# International Research Project: IKT Tests Passive Root Protection Measures in a Globally Unique Experimental Setup


IKT Managing Director Roland W. Waniek (l.) and Leo Bloedjes from the city of Almere, Netherlands inaugurate the test facility and the information board.

**Sewers and tree roots**—this gets the alarm bells ringing for pipe network operators, because with root ingress, for example into **sewers** is something they are struggling with almost daily. In other networks, such as **district heating**, gas or drinking water, the **roots around pipes** are more problematic, as they can transfer enormous loading during storms, for example. You don’t want roots in the pipe trench and especially within the pipes.
But, you don’t want to start chain sawing the **green infrastructure** of the city. Fortunately, there are **innovative products and processes** that may help keep the roots away from the pipes. Whether they can really do this is currently being

investigated by IKT in an **international project** together with partners from The Netherlands. Passive measures to protect pipes from root ingrowth such as plates, low-porosity backfill materials, mats and special pipe joints are being tested in a **test setup** that is **unique in the world**.

Pipelines and roots: The newly planted trees are part of the test facility which is investigating passive root protection measures.

This open-air test area was set up by IKT in cooperation with IKT Nederland, the city of Almere and the RIONED foundation in The Netherlands. This project investigates how effective **ecologically sustainable concepts** for resolving conflicts between urban green areas and underground pipelines can be.

## Watching the roots grow

**Five trees** have been planted along two sewer pipes in a new development area in the City of Almere, near Amsterdam, whose roots are now under observation, in the truest sense of the word, because glass panes were installed at two points so that you can actually **watch the roots grow**.

## Explaining research in an understandable

## way

Research made visible: a new information board explains the project, the experimental setup and the goals.

In order for residents and passers-by to understand what the system is all about, an **information board** has been set up to explain the project and its goals in a comprehensible way. **Leo Bloedjes** from the city of Almere, IKT project manager **Mirko Salomon**, IKT Nederland branch manager **Sebastiaan Luimes** and IKT managing director **Roland W. Waniek** inaugurated the experimental set-up and the information board.

## 24 systems under test

24 systems made of various materials were installed on the sewer pipes and in the pipe trenches of the test facility to provide **passive protection against root ingrowth**. These include special pipe connections, low-pore backfill materials, plates and mats. The **products and processes** that are being evaluated were selected by the client, i.e. they are the systems of particular interest for the city of Almere.

## Safe lines under the green city

In this international research project, the **effectiveness of the installed systems** is now being investigated over a period

of several years. The first excavations to examine their performance are planned for Floriade 2022, the International Horticulture Exhibition Expo that takes place in The Netherlands every 10 years, and in 2022 has the Theme **Growing Green Cities**. Almere is hosting the Expo and experimental set-up is near the exhibition grounds and the participants think that this is really a good fit with that theme.

Even before the excavations, the experimental setup provides insights into the subsoil.

After the excavations, the **barrier function** of the systems against growing tree roots will be analysed for the first time. The researchers will then derive initial **recommendations and guidance** from the results, which support network operators in **selecting suitable root protection measures**. In addition, these long-term performance considerations can also provide valuable information for the **development or optimization of products and systems** for root protection of pipes.

## Keeping roots and pipelines at a distance

Underpinning this is the fact that underground pipes and the roots of the city trees share the same **ground space** and repeatedly clash. Due to high groundwater levels in Almere, the **space conditions under the roads** are particularly cramped. Underground sewers have to be installed in Almere at depths of

only about one meter below the ground level. In the past, to avoid later root ingrowth where new underground pipelines were being installed, individual trees were felled as a precautionary measure. In times of **climate change**, this is a very unpopular measure, which one absolutely wants to avoid in the future. Therefore, the Gemeente Almere is very interested in **new concepts** that combine a **green city** and optimal **protection of the pipes** against root ingrowth.

## Do systems work in the long term?

Sheets, foils, pipe connections, backfilling materials: The test set up contains 24 passive root protection measures.

The aim here is either: to make the **bedding area** of the pipes as **unattractive** as possible **for roots** (low-pore backfill materials); to **direct root growth** into harmless areas (using plates and foils); or to prevent the roots from growing into the pipe (casing pipes and using root-resistant joints). Whether these measures can keep the roots away from the pipes over a long period of time and **effectively prevent roots from growing around or into the pipes** has hardly been researched to date.
With this international research project, the participants want to make a **contribution to a better urban environment**, greener cities and safer sewer operation. And contribute to

better relations—between pipe network owners and tree owners as well as between neighbouring countries.

Where are they going? The first roots from the trees can be seen on the glass panes of the test facility.

