Uponor Infrastructure Solutions – Technical Handbook

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INTRODUCTION

1. Foreword

Clean water is our most precious resource. Only a tiny fraction of the world's water resources are fit for human consumption. Water management is crucial to human health and productivity and is a vital public service.

Uponor plays its own part in meeting these challenges. Our core purpose is to partner with professionals in creating better human environments. We have a long tradition in the development of pro-environmental, long-lasting , watertight and reliable products that save clean water and energy throughout their service life. Uponor products are also made from highly recyclable materials.

The technical development of the infrastructure solutions sector is a key aspect of our operations. Uponor is represented in a number of official and standardisation working groups tasked with creating practices and guidelines for the industry. We also promote the industry's development through our own training and publications. This Technical Handbook is our latest significant contribution in this area.

The manual is intended for the design and installation of infrastructure systems and to ensure the proper use of Uponor's products. A correctly designed and installed system will guarantee reliable operation for decades to come.

The manual is a continuation of our Designer’s Handbook for Municipal Pipe Systems. It is the culmination of years of dedicated product and service development and close collaboration between Uponor and our Nordic partners, and represents the latest in Uponor know-how, expertise and innovation.

Uponor Suomi Oy
Infrastructure and Environment

Uponor as a Partner

Uponor specialises in creating innovative, high-quality housing and infrastructure systems that improve people's well-being and quality of life.

Uponor's broad Infrastructure Solutions range covers gravity sewers, manholes, chambers and catchpits, cable protection conduits and pressure pipe systems. Its Building Solutions range includes heating and water supply plumbing systems, ventilation systems, wastewater treatment tanks and many other products.

Our comprehensive solutions are based on more than 40 years of experience and know-how. In addition, non-stop product development ensures our ability to deliver ever better solutions and ecologically friendly production methods well into the future.

Close customer cooperation has always been at the heart of what we do. We promote such cooperation by offering our customers professional training and cutting-edge technical expertise. A strong customer focus forms the foundation of our operations.

Our Customers

We count our ability to maintain good, close relationships with our customers among our key strengths. We view our customers as our cooperation partners. Together, we develop the industry, new technologies and best practices. The opinions and feedback of our customers are essential ingredients in the development and improvement of our products.

We invest strongly in maintaining a strong presence, and in exhibitions, fairs and annual meetings. This ensures that customers find it as easy as possible to keep in touch and give feedback. The result is open, fruitful dialogue.

Our large group of sales experts engages actively in productive discussions with the customer, receiving feedback and addressing any questions or issues.

Uponor Academy

Uponor makes professional training easy. Our Uponor Academy has been training professional partners and customers in Uponor systems installation since 2006. Academy programmes are designed for all professionals in the HVAC/plumbing field, including distributors, designers, installers, authorities, contractors and educators.

The Uponor Academy will provide you with practical instructions and advice on the correct and effective use of Uponor products, and on how to interpret regulations regarding their use and installation. Each training day includes a comprehensive theory component, followed by hands-on training on Uponor products. We also offer bespoke workshops tailored to specific installations.

Uponor Academy holds several training workshops, throughout the year. The training content is based on six core topics, each of which can be modified and supplemented as needed. For a precise training schedule, check the training calendar online at www.uponor.fi/Academy.

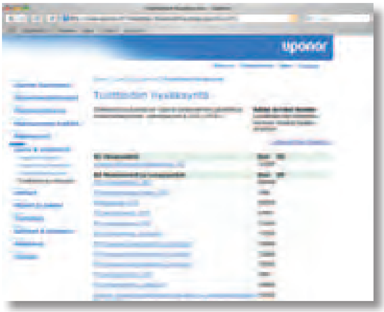
Uponor expertise

Uponor offers more than just product systems. We offer our customers comprehensive expertise, from installation planning and design to system handover, drawing on our more than 40 years of know-how and experience. In this way, we help our customers find the very best technical and economic solutions for their needs.

Uponor-yhdyskuntatekniikan käsikirja

We invest strongly in close dialogue with the customer throughout the process. This helps ensure that all parties are kept fully informed and that the project is carried out as cost-effectively as possible. Close cooperation also guarantees the right choice of systems and products. Whenever advice or technical support is needed, Uponor's specialists are always on hand and ready to assist. Our sales representatives are able to provide expert assistance in resolving technical issues, and the very latest know-how in the field is available direct from our product management team, which is responsible for all Uponor publications.

This Technical Handbook is designed to meet the need for technical information on Uponor's products, enabling our customers, product advisors and end users to make the best possible product choices. It also provides important guidance on the transportation, storage and installation of Uponor products. Our ultimate goal is to provide comprehensive, high-quality systems with a long and flawless service life.



The manual is also supplemented by our Uponor website, from which you can download CAD images of our products and check the latest system approvals. If you need any additional information or advice, you can always get in direct touch with your Uponor contact person.

1.1 Uponor and the Environment

Uponor is continuing its long history of investment in environmental performance improvement. An environmental programme was approved for Uponor in the year 2000, redefining the Group's principal environmental operating policies and standards, and establishing indicators for monitoring our work. The main principal behind the programme lies in taking more active account of the environmental impacts of our operations. By developing our working environment, we seek to become a leading provider of environmentally friendly solutions within our sector.

Our main objectives:

- development of environmental products
- continuous development of our manufacturing processes
- waste minimisation
- use of recyclable plastics

Environmental considerations are an intergral aspect of our operational system, which encompasses the requirements of the SFS-EN ISO 9001:2000 quality management system and ISO 14001:2004 standards at our Nastola and Forssa plants.

The goal of our operational policy is to secure Uponor's position as a reliable supplier of high-quality plastic pipe systems in its chosen business areas, in the most environmentally responsible way possible. Our quality management system has been certified since 1991 and our environmental management system since 1999. Uponor aims to become an environmental pioneer in the industry by exceeding official environmental standards. We are increasing staff awareness in line with our environmental programme – we all share responsibility for the environmental effects of our operations.

For more on our environmental commitment, visit us online at www.uponor.fi.

UPONOR INFRASTRUCTURE

MATERIALS AND SERVICE LIFE

2. Materials and Service Life

Plastic pipe systems form the basis of all modern water supply and sewerage networks.

Uponor's systems are based on three plastic types:

- polyethylene (PE)
- polypropylene (PP)
- polyvinyl chloride (PVC)

Of these, PE and PP are made from oil and are classed as thermoplastics. Thermoplastics can be moulded and melted at a high temperature; these properties are utilised in the production of pipes and fittings as well as their jointing and installation.

Uponor utilises the properties of thermoplastics in several manufacturing processes, such as

- pipe extrusion
- die casting of fittings and inspection chambers
- rotational moulding of manholes and inspection chambers, tanks and traps
- welding of fittings and special structures

Polyethylene (PE)

Historically, polyethylene (PE) has been classified as either low density (PEL or PE-LD), medium density (PEM or PE-MD) or high density (PEH or PE-HD). Material density has thus been used as a universal indicator of PE properties. However, since density alone does not describe PE properties with sufficient accuracy, a new grading system – defined by the ISO 9080 standard – was subsequently introduced in the 1980s. This new standard describes, for example, the durability of PE materials used in pipe systems, as calculated based on hydrostatic tests conducted under various pressure and temperature conditions.

Pipe material durability is expressed in terms of Minimum Required Strength (MRS). In addition to MRS, the thermal stability of pipe materials is also evaluated. Combined, these give an extremely accurate estimate of the service life properties of pipe materials.

Uponor currently uses the following polyethylene grades:

Grade	MRS (MPa)*
PE80	8,0
PE100	10,0

*) Minimum Required Strength, an indicator of long-term hydrostatic strength

Table 2.1

In addition to the density and durability of plastics, it is also important to verify their melting properties.

The Finnish Ministry of the Environment stipulates that the materials of PE potable water pipes must meet the ministry's requirements. As a result, Uponor continuously tests its raw materials, and finished pipes and fittings, to ensure that they correspond to set performance requirements concerning odour, taste, total organic carbon (TOC), phenols and turbidity.

Polypropylene (PP)

In recent years, polypropylene has been increasingly used in stormwater and wastewater systems, largely due to its high impact resistance and good temperature resistance in cold conditions.

PP ranks between PE and PVC in terms of stiffness, but has a lower density than PE. PP is especially well suited to the production of highly structured pipes and fittings.

As with PE, PP is also mainly described in terms of density, melt flow behaviour and thermal stability.

Polyvinyl chloride (PVC)

PVC is chiefly used for wastewater systems and high-pressure pipes. Used in Finland for half a century, this material has proven itself in terms of its high durability and stiffness properties, as well as resistance to highly aggressive substances.

Uponor only uses PVC-U (un-plasticised PVC), to which no plasticisers (phthalates) have been added. PVC is denser and stiffer than PE and has lower impact resistance in cold conditions.

The material's mechanical properties primarily depend on its molecular weight, which is measured by its U-value and Vicat softening temperature (VST).

Long-term testing of Uponor's PVC pressure pipe systems is performed in the same way as for its PE pipes, in compliance with the SFS-EN ISO 9080 standard.

All raw materials and finished pipes and fittings are regularly tested, to ensure strict compliance with Finnish Ministry of the Environment requirements regarding potable water pipes.

