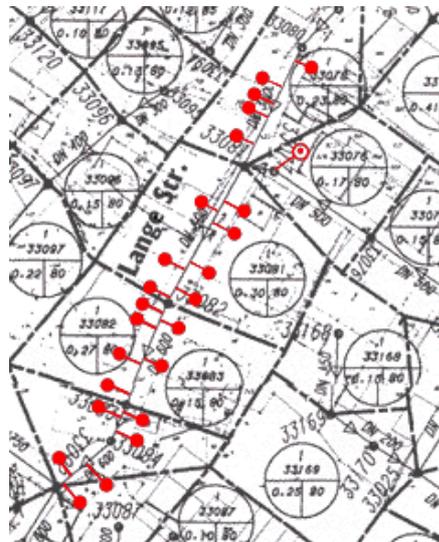


Fig. 4: Infiltration flow from private house connections

Both data especially these about observed private infiltration sources (fig. 4) may easily be transferred into a central electronic based register such as geographical information systems (GIS). In addition to the observed infiltration-inflow the register may easily provide more detailed information about

- the position of the house connection,
- the owner of the connected realty and
- eventually the age and material of the private house connection.

As a result the register could be used as a perfect tool supporting any further rehabilitation planning.

The Rehabilitation

Regarding the common fact that many private house connections are even more leaking than the public sewerage systems are, a rehabilitation will in most cases have to include a number of private sewage pipes. For this the results from a standard TV-inspection will not provide sufficient information about the actual conditions of the private house connection. Among other things additional information would be needed about the sources of extraneous water.

Therefore at this stage of rehabilitation-planning only a satellite camera-system will show whether a leaking pipe or a private drainage system are the sources of groundwater infiltration flow. The results of this TV-inspection may be added to the already existing register of private house connections delivering groundwater into the public sewerage system. The register may be extended by additional data (fig. 5). Such as

- observed damages: kinds of damage (photos), positions of damage and significance of damage,
- rehabilitation: suggested methods and reckoned costs.

Containing these information geographical information systems could be a new tool for all stages of a rehabilitation process:

- The stage of planning: Supporting decisions by a concise information-management, e.g. concerning the results of any TV-inspection.
- The stage of public information: Briefing private owners about the conditions of their house connection, e.g. by showing camera pictures.
- The stage of rehabilitation process: Monitoring the development and problems of the rehabilitation, e.g. actual and allocated progress, managing costs and external services.



Fig. 5: A Geographical Information System (GIS) supporting the rehabilitation process for private house connections

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