And for the people visiting the test facility there is already something to see: The **first roots have appeared** behind the viewing panes.

### Web guide

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# IKT Compare: Can Short Liners Repair House Connections?

How do short liners perform? IKT figured it out in its latest IKT Compare project.

**Short liners** are often the first choice for **repairing local damage** in house connections. But, can they deal with **seriously damaged pipes**? The results of the new **IKT-Compare project "Short Liner for House Connections"** are now available.
IKT institute has found in its most recent IKT-Compare project that in principle short liners (also referred to as patch or point repairs) can make **good quality repairs** to house connection pipes, even when the pipe is **severely damaged**. Eight short liner systems were tested and achieved scores ranging from **"VERY GOOD"** to **"SATISFACTORY"**. The evaluation did find significant **differences in performance** between the systems that were examined.

**Twinbond Liner** was the best performer with a score of **VERY GOOD (1.2)**. Second place went to **epros DrainPacker** (Trelleborg) also graded **VERY GOOD (1.4)**. Bodenbender Point-Liner-System (1.7), Berolina Repair System (2.5), Cosmic TopHat system (2.5) and MC Konudur LM-Liner (2.5) each received a GOOD grade. Alocit short liner (2.7) and I.S.T. Spot Repair System (2.9) were graded SATISFACTORY.

The project has been undertaken in co-operation with **twelve sewer network operators** which wanted to understand the **strengths and weaknesses** of this widely used technology. It has been **funded** by the North Rhine-Westphalian **Ministry of the Environment** and the **network operators**.

Download table of results
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## Tough testing of short liners

Deliberate defects: IKT has installed eight test sections with a total of 64 cases of damages in its large test pit.

A rehabilitation using a short liner should be able to restore the **structural stability** of a pipe, secure its **hydraulic performance** and **seal a damaged area**. For this reason, the IKT Compare team and the network operators involved placed particular emphasis during testing on the **water tightness**, **operational reliability** and **structural stability** of the rehabilitation. The particular focus was **resilience external water pressure**.

## Test set-up damage scenarios

For this project IKT built eight identical **1:1 scale rigs**, in its large-scale test pit (15m by 6m by 6m), into which suppliers installed their short liners. Each rig comprised a

length of sewer to which were attached one **house connection pipe** on the same level as the sewer pipe and two house connection pipes from a higher level. The house connection pipes were prepared with **defined areas of damage**, including milled patterns of **cracks**, the removal of some or all of the **joint seals** and **broken sections**. A total of **64 damage patterns** were produced – eight in each of the eight test rig setups.

Two up, one down: the test set-up.

These **patterns of damage** were arranged as follows:

- **Test Setup I** (the lower house connection pipe, to which a 2m head of external groundwater was subsequently applied): cracks, a broken joint, a radially displaced joint and a joint displaced at an angle
- **Test Setup II** (the two higher house connection pipes, to which a 1m head of groundwater pressure was subsequently applied): a defective change of pipe material, defective change of pipe diameter and material from cast iron DN 150 to PVC DN 125, a defective change of pipe diameter and material from clay pipe DN 150 to PVC DN 125, and a break in the joint of a 45 degree bend

Following **installation** of the eight different short liner systems into separate test rigs, an **extensive testing programme** began, starting with initial **visual inspection** and **leak tests**. This was followed by short-term and long-term

**external water pressure tests**, **high-pressure jetting** at different pressures and using different types of nozzle, simulated **backing-up of water**, **changing groundwater levels**, and **cleaning** with rodding devices.

Frequent visual inspections and leak tests were undertaken as the programme progressed. Finally, when the test rigs were exhumed from the test-pit, the **cross-section reduction** was measured and the **adhesive tensile strength** and **ring stiffness** of the installed liners were assessed.

## Grading of performance

In-situ tests: lab tests were validated through in-situ observation of the same systems being installed at actual construction sites.

In addition to physical tests, the **QA/QC procedures** were examined. The laboratory results were validated through **in-situ observation** of the same systems being installed at actual construction sites. The **final scores** in this IKT Compare test are based on these three evaluations. The **range of grades** applied is from VERY GOOD (score of 1.0) to INSUFFICIENT (score of 6.0).

## Weighting of scores: Water Tightness counts for the most

To derive the final scores the results of the **1:1 scale testing system tests** were given a **85% weighting** and the results of the **QA/QC** evaluation **15%**. For the 1:1 scale test score, the three test criteria were weighted as follows: “water tightness” (60 percent), “operational reliability” (20 percent) and “structural stability” (20 percent).

Ongoing observation. IKT testers regularly check the installed short liners for leaks.