Material properties

	PVC		PEM		PEH		PP	
Ignitability	poor	–	high	++	high	++	high	++
Combustibility	no	–	yes	++	yes	++	yes	++
Tensile strength MPa	44	++	15	–	22	+	30	+
Elastic modulus MPa	3000	++	400	–	900	+	1250	+
Linear thermal expansion coefficient mm/m°C (Thermal expansion)	0,08	+	0,13...0,17	–	0,17	–	0,18	–
Thermal conductivity W/m°C (Insulating capacity)	0,16...0,21	++	0,32	+	0,43...0,52	+	0,22	++
Max. operating temperature °C - continuous	75	++	45	+	45	+	85	++
Max. operating temperature °C - momentary	95	++	85	+	85	+	100	++
Adhesive bonding capacity	yes	++	no	–	no	–	yes	+
Weldability	no	–	yes	++	yes	++	yes	+
Flexibility	poor	–	good	+	good	+	good	–
Impact resistance, cold (-20 °C)	poor	–	good	+	good	+	excellent	++
Impact resistance	good	+	excellent	++	excellent	++	excellent	++
Chemical resistance	(good)	+	excellent	++	excellent	++	excellent	++
Recyclability	good	+	good	+	good	+	good	+
Density kg/m^3 (Mass)	1400...1500	+	939...943	+	940...970	+	900...938	+
Oil / gas permeability	impermeable	+	permeable	–	permeable	–	permeable	–

Rating scale: – poor + good ++ excellent

Table 2.2

Virtually all materials change over time. Metal corrodes, stone weathers and wood decays. These ageing processes are caused by changes in the material's physical and chemical properties over time, due to external factors.

Plastics also age. The rate of ageing is influenced, for example, by the temperature and oxygen level of the operating environment. Over time, the bonds between polymer chains in plastics break down, causing the material to become brittle.

During production, additives are added to plastics to slow this process. These include substances such as antioxidants, which bind oxygen and thereby prevent the oxidisation of the plastic’s polymer chains.

Uponor ensures that the mechanical and chemical properties of its plastic products are preserved during the manufacturing process (e.g. extrusion and die casting) and throughout the service life of the installed system.

The design life – in this case the technical service life – of a plastic product refers to the product's in-service lifetime, after which the material's mechanical properties deteriorate through ageing, to the extent that the product no-longer meets its required performance criteria.

In most cases, the effects of physical and chemical ageing become evident only after very long service periods.

Uponor verifies the technical service life of its plastic products by conducting accelerated aging trials in controlled and closely monitored laboratory conditions.

Long-term material testing – accelerated aging

Accelerated aging reveals the effects on the tested product of chemical oxidisation and other deteriorating phenomena within a given time period.

By exposing a series of corresponding product samples to high temperature and humidity conditions, the point in time at which the product will no longer meet its performance requirements can be calculated.

Studies show that the rate of ageing virtually doubles with every 10 °C increase in temperature.

The technical service life of the plastics used in pipes and fittings can be calculated using compression tests carried out under different load and temperature conditions.

Example:

To determine the service life of a material in temperatures of +20 °C, accelerated testing is carried out at a temperature of +80 °C. If the material's acceleration factor is 2 per 10 °C increase, the result of testing at 80 °C (e.g. 14 000 hours) is multiplied by 64 (26, because the temperature difference is 6 x 10 °C). This gives a result of 896 000 hours, i.e. approximately 102 years. The test method (regression analysis) is defined in detail in the ISO 9080 standard.

The failure stress, calculated based on a 50-year service period and a +20 °C operating temperature, is rounded off to the nearest MRS value. This value, which serves as a measure of durability, is used in the design of pressure pipes.

Many material tests begun by raw material producers 50 years ago are still used today. To date, the results of these long-term tests indicate that accelerated aging is a realistic and reliable method of calculating the service life of plastics.

In the production of Uponor pressure and sewer pipe systems, we only use materials that meet the requirements of a service life of at least a 100 years. If installed correctly and used in normal operating conditions, our products give more than a century of reliable service.

Minimum required strength (MRS) as a function of temperature and time

Sample service life curve for Uponor PE80

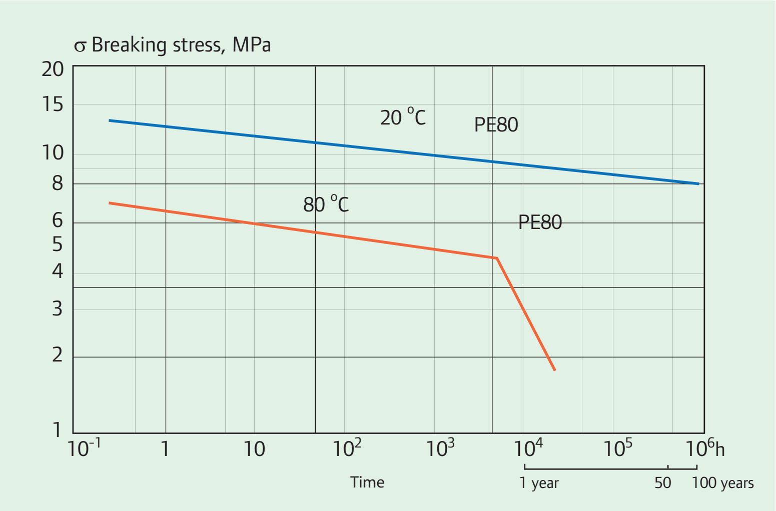


Diagram 2.3

Sample service life curve for Uponor PE100

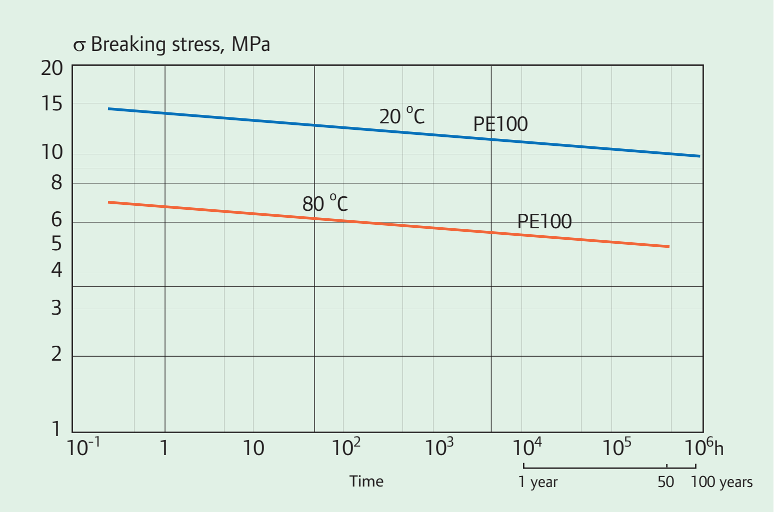


Diagram 2.4

Sample service life curve for Uponor PVC

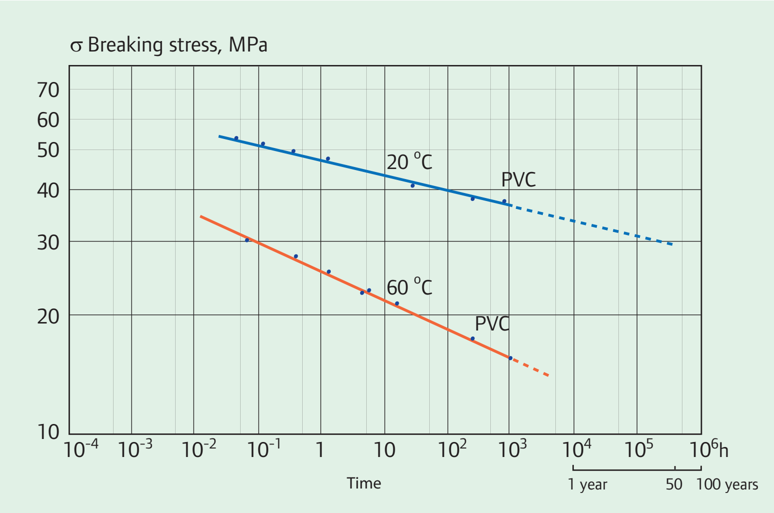


Diagram 2.5

Sample service life curve for Uponor PP

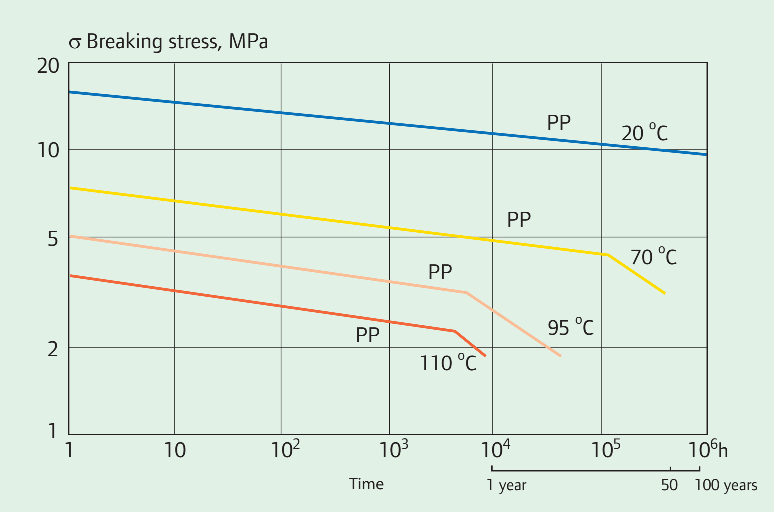


Diagram 2.6

Seals

The socket joints of Uponor's pressure pipe and gravity sewer system pipes and fittings are sealed with elastomer or rubber-based seals. These seals comply with standards EN 681-1 or -2 concerning the material requirements for pipe joint seals used in water and drainage applications.

The durability and deformation of the seals are tested and their oil and petrol resistance determined.

Uponor mainly uses the following seal materials:

- NBR: nitrile rubber
- SBR: styrene butadiene rubber
- EPDM: ethylene propylene diene monomer rubber
- TPE: thermoplastic elastomer

The table below shows the materials used in Uponor's systems.

System and material specifications

Systems/materials	Pipes	Fittings	Jointing methods
Pressure pipe systems			
Uponor PE pressure pipe system	PE	PE	Welded (PE)
Uponor ProFuse pressure pipe system for potable water applications		PE	PE Welded (PE)
Uponor ProFuse pressure pipe system for wastewater applications	PE	PE	Welded (PE)
Uponor ProFuse pressure pipe system for gas applications	PE	PE	Welded (PE)
Uponor PVC pressure pipe system	PVC	PVC	S (SBR)
Gravity sewer systems			
Uponor building sewer system, 110-160 mm	PP	PP	SO (NBR)
Uponor PVC underground sewer system, 160–400 mm	PVC	PVC	S (SBR)
Uponor Dupplex underground sewer system, 160–400 mm	PP	PP	S (SBR), SO (NBR)
Uponor Ultra Rib 2 underground sewer system, 200–560 mm	PP	PP	S (SBR), SO (NBR)
Uponor PE stormwater system, 800-1,600 mm	PE	PE	S (EPDM)
Uponor PP stormwater system, 110-893 mm	PP	PP	S (SBR)

S = Seal

SO = oil and petrol resistant

Table 2.7

Overall assessment of the system's service life includes testing of the long-term properties of pipe seal materials in accordance with the EN 14741 standard. Pipe joints are tested by monitoring the long-term properties of the joint seals in relation to compression stress. This is done to verify that the service life of the seal material corresponds to that of the PVC, PP and PE pipe materials.

Example seal service life test

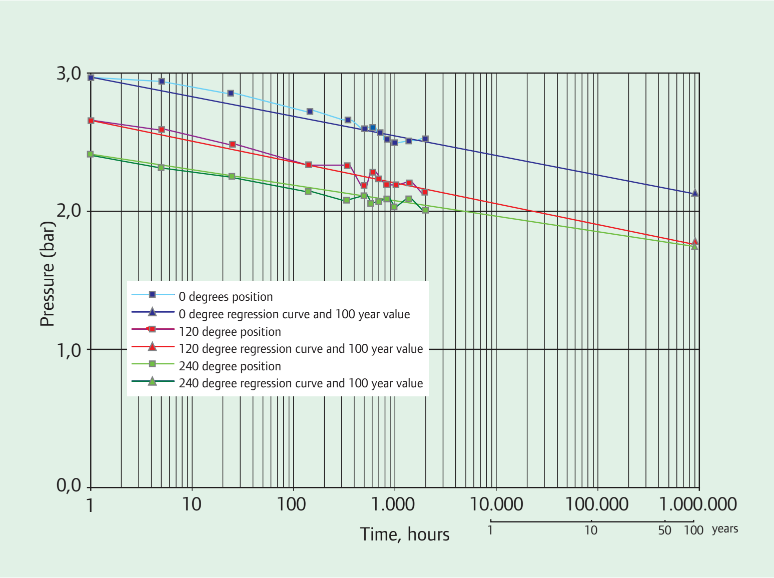


Diagram 2.8

Chemical resistance

Chemical resistance is measured on the basis of a range of variables, such as temperature, chemical concentration, time and pressure. If oil or oily fluids are to be conveyed to underground storm and wastewater pipes, or if such fluids are present in the pipe environment, the pipes must be fitted with oil and petrol resistant seals. These seals are marked in yellow.

Uponor pipe materials are highly resistant to all common chemicals encountered in normal operating conditions.

When considering material selection, consideration must also be taken of the jointing methods and pipe seals, as well as the pipe materials. The following table provides a useful overview of the chemical resistance of different pipe materials and components.

Chemical resistance

	Weak acids		**Strong acids**		**Weak alkalis**		**Strong alkalis**		**Petrol**		**Oil**		**Acetone**		**Sugar solution**	
	20˚C	**60˚C**	**20˚C**	**60˚C**	**20˚C**	**60˚C**	**20˚C**	**60˚C**	**20˚C**	**60˚C**	**20˚C**	**60˚C**	**20˚C**	**60˚C**	**20˚C**	**60˚C**
Pipes																
PVC	++	+	++	+	++	++	++	+	++	++	++	++	-	-	++	++
PP	++	++	++	+	++	++	++	++	++	-	++	++	++	++	++	++
PE	++	++	++	+	++	++	++	++	++	+	++	+	++	++	++	++
Seals																
NBR	++	+	+	-	++	++	++	++	++	+	++	+	-	-	++	++
SBR	++	+	+	-	++	++	++	+	-	-	-	-	-	-	++	++
TPE	++	++	++	++	++	++	++	++	++	-	++	-	+	+	++	++
EPDM	++	+	+	-	++	++	++	+	-	-	-	-	++	-	++	++

++ = Resistant
\+ = Partially resistant
\- = Non-resistant

Table 2.9

For detailed information on chemical resistances, see the following publications:

- ISO/TR 10358 "Plastics pipes and fittings – Combined chemical resistance classification table"
- ISO/TR 7620 "Rubber materials – Chemical resistance".

These standards describe the resistance, to more than 400 chemical substances, of common pipe materials.

Thermal effects

As mentioned above, the service life of plastics is determined by means of melt flow tests carried out under different pressure and temperature conditions. As the operating temperature increases, the material’s maximum permissible operating pressure decreases.

The recommended maximum operating temperature for PVC, PE and PP gravity sewer pipes is normally +60 °C, although the recommended maximum for Uponor's PE stormwater system is +45 °C.

Uponor pipes can withstand momentary (max. 2 min) temperature spikes of +95-100 °C, if the wastewater flow rate is below 30 l/min.

To guarantee pressure resistance, the recommended maximum temperature for PE pressure pipe systems is +40 °C and for PVC systems +45 °C, cf. standards EN 1456 and EN 13244.

However, higher pressures and/or temperatures may be used in special applications, where a reduced service life is acceptable. For more information, please refer to the pipe system manuals.

Pressure resistance of plastic pipes

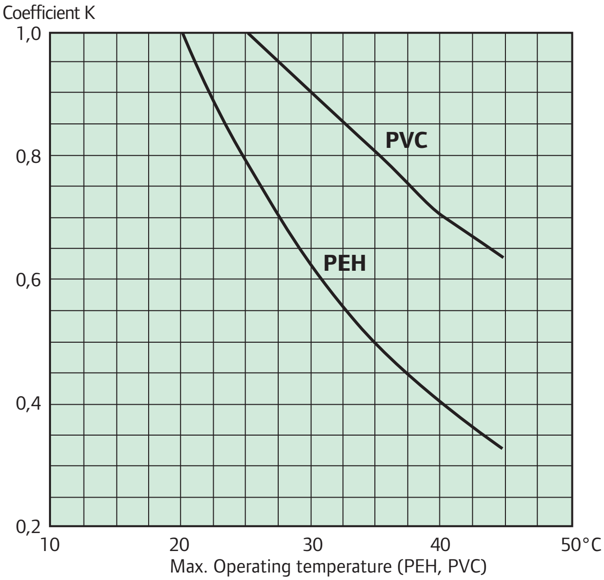


Table 2.10 pressure resistance coefficient K for PEH and PVC pressure pipes at different temperatures. Application: potable water. Design life 50 years.

Plastic grade	Marking
Polyethylene High-density PE-HD	02 PE-HD
Polyvinyl chloride PVC	03 PVC
Polyethylene Low-density PE-LD	04 PE-LD
Polypropylene PP	05 PP

Material recycling

A key requirement of ISO 14001 environmental management certification, as granted to Uponor Finland Oy, is the establishment of a recycling system for used and residual plastic materials.

All businesses, municipalities and other actors, who regularly handle construction waste containing rigid PVC, are encouraged to support environmental efforts by participating in the collection, recycling and reuse of their plastic waste.

If the product markings are no longer visible on the pipes, the pipe material can be identified by its specific weight. As a quick test: PE and PP float on water, while PVC sinks.

UPONOR INFRASTRUCTURE

QUALITY ASSURANCE AND PRODUCT TESTING

3 Quality Assurance and Product Testing

Uponor's quality management system covers all stages of its products' service life. Thus, the system not only ensures the quality of individual products, but is also used to manage the development of existing and future ones. In addition, technical advice, the handling of orders and claims, and other key processes are handled.

Quality assurance underpins all of Uponor's operations and continuous improvement is fundamental to the way we work. Our development processes go hand in hand with the latest technical developments and are continuously adapted to the changing requirements and needs of our customers and society.

Our continuous internal quality assurance system is centrally controlled by the Uponor Laboratory, guaranteeing uniform product excellence across all of our production facilities.

The Technical Research Centre of Finland (VTT) conducts independent quality certification inspections of our products and processes. Through these inspections, the entire Uponor quality assurance system is verified, from raw material reception to the handover of the ready product.

Quality certification

Our quality management process is based on the ISO 9001:2000 standard, under which Uponor has been certified (quality system approved by the Council of the European Union). Uponor chose to acquire the broadest level of quality certification – Module H. The H module includes Module E i.e. product tests and inspections, as well as monitoring and measuring equipment control. It also contains Module D i.e. production, inspections, finished product testing, production planning, purchasing and customer service etc. In addition, it covers development and design.

In addition to the finished products, the following areas are also subject to inspection

- Design and development
- Planning of product realisation
- Customer communication
- Purchasing
- Control of production and service provision
- Validation of processes for production and service provision
- Identification and traceability


DNV

Det Norske Veritas

Management System Certificate

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DNV

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Environmental certification

Uponor has a clearly defined environmental profile, aimed at its internal operating environment as well as the external environment. The effects of our operations, both on the working environment and the environment in general, are continuously monitored. Uponor's environmental management system has been awarded the ISO 14001:2004 environmental certification.

Uponor encourages businesses, public authorities and other actors to support environmental efforts by participating in recycling. Participants in the recycling programme handle waste materials, pipe waste (e.g. products damaged on site) and used products on a daily basis.

Plastic pipe waste is returned to local collection points, where the materials are efficiently sorted for recycling into new products.

Quality assurance

Uponor’s quality assurance begins before the raw material reaches the plant. Raw material suppliers are required to provide a production and testing certificate for each material batch prior to delivery. Samples are then taken from the batch for internal testing and inspection. Permission to unload the delivery is given only after the test results have been completed and approved.

Pipe extrusion is conducted under continuous inspection, and information is automatically collected on the extrusion process and the pipe dimensions. Samples are then taken from each completed production batch.

The products are systematically checked during or after production, for the following:

- Diameter
- Wall thickness
- Pipe length
- Weight (kg/m)
- Socket condition
- Ring stiffness
- Impact resistance
- Deformation
- Joint tightness
- Pressure resistance
- Tensile strength
- Density
- Melt mass-flow rate (MFR)
- Thermal stability
- Surface colour and quality
- Finished product

In addition to the above continuous inspections, our products are also subject to the following long-term tests in connection with certification and inspection by independent, external bodies:

- Combined ground loading and high temperature resistance test (box loading test, BLT)
- Internal pressure resistance
- Strohhalm test
- Long-term pressure resistance

Product Testing

Sample test methods and their practical applications

The test methods used serve as indicators of pipe performance in normal use. Brief descriptions of some of the main methods applied, and their relevance to pipe performance, are presented below.

1. Ring stiffness

Plastic underground sewer pipes are classified according to their short-term stiffness. Pipe stiffness class is a key consideration when selecting the right pipes for installation.

Ring stiffness is determined according to the EN ISO 9969 standard, using the measurement unit kN/m2. Immediately after installation, the average pipe deformation depends on the ring stiffness and the installation conditions, i.e. the installation method and ground consolidation. High ring stiffness and effective sealing reduce deformation, and are often leading requirements of pipe inspections. Various designations for ring stiffness have been used over the years. The following table shows the former and current designations:

2. Deformation test

Pipe durability in extreme load conditions is verified by the deformation test. The pipe must withstand 30% local deformation for a 30-minute period, without sustaining permanent damage.

3. Effects on joint tightness of angular and diameter deformation

This test is carried out in accordance with the EN 1277:2004 standard, but with tighter test deformation requirements applied. The test gives an accurate indication of joint tightness, in the wake of the kinds of deformation that can occur during pipe laying and trench filling.

Stiffness classes

Current designation	SN 2 (L)	SN 4 (M)	SN 8 (T)	SN 16 (E)
Stiffness according to ISO 9969 [kN/m^2]	Min. 2	Min. 4	Min. 8	

For cable protection products, the ring stiffness classes SN 8 (class B) and SN 16 (class A) are used.

Table 3.1

4. Impact resistance test

Uponor carries out impact resistance testing in accordance with the EN 744:1995 and EN 1411:1996 standards, in a temperature of -20 °C. This test reveals the pipe's resistance to sharp blows, such as occur during handling and installation. Tests are also conducted in extreme sub-zero temperatures, to verify their transportation and installation performance in Arctic conditions.

5. Combined ground loading and high temperature resistance test (box loading test, BLT)

Pipes, fittings and joints must be able to withstand the external phenomena to which each Uponor system will be exposed during its service life. Performed in accordance with the EN 1437 standard, the related test simulates pipe behaviour at high temperatures, while determining pipe resistance to traffic and ground loading.

6. Strohhalm test

The Strohhalm test was developed by Uponor in connection with the design of the Ultra Rib 2 system. The intention was to simulate and determine the sealing performance of pipe joints, for example, with respect to root penetration. This method measures the changes between the pipe socket and the seal after 2 000 and 10 000 hours. Based on a maximum joint pressure of 2 bar, the results are then extrapolated over 100 years. The current EN 14741:2006 standard has been developed based on this test.

7. Density

Density testing measures the density of pipe materials according to the EN ISO 1183-1:2004 standard. Plastics used for pipe production are MFR tested on a continuous basis.

The tests are carried out during raw material acceptance inspections, with the finished products being randomly spot tested. Through pipe density measurement, steps are taken to ensure that the correct material types and qualities are used for the right applications.

For example, the minimum density of PE used in pressure and gas pipes must be at least 930 kg/m^3.

8. Melt mass-flow rate (MFR)

The MFR test determines the melt mass-flow rate of a pipe material according to the EN ISO 1133:2005 standard. Plastics used for pipe production are MFR tested on a continuous basis. This method was originally developed for the characterisation of polyethylene, but is also applied to numerous other polymer materials.

For example, the following MFR is required for PE: $0.2 \leq \text{MFR} \leq 1.4$ g/10 min, using 5 kg at 190 °C.

Please note: Comparison of MFR values is only possible if the test methods used are fully congruent.

In addition to quality assurance, the MFR can also be used for determining whether different polyolefin pipes can be welded together.

9. Oxidation induction time (OIT)

The OIT test, conducted according to the EN 728:1997 standard, determines the oxidation induction time of the pipe material i.e. the level of antioxidants contained in the raw material, the pipe or the fittings. Antioxidants are desirable in polyolefin plastics (e.g. PP and PE) because they prevent the generation of harmful oxygen compounds when the materials are heated during production and welding. Oxidised PE is unweldable.

The minimum requirement is that PE pressure pipes or fittings intended for gas or water applications must be able to withstand 20 minutes of pure oxygen exposure at +200 °C.

The above tests and measurements represent typical examples of the types of tests and inspections which Uponor products must pass, depending on the product type and the intended target application.

Once the tests and measurements are completed, the results are finally collected in product protocols, and these are in turn recorded in our quality assurance database. The database enables complete traceability, down to the individual product or product serial number and further back to the subcontractor/ raw material supplier.

Uponor fully meets all product standards requirements and Nordic Poly Mark quality certification requirements. Uponor also implements additional internal quality requirements, which are described in the product sections of this manual.

UPONOR INFRASTRUCTURE

APPROVALS

4. Approvals and Certification

We view the accreditation, certification and type approval of Uponor products and systems as a vital aspect of our chosen quality control approach. The following sections give an overview of Uponor's product certification and continuous development processes. They also describe the general rules concerning product approval and their importance in guaranteeing the quality of our products and systems.

Uponor and product certification

Uponor actively participates in standards committees and working groups. On an ongoing basis, the aim is to ensure that product standards include effective, product-specific requirements, guaranteeing the safety of pipe systems and, ultimately, of the consumer.

Uponor water supply and sewerage systems are designed and developed to meet the high quality demands set by Nordic operating conditions. We continuously strive to optimise our pipe systems to meet the special needs of this market. Uponor's participation in the development of the Nordic Poly Mark quality certification scheme ensures that we have the right know-how to continue developing and offering premium quality products to the Nordic market. Uponor commissions independent audits of its systems, mainly from the SP Technical Research Institute of Sweden and the Technical Research Centre of Finland (VTT).

As a centralised function of the Uponor Group, product certification forms an integral part of the Uponor quality management system.

Because Uponor's products are manufactured in different production units, centralised quality management ensures that all products fully meet our strict quality standards, irrespective of where they are produced. In addition to national and international product requirements, Uponor's quality standards also include numerous supplementary requirements and inspection stages, from raw material reception to the handover of the finished product. These requirements are based on geometric requirements as well as mechanical and physical tests designed to ensure that the functional and service life requirements set for Uponor products are met.

Continuous quality assurance is a key requirement of our ISO 9001 certified quality management system.

DNV

DET NORSKE VERITAS

MANAGEMENT SYSTEM CERTIFICATE

Sertifikaatti Nro. 1179-2002-AQ-HEL-FINAS

Täten todistetaan, että

UPONOR NORDIC

UPONOR SUOMI OY: Forssa, Nastola; Suomi
UPONOR INFRASTRUKTUR: Fristad; Ruotsi
UPONOR A/S: Hadsund; Tanska

noudattaa seuraavaa laatujärjestelmästandardia:

ISO 9001:2000

Tämä sertifikaatti kattaa seuraavat toiminnot/palvelut:

MUOVISTEN PUTKIJÄRJESTELMIEN JA NIIHIN LIITTYVIEN TARVIKKEIDEN TUOTEKEHITYS, VALMISTUS JA MARKKINOINTI.

Paikka ja aika
Espoo, 2007-05-04

Akkreditoitu yksikkö
DNV Certification OY/AB

Kimmo Haarala
Johdon edustaja

FINAS
Finnish Accreditation Service
S001 (EN 45012)
(ISO/IEC Guide 62)

Sertifikaatin voimassaolo päättyy
2009-04-30

Alkuperäinen sertifikaatti myönnetty
1991-10-22

Tämä sertifikaatti on käännös alkuperäisestä englanninkielisestä sertifikaatista.

We have also been awarded ISO 14001 certification for the Uponor environmental system, which ensures continuous monitoring and mitigation of the effects of our operations on the environment, as well as continuous improvement of our internal work environment.

DNV

DET NORSKE VERITAS

MANAGEMENT SYSTEM CERTIFICATE

Sertifikaatti Nro. 1180-2002-AE-HEL-FINAS

Täten todistetaan, että

UPONOR NORDIC

UPONOR SUOMI OY: Forssa, Nastola; Suomi
UPONOR INFRASTRUKTUR: Fristad; Ruotsi
UPONOR A/S: Hadsund; Tanska

noudattaa seuraavaa ympäristöjärjestelmästandardia:

ISO 14001:2004

Tämä sertifikaatti kattaa seuraavat toiminnot/palvelut:

MUOVISTEN PUTKIJÄRJESTELMIEN JA NIIHIN LIITTYVIEN TARVIKKEIDEN TUOTEKEHITYS, VALMISTUS JA MARKKINOINTI.

Paikka ja aika
Espoo, 2007-05-04

Akkreditoitu yksikkö
DNV Certification OY/AB

Kimmo Haarala
Johdon edustaja

IAF

FINAS
Finnish Accreditation Service
S007 (ISO/IEC Guide 66)

Sertifikaatin voimassaolo päättyy
2009-04-30

Alkuperäinen sertifikaatti myönnetty
1998-12-01

Tämä sertifikaatti on käännös alkuperäisestä englanninkielisestä sertifikaatista.

Future products

Uponor invests in the continued development and improvement of its sewer and distribution piping systems. The development of new products is centralised and carried out in close cooperation with customers, end users, pipe system owners and subcontractors. We also collaborate closely with raw material suppliers, for example in the development of new plastics. Material properties have a major impact on end product characteristics and production efficiency. Uponor supplements its strong, in-house expertise in materials development as necessary, by partnering with external experts, such as material suppliers.

In many cases, no ready norms or standards are in place for new products. At the product development stage, Uponor creates a plant-specific factory standard, based on existing standards and supplementary requirements set for the new product. Such factory standards have been used as the basis for many current European EN standards – including several of Uponor's No-Dig systems and the Uponor PE stormwater double-wall pipe system. However, no standards yet exist for the largest diameter pipes.

Uponor is thus an innovative and leading partner in the development of infrastructure systems which benefit society.

Approvals and certifications

For details on approvals and certificates awarded for specific products, please refer to the relevant product sections of this manual.

The approval and certification of our products and systems is a continuous and evolving process. For the latest updates, visit us at www.uponor.fi.

Conformity of building products – CE marking and national systems

Due to globalisation and market liberalisation, products are increasingly subject to standardised international requirements, such as the European EN standards and CE marking. The Council of the European Union took the decision to introduce CE marking in 1993. The CE system presents guidelines for marking products for sale and use within the EU and the European Economic Area (EEA).

The EN standards specify the standardised characteristics that must be declared for products, and the methods used to declare them. CE marking, however, does not always require the declaration of all of these harmonised characteristics. Additionally, if product performance requirements for a given purpose are not stipulated within an EU member state, the manufacturer is free from any obligation to indicate product compliance.

The regulations of the EU Construction Products Directive were incorporated into Finnish law in 2003. This Directive aims to ensure the CE marking of building products and their compliance with six essential requirements for use in construction. Of these, the following three are of direct relevance to pipe systems:

1. Mechanical resistance and stability (ability to withstand internal water pressure and external ground pressure)
2. Safety in case of fire (applies only to installations within buildings)
3. Hygiene, health and the environment (leak-tightness, drinking water quality)

Under EN standards, requirements set on water and drainage systems represent only a fraction of those set under national product standards.

In the EU internal market, a pipe system owner cannot require products to be approved prior to installation, to fulfil a national standard or certification system, in order to verify their conformance with minimum qualitative requirements. However, the system owner can specify requirements concerning both the products and quality assurance including, for example, inspections by an independent inspection body.

All pipe products and sysyems based on harmonised European standards bear the CE mark.

Nordic Poly Mark and INSTA-CERT

Due to today's high construction costs, the majority of pipe system owners demand extremely long system service lives. A typical high-quality plastic pipe system has a design life of more than 100 years. Because the cost of pipes and fittings make up only a fraction of overall construction costs, high-quality pipes and connections are the most economic choice.

Nordic Poly Mark certification, a voluntary scheme controlled by INSTA-CERT, was established in response to efforts by the Nordic construction sector to maintain the Nordic region's high product safety and quality standards. The Nordic Poly Mark is a guarantee to the pipe system owner that the requirements stipulated in quality and safety standards, and in the scheme’s own special requirements for certification (SBCs), have been fully met in the manufacture, inspection and delivery of the pipe product.

The certification system is based on type testing carried out in connection with product approval, and on continuous internal and external inspections and quality assurance procedures.

Type testing and external inspections are conducted by an approved independent inspection body. Inspections include auditing of the producer's quality system, laboratory premises and equipment and personnel training, as well as actual product testing (internal inspections).

Independent inspection bodies responsible for the inspections must be INSTA-CERT approved, while inspection bodies within the plastic pipe sector must also be FINAS accredited.

The objective of the Nordic Poly Mark scheme is to ensure that high quality is maintained in Nordic plastic pipes. To achieve this, many additional special requirements, each rigorously tested by external research institutes, are set for Nordic pipe products.

Whereas the quality control of CE marked products is based solely on information given by the manufacturer, under the Nordic Poly Mark scheme quality control is always verified by an external body.

Comparison of CE marking and INSTA-CERT Nordic Poly Mark scheme requirements.

Comparisons between Uponor’s tightened requirements, CE marking and the Nordic Poly Mark can be found in the product sections of this manual.

Description/properties	**CE marking**		**INSTA-CERT Nordic Poly Mark**	
	Drain	**Pressure**	**Drain**	**Pressure**
Product certification				
Type test, third party	-	-	++	++
Internal control	+ [1]	+ [1]	++	++
External control, third party	- [2]	- [3]	++	++
Materials				
Density, PE/PP/PVC	-	-	++	++
Melt mass-flow rate, PE/PP	-	-	++	++
Thermal stability, PP/PE	-	-	++	++
U-value, PVC	-	-	++	++
Vicat softening point, PVC	-	-	+	++
Minimum required strength	n/a	+ decl	n/a	++
Product				
Dimensions	decl	decl	++	++
Appearance	-	-	++	++
Marking	-	-	++	++
Surface quality	-	-	++	++
Longitudinal reversion	-	-	++	++
MFR change	-	-	++	++
Impact resistance	-	-	++	++
Ring stiffness	decl	-	++	n/a
Pressure resistance	-	+	++	++
Dichloromethane resistance, PVC	-	-	++	++
Weather resistance	-	-	n/a	++
System				
Joint tightness	+ decl	decl	++	++
Combined ground loading and high temperature resistance test (BLT) (underground pipes)	-	n/a	++	n/a
Elevated temperature cycling test (building pipes)	++	n/a	++	n/a
Effect on drinking water quality	n/a	[4]	n/a	++

Comparison of scheme requirements

++ included at current Nordic level

\+ included, but at lower than current Nordic level

\- not included

n/a not applicable to application

decl manufacturer's declared value required

[1] Extent of internal control is determined by the manufacturer

[2] Fire properties can be submitted to third party control, depending on classification

[3] Drinking water tested by third party.

[4] Because CE marking requirements concerning contaminants are still under preparation, the levels relating to current standards in Denmark and Finland are unknown

INSTA-CERT certified products carry the Nordic Poly Mark and the relevant EN standard code.

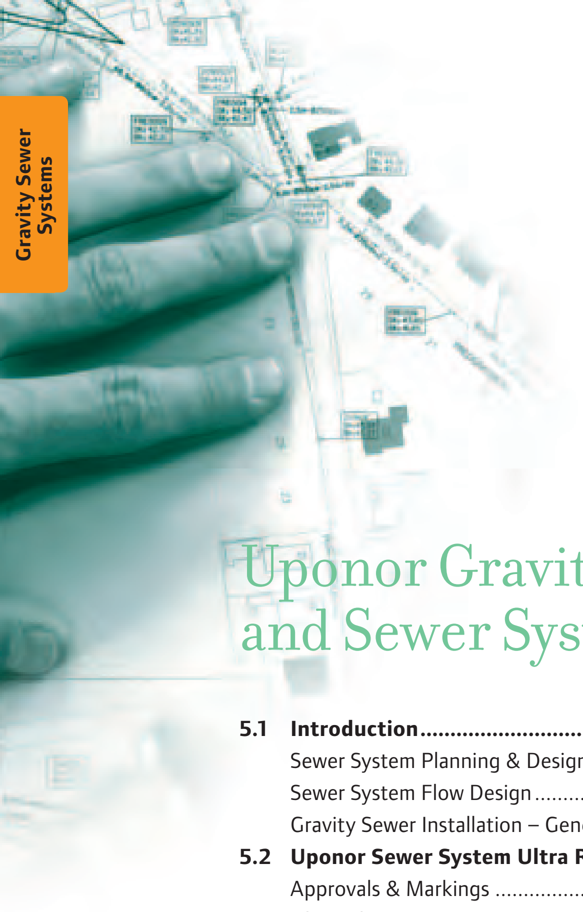
Table 4.1

EN standard and third party testing is conducted according to the same principles as the INSTA-CERT programme.

This programme, formerly based solely on Nordic accreditation rules (of the Nordic Committee on Building Regulations (NKB)), is now often derived from EN standards.

UPONOR INFRASTRUCTURE

UPONOR GRAVITY SEWER SYSTEMS



Uponor Gravity Drainage and Sewer Systems

5.1 Introduction

The plan regulations define the possible building types and geotechnical requirements for the site. To minimise the risk posed by the negative and unforeseeable environmental effects of storm- and wastewater sewer, investments must be made in safe, watertight and long-life systems.

Uponor's plastic storm- and wastewater systems offer complete piping solutions, from individual house connections to trunk networks. Uponor has a range of pipe systems suitable for all network designs and applications.

Gravity drainage and sewer systems

- Uponor Dupplex Sewer System
- Uponor Ultra Rib 2 Sewer System
- Uponor PVC Sewer System
- Uponor PE Stormwater System
- Uponor PP Stormwater System
- Uponor Chamber System
  - Uponor Chamber Packages
  - Uponor Modular Chambers
  - Uponor Bespoke Chambers

Land drainage

- Uponor Land Drainage System
- Uponor Field Drainage System

The table below shows the relationship between the system type, pipe size and the end-use application.

Systems and pipe dimensions	Application	
	Storm- and wastewater sewer	Stormwater drainage Subsurface drainage
Uponor Dupplex Sewer System 160-400 mm	x	
Uponor PVC Sewer System 160-315 mm	x	
Uponor Ultra Rib 2 Sewer System 200-560 mm	x	
Uponor PE Stormwater System 800-1600 mm	x	
Uponor PP Stormwater System 110-893 mm		x
Uponor Land Drainage Systems 50-315 mm		x

Table 5.1.1

This introduction section covers the general rules for the structural and flow design of storm- and wastewater sewers. It also provides a background for the following product sections.

Sewer System Planning & Design

A piping plan forms the basis of sewer system construction. Such a plan is drawn up on the basis of the pipe system's functional requirements and a geological survey of the installation site. Plastic pipes are flexible, functioning interactively with the surrounding soil. Pipe flexibility reduces the load on the pipe, while the earth pressure exerted on its sides increases the pipe's load carrying capacity through interaction with the surrounding soil. System design must take account of the possible installation of other pipe systems in the same trench, as well as freeze protection and thermal insulation requirements. The degree of pipe deformation, i.e. deflection, during pipe laying and backfilling is influenced by the following factors:

- pipe installation quality
- traffic load
- embedment and backfill material quality
- compaction
- groundwater level

Cross-sectional dimensions and trench configuration are presented in a plan drawing, based on the pipes to be installed in the trench, and their sizes and soil characteristics. Common pipe trench dimensions are shown in Figure 5.1.2.

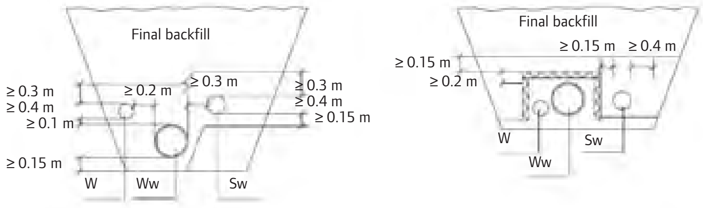


Figure 5.1.2. Typical pipe trench dimensions.

Buried pipe behaviour and deflection

Soil-pipe interaction exists between the buried pipe and the embedment (haunching and initial backfill) materials surrounding it. The nature of this interaction depends on the characteristics of the pipe and surrounding material. The behaviour of a buried plastic pipe can be described as follows (Figure 5.1.3).

Target

In ideal conditions, the earth and groundwater pressure are evenly distributed around the buried pipe (a).

Practice

The backfill above the pipe exerts a load on its upper surface (b). In the case of gravity sewers, maintaining the bedding at the required gradient causes loading on the under-surface of the pipe (c). If the pipe receives insufficient side-support from compacted surround material, its inherent stiffness will be insufficient to prevent it from partially flattening, or 'ovalling', if a load is exerted from above (b+c). This can be avoided by compacting the material on both sides of the pipe to form a consolidated, homogenous surrounding zone. Effective structural interaction between the pipe and its surrounding embedment (d) is thereby ensured.

If the plastic pipe is supported evenly around the entire pipe ring (i.e. circumference), the pipe will retain its original roundness.

When designing plastic gravity sewer systems and installing plastic piping, it should be recognised that the embedment materials beneath and around the pipe cannot always be placed in an entirely homogenous manner. Over time, what starts off as an even load on the pipe ring may become uneven and deviate from the pipe's ideal operating conditions. This causes the pipe to undergo deflection, changing from round to slightly oval, due to asymmetric loading with respect to the pipe ring (unevenly exerted earth pressure). The deflection of the buried pipe increases, until the vertical and horizontal components of the exerted earth pressure are in balance.

In order to ensure a long service life, pipes must be placed and embedded in such a way that, immediately after installation, any pipe deflection due to the non-homogeneity of the embedment and backfill materials is as low as possible.

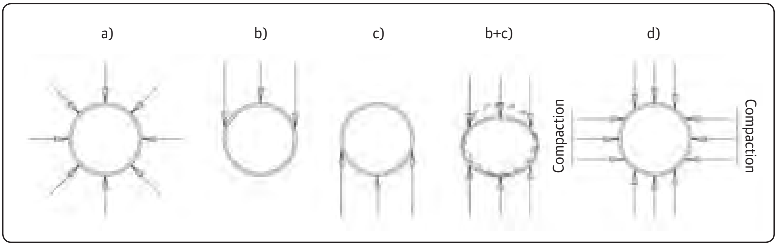


Figure 5.1.3 Buried plastic pipe behaviour. Schematic drawing.

As a guideline for the placement and consolidation of embedment materials, a maximum allowable pipe deflection limit should be set for the installed pipe. The limit value is expressed as the maximum allowable percentage change in the inside diameter, with respect to the design outer diameter of the pipe, compared to the calculated inside diameter of a perfectly round pipe, as measured after installation.

The deflection limit primarily depends on the pipe material. The maximum deflection values are based on the specification that, if these installation instructions are followed, the pipe deflection should not exceed 15% during the service life of the pipe system (50 yrs).

When assessing post-installation pipe deflection, account must be taken of the fact that the plastic pipe may be subject to 'ovalling' deformation during storage. In such a case, a degree of ovality will be present at the time of installation. This ovality must be included in the maximum post-installation deflection limit. Table 5.1.4 shows the maximum ovality tolerances of different plastic gravity sewer pipes. Tolerance is calculated as the percentage change in the outside diameter of the pipe, compared to the pipe's nominal outside diameter.

The values in the table represent the maximum allowable local deflection 2–3 weeks after installation.

If pipe deflection measurements carried out as part of the pipe system's approval inspection show values in excess of the tolerances given in Table 5.1.4, the causes of the deformation must be determined. The typical cause is careless placement and compaction of the pipe bedding and backfill. Based on the measurement results and the assessment of causes of deflection, deflection monitoring should be considered on a case by case basis. If long-term monitoring is required, a monitoring schedule must be drawn up. Deflection studies show that, if the external loading on the pipe remains constant, a plastic pipe typically achieves dimensional stability within 1-2 years after installation.

Maximum post-installation cross-sectional ovality and deflection tolerances for plastic gravity sewer pipes

Pipe material	Maximum pipe ovality %	Maximum cross-sectional deflection after installation %
PVC	1	8
PE	2	9
PP	2	8

Table 5.1.4

Installation conditions, for which structural calculations are not required

In the following installation conditions, where pipes of at least SN 8 stiffness are used, the load carrying capacity and deflection need not be calculated.

1. Depth of cover
   a. Min. 1.0 m for traffic loading areas and min. 0.8 m for pedestrian areas, yard areas etc.
   b. Max. depth of cover 6.0 m
2. Pipe installation works must meet the requirements of the 'demanding' or 'normal' installation categories, as follows:
   a. Demanding installation category
      i. Pipe must be placed on 15 cm deep bedding.
      ii. The bedding must be levelled and thoroughly compacted before laying the pipe.
      iii. Haunching and initial backfill along the sides of the pipe thoroughly compacted in max. 20 cm layers.
      iv. Mechanical compaction only at ≥ 30 cm backfill above the pipe crown.
      v. Standard-Proctor compaction density: ≥ 98 %.
   b. Normal installation category
      i. Pipe must be placed on 15 cm deep bedding.
      ii. The bedding must be levelled and thoroughly compacted before laying the pipe.
      iii. Haunching and initial backfill along the sides of the pipe thoroughly compacted in max. 40 cm layers.
      iv. Mechanical compaction only at ≥ 15 cm backfill above the pipe crown.
      v. Standard-Proctor compaction density: ≥ 95 %.
3. If the trench is supported, the trench shoring must be raised as the haunching and initial backfill compaction proceeds, to ensure no voids are left when the shoring is removed. If this is not done, the compaction will fail to meet the requirements of both demanding and normal installation.
4. Max. pipe diameter 1100 mm
5. Depth of cover / pipe diameter > 2.0
6. Bedding or backfill sand or gravel must be Class 1.

Ring stiffness selection – plastic pipe deflection

If the installation conditions are as described above, and all the related requirements are met, pipes of the SN 8 stiffness class can be used.

The chart on the following page shows the average deflection of the installed pipe (immediately after installation), as a function of ring stiffness and of the installation's classification as demanding or normal. These figures are based on extensive measurement trials conducted on installed pipes belonging to these two ring stiffness classes.

Pipe deflection can continue increasing for 1–3 years after installation. Experience suggests that deflection increases by around 1% at demanding installation sites and by about 2% at normal sites.

Deflection curve

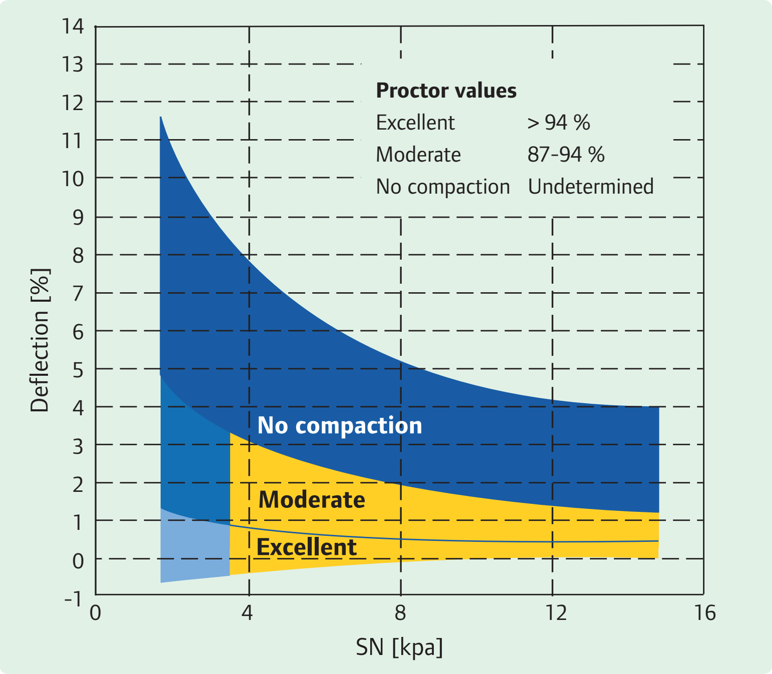


Diagram 5.1.5

Pipe ovality resulting from deflection affects pipe capacity, because the flow capacity of an oval pipe is marginally lower than that of a round one. The reduction in flow rate can be calculated using the following table.

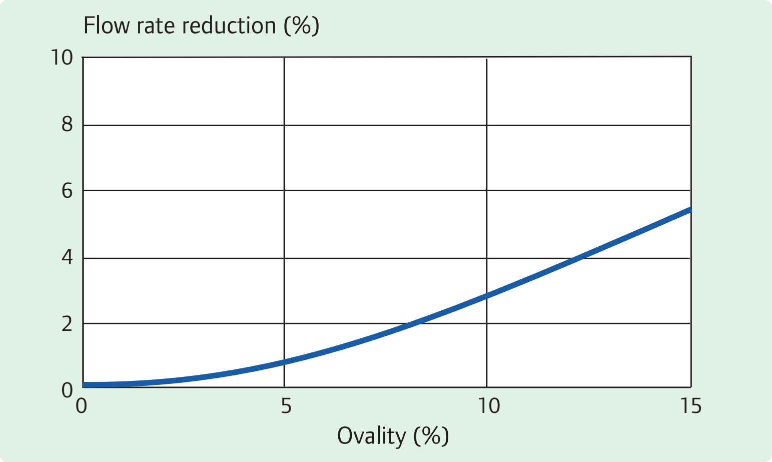


Diagram 5.1.6

Pipe supports

When installing a sewerage system beneath a building, where there is a high risk of the surrounding soil subsiding, the pipes must be supported. To ensure the sewer's stability and that it is protected from damage, support must be provided using pipe brackets of sufficient quality and number. Pipes must have no angular deformation and the gradient must remain unchanged over time.

Support brackets must be made of corrosion-resistant acid-proof steel. Because they corrode and fracture over time, galvanised and stainless steel brackets are insufficiently durable. Plastic brackets are also unsuitable, due to their plasticity: they stretch over time, causing the pipe gradient to alter.

Key pipe support requirements:

- ensure that brackets are sufficiently closely spaced
- use corrosion-resistant material
- ensure a stable support system
- ensure effective fastening to structures
- ensure sufficiently wide brackets for plastic pipes, thereby avoiding pipe damage.

Straight pipes must be supported at each and every socket. The bracket spacing distance depends on the type of pipe, the installation requirements and the earth loading. Support must be properly executed, to prevent pipe damage and loosening of the pipe joints.

Contact the Uponor Technical Support team for further assistance, if necessary.

Support spacing

When supporting PE pipes, the distance between brackets must not be too great, as this can cause the pipe to bend. The following tables show the bracket spacing for Uponor's systems.

The pipe support design must take different load factors, such as water pressure testing and pressure surges, into account.

Interior building pipes

	Horizontal sewer			
Vertical sewer				
Pipe diameter	**L1**	**L2**	**L1**	**L2**
32	0.5 m	2.0 m	1.0 m	2.0 m
50	0.5 m	2.0 m	1.5 m	2.0 m
75	1.0 m	3.0 m	2.0 m	3.0 m
110	1.0 m	3.0 m	2.0 m	3.0 m
160	2.0 m	3.0 m	2.6 m	3.0 m

L1 = distance between brackets

L2 = distance between fixed brackets

Table 5.1.7

Outdoor pipes

	Maximum bracket interval (guideline)	
Pipe type	**Horizontal sewer**	**Vertical sewer**
Uponor PVC Sewer System	10 x de (max. 3.0 m)	30 x de (max. 3.0 m)
Ultra Rib 2	10 x de (max. 2.0 m)	30 x de (max. 3.0 m)
Dupplex	10 x de (max. 2.0 m)	30 x de (max. 3.0 m)
Uponor PP Stormwater System	10 x de (max. 2.0 m)	30 x de (max. 3.0 m)
Uponor Pre-Insulated Sewer System	10 x de (max. 2.0 m)	30 x de (max. 3.0m)
Uponor PVC Pressure Pipe System	12 x de (max. 3.0 m)	30 x de (max. 3.0 m)
Uponor PE Pressure Pipe System	10 x de (max. 1.6 m)	30 x de (max. 3.0 m)
ProFuse	10 x de (max. 1.6 m)	25 x de (max. 2.6 m)

Table 5.1.8

Only use brackets specially designed for use with plastic pipes. Loose brackets allow axial thermal movement of the pipe. Since fixed brackets lock the pipe firmly into place, use fixed brackets on sockets and branch sections. Fastenings and brackets located beneath load-bearing base floors must be made of acid-proof steel.

When hanging socket pipes, a fixed bracket must be installed at the base of each socket. Loose brackets must be used between socket joints, to allow thermal movement. When supporting pressure pipe systems, the need for support due to pressure loading must also be taken into account.

Insulation requirement

Interior building pipes

Plastic pipes generate less condensation than metal ones. In practice, pipes must always be insulated wherever temperature differences might cause condensation. With respect to the insulation of pipe lead-throughs, fire safety regulations take precedence over moisture protection.

Special requirements for large-diameter pipes, stormwater basins, inspection chambers and tanks

Groundwater conditions must be given careful consideration in the installation of large pipes, stormwater basins and inspection chambers. Plans must take account, for example, of hydrostatic uplift, caused by groundwater, in chambers, tanks and oil and petrol separators. These factors are covered in more detail in the various product sections.

Sewer System Flow Design

When determining the pipe system's dimensions, for trouble-free operation it is important to ensure that the system has sufficient flow and self-cleaning capacity. Using a case study, this introductory section describes the design principles of storm- and wastewater sewers. The example given illustrates the design method, while the relevant design charts are presented in the appendix.

Gravity sewer design example

The correlation between hydraulic gradient and flow rate in a full pipe, as well as the speed of water flow, can be determined using the flow chart shown below.

From the Uponor Dupplex pipe chart, we can see, for example, that
a flow rate (Q) of 20 l/s and
a hydraulic gradient (I) of 6 ‰
(6 mm/m)
require the use of a d_e 250 mm pipe.

The total capacity of the pipeline is
$Q_t = 30$ l/s
and the flow velocity in a full pipe is
$v_t = 1.2$ m/s
If the minimum flow rate is, for example, 5 l/s, then
$Q/Q_t = 5/30 = 0.17$

As the chart for a partially filled pipe shows, at this filling ratio the relative water level is
$h/d_i = 0.28$
the relative flow velocity is
$v/v_t = 0.76$
and the relative hydraulic radius is
$R/R_t = 0.65$

In the above calculations, the pipe's outside diameter has been used. When calculating self-cleaning capacity, however, the inside diameter of the pipe is used, as this gives a more realistic value. For example, the inside diameter of a 250 Dupplex pipe is 216 mm.

Flow velocity
$v = 0.76 \times 1.2 \approx 0.91$ m/s
Water level

$$h = \frac{0.28 \times 216 \approx 60.5 \text{ mm}}{0.65 \times 216}$$

Hydraulic radius
$R = 4 = 35.1$ mm

The self-cleaning capacity of the pipe can be determined by calculating the friction stress using the formula

$T = \gamma \times g \times I \times R$

where

T = friction stress N/m^2

γ = density of water = 1000 kg/m^3

g = acceleration due to gravity = 9.81 m/s^2

I = gradient m/m

R = hydraulic radius m

In the above example, the friction stress is

$T = 1000 \times 9.81 \times 0.006 \times 0.0351$
$= 2.07$ N/m^2

According to research, a sewer pipeline can be regarded as self-cleaning if its friction stress exceeds 1.0 N/m^2. In the above case study, the sewer is self-cleaning, guaranteeing trouble-free operation. If the friction stress is below 1.0 N/m^2, the sewer gradient should be modified.

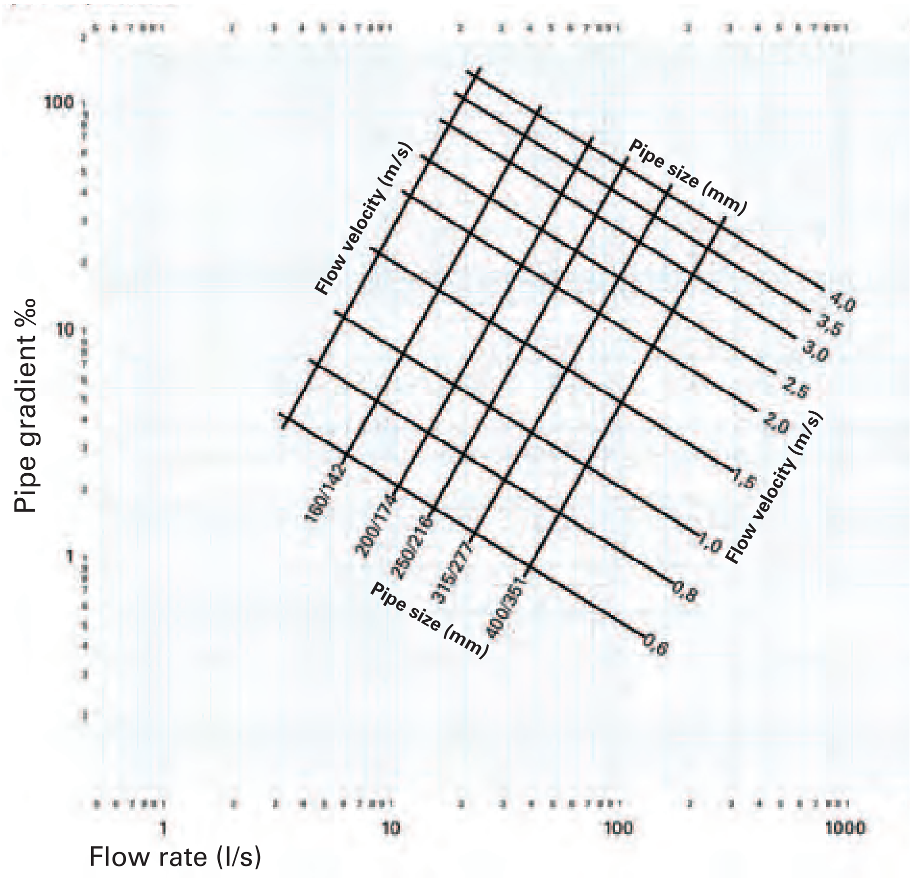


Figure 5.1.9

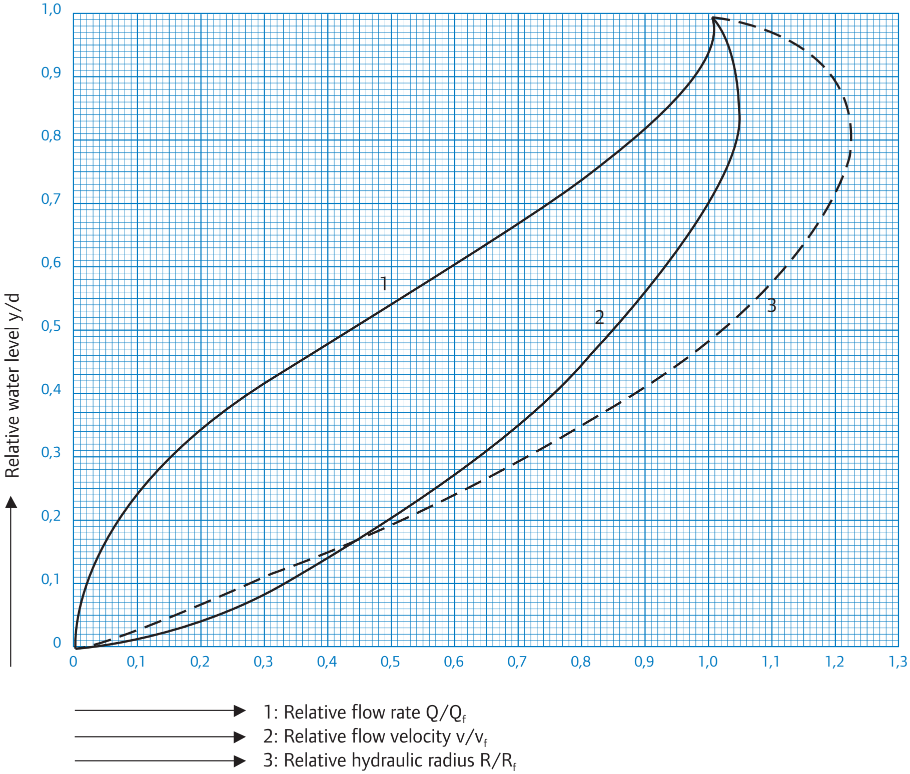

1,0
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
Relative water level y/d
0
0,1
0,2
0,3
0,4
0,5
0,6
0,7
0,8
0,9
1,0
1,1
1,2
1,3
1
2
3
1: Relative flow rate Q/Q_f
2: Relative flow velocity v/v_f
3: Relative hydraulic radius R/R_f

Figure 5.1.10

Gravity Sewer Installation – General Instructions and Supervision

Account must be taken of the specific conditions at the installation site, and of the installation process, in the project design, installation works and timing of installation. To ensure that, when in service, the pipes perform to their full capacity, trench excavation, pipe placement and backfilling must be carried out with extreme care and precision. Studies show that careful installation is the single most important factor in achieving a good end result. Ultimately, the developer will decide which installation instructions should be followed.

Uponor's instructions for sewer installation are presented below.

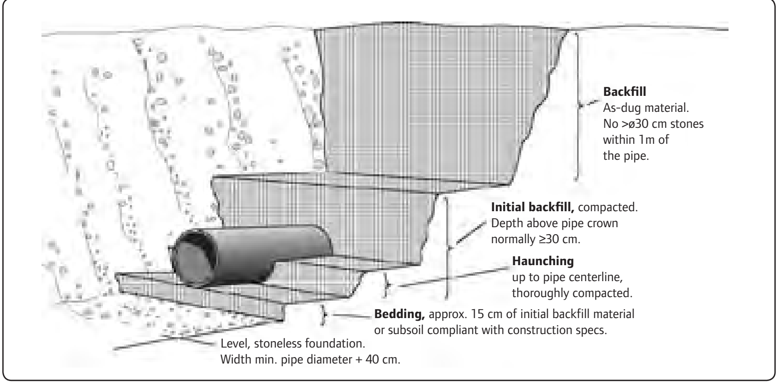
A. Trench construction

The trench bottom must be made firm and even throughout, particularly in unstable soils where uneven depressions can form beneath the pipe during trench filling, and during compaction of the backfill above the pipe. To prevent collapse or subsidence, pipe trenches in or near roads and paved areas must be built and backfilled correctly. In certain cases, trenches in cohesive soils may be left without sloping. The trench width must allow a space of 0.4 m between the outermost pipe and the trench wall.

B. Bedding

The pipes are installed on a bedding layer, to provide even support and bring them to grade. A 15 cm deep bed is normally sufficient.

If natural aggregate is used for the bedding, the maximum grain size is determined by the pipe's outside diameter. The maximum stone size for pipes with an outside diameter of more than 600 mm is 60 mm.



Backfill
As-dug material.
No >ø30 cm stones within 1m of the pipe.

Initial backfill, compacted.
Depth above pipe crown normally ≥30 cm.

Haunching
up to pipe centerline, thoroughly compacted.

Bedding, approx. 15 cm of initial backfill material or subsoil compliant with construction specs.

Level, stoneless foundation.
Width min. pipe diameter + 40 cm.

Figure 5.1.11

The maximum stone size for all pipes with an outside diameter of under 200 mm is 20 mm.

If crushed aggregate is used for bedding, the maximum grain size