The assessment of QA/QC comprised **five criteria**: the installation manual, the available training courses, the system’s DIBt (German Government’s approval body) approval, external production monitoring, and a comparison between the installations observed in the laboratory and in the field. The results for each criteria were given a 20% weighting in the final QA/QC score.

In addition to the test criteria used to derive the comparative scores of the systems, **supplementary information** was collected and presented that would be of interest to the end user. These include results from **internal pressure tests** undertaken after the rigs were excavated and the **adhesive tensile strengths** of the liner bonding to the host pipe. The **preparatory measures** undertaken by the installer, such as

initial inspection, substrate preparation and cleaning, were documented. Also presented are: the number of on-site working days, the number of installation staff, the time required for preparatory work and installation, and the costs.

### The Steering Committee – twelve cities

**Members** of the Steering Committee for the IKT Compare project "Short Liner for House Connections" are the following German **cities**: Billerbeck, Burscheid, Dortmund, Duisburg, Düsseldorf, Gelsenkirchen, Göttingen, Hagen, Herne, Rheda-Wiedenbrück, Schwerte, and Arnhem from the Netherlands.

## What the systems can do

Repair objective: to seal damaged house connections.

In this IKT Compare project, the system suppliers demonstrated that **serious damage** to house connections can be **reliably sealed** using short liners, including breaks, cracks, misalignments and deflections. In particular, the **Twinbond** and **Trelleborg** systems proved to be the **most reliable** under permanent groundwater load, jetting, simulated backflow events and changing groundwater levels. For this they were deservedly awarded the **score of 1.0** for water tightness.

## Special Challenges

In principle, it was also shown to be **possible to seal** the changes in nominal diameter and pipe material in **Test Setup II**. However, four of the systems came up against their **performance limits** here, showing weak points, which led to **infiltration**. In one case, gushing water was visible immediately after installation. Therefore, changes in diameter and material require **special attention** during installation.

## Results of Test Setup I

All eight short liners showed **very good** to **satisfactory** results for the four damage patterns in **Test Setup I**: cracks, broken joint, radially displaced joint and joint displaced at an angle. **No infiltration** was observed during the whole test period. However, about half of the systems showed **visual abnormalities** in the form of moisture and/or discoloration at some locations, but without the formation of droplets.

## Structural stability assured

Adhesion test

The structural stability testing of the short liners showed that they basically have **reliable adhesive and load-bearing performance**. For products with full-surface bonding of the liner to the host pipe, hardly any abnormalities were observed, i.e. no crack formation, no excessive deformation,

no stability failure nor large-surface loosening of the adhesive bond. Five systems showed **partial loosening** of the adhesive bond at points of changing diameter or pipe material, albeit without any consequences.
The Cosmic system is not intended to bond over the full-surface, only at the start and end of the liner. However, the supplier was able to submit a **static proof** which confirmed the structural stability of the short liner observed in the test.

## Operational activities

High-pressure jetting did not affect the short liners.

The test scenarios **simulating sewer operation**, such as high-pressure jetting, water backing-up in the pipe, and changing groundwater levels, had **no significant effects** on system performances.

## Good QA/QC

There were **no issues** with quality assurance: seven out of the eight systems fulfil all the criteria for quality assurance and receive a grade of 1.0. The Cosmic system does not have a DIBt approval and so gets a grade of 2.0.

## Conclusion

In conclusion the IKT Compare project “Short Liners for House Connections” has demonstrated that **short liners can renovate**

**even severely damaged sewer pipes**. However, changes in diameter and material require special attention during installation as they might cause serious problems. It is important to select the **right system for the task**, to understand the limitations of individual systems, and apply the necessary QA/QC before, during, and after installation.

Download table of results
Download product test report (German)

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**IKT Compare: How good are products really?**

Defined damages: preparing the test rigs

**The objective** of IKT Compare projects is to provide network operators with **reliable, neutral, and independent information** on the strengths and weaknesses of products and methods in sewer technology. IKT Compare projects are always undertaken **in collaboration with network operators**. Their representatives form a **steering committee** which takes all important decisions on how to test the products.
At the core are **tests under realistic service life conditions**

such as traffic and ground loads, groundwater pressure and high-pressure jetting.
Each IKT Compare project is accompanied by a steering committee set up of network operators. The committee meets regularly and takes decisions on:

- products to be tested
- scope of the test programme
- test criteria
- test set-up
- final grading and assessment of the test results

The actual testing and documentation of the results are carried out by IKT, as a neutral and independent institute. As a result, network operators are provided with **independent, practice-related, and technically well-founded information** on the strengths and weaknesses of products, their applications and limits.

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# Inspecting pressure sewer pipes: Potential, requirements and results


Test rig: IKT research on inspection and condition-surveying of pressure sewer lines

Pressure sewer pipes are well down a sewer operator's list of their favourite parts of the network. Because there are **no inspection or maintenance ports**. Because the precise location of the pipe is often not known. Because **numerous bends** obstruct the flow. They can be found in practically all drain and sewer networks, but their characteristics and their special design confront sewer network operators with a **real challenge** when it comes to inspection and condition surveying.

## Legal provisions

Pressure sewer lines are subject to the legal provisions concerning **inspection** and **condition survey**, as defined for example in German federal states' regulations for self-inspection and **self-monitoring**. Sewer network operators frequently find themselves facing special challenges in implementing the required inspection work. High points and low points with no valves complicate draining and venting. There is a **danger of blockages** of the gravity system if pump operation is interrupted, with the potential for **back-ups** and flooding.

## IKT research project

The IKT research project "Inspection and condition-surveying

of pressure sewer lines and culverts”, which was conducted by IKT jointly with more than twenty sewer network operators, found that **life-cycle observation** of pressure sewers is becoming ever more important. The main results provide sewer network operators and technology suppliers with better understanding of the requirements for **inspection technologies**, the performance of **water tightness tests** and the selection of **rehabilitation methods** for pressure sewer pipes. A qualitative **risk model** for prioritizing pipe-specific inspection, which is already being used by operators, is also discussed.

### Research Project: Pressure Sewer Lines

Read the whole article with key research results (PDF, 7 pages)

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# Manhole Rehabilitation: Comparative testing of 13 different methods

On-site installation conditions simulated in IKT’s large-scale test facility

Can **wastewater manholes** be rehabilitated so that they remain **permanently watertight**? What are the benefits and the drawbacks of mortar coating, plastic coating and lining. What quality can be expected? This first **comparative product test** in this field gives you the answers!
**“Now for the manholes”** – this is a train of thought in the repair/rehabilitation departments of many wastewater network operators. There is, indeed, little point in rehabilitating wastewater pipes without paying attention to the **numerous defective manholes**. This is particularly true in water infiltration zones, since a really watertight sewer network can only be achieved provided the manholes are also rehabilitated.

## Under test: thirteen manhole rehabilitation methods

Which of the many manhole rehabilitation methods should we choose? Which one will seal **reliably and durably**? Which is suitable in which situation, and which are not suitable? Thirteen commercially available methods have now been **analysed** in IKT‘s “Manhole Rehabilitation” Comparative Test. The **results** range from GOOD to ADEQUATE, with one method failing the test.

**Comparative Test: Manhole Rehabilitation**

Read the whole article with all test results (PDF, 10 pages)

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# Handling of drainage-system water from private sites


Illegal drainage system connection to a public sewer

The discharge of site and drainage-system water into the public sewer network is expressly prohibited in the majority of waste-water regulations in North Rhine-Westphalia. In many municipalities there are, nonetheless, numerous such drainage connections. How, then, should this issue be handled at local

level? A guideline drafted by the IKT and the NRW Municipal Agency (KommunalAgenturNRW) provides orientation.
There can be a range of reasons for connected water-drainage systems. It may be, for example, that a drainage system was actually intended only for the construction phase, but then remained connected “just to be on the safe side”. Or the drainage system might have been installed despite the ban on permanent drainage. Leaking building sewer laterals and site sewer laterals can also act as drainage systems. Why do the municipalities prohibit the discharge of ground and drainage-system water, and why is drainage-system water discharged, despite the ban?

Read more…

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# Municipal PR activities on private waste-water systems


The NRW environment ministry’s “Private waste-water sewers” image reference collection

In Phase 1 of this project for the Environment Ministry of the state of NRW, the tools and materials used to provide the public with information about private sewer pipes are to be refined. Various new mechanisms and tools are to be created or further developed for this purpose.
In addition, an aid to decision making about the refurbishing of site drainage systems is to be developed to assist owners and system operators through advisory services for the preparation and implementation of refurbishing projects. An image reference collection, developed during Phase I is also to be augmented, and verified.

## Project title

“Municipal PR activities on private waste-water system:
Communication concepts for PR work and investigations into damage assessment and advisory refurbishing services (Project Phase II)”

## Download report

(German version only)
NRW image reference collection – Private waste-water sewers (54 pages)

## Project management

IKT - Institute for Underground Infrastructure

## Client

Ministry for Climate Protection, Environment, Agriculture, Nature Conservation and Consumer Protection of the German State of North Rhine-Westphalia (MKULNV)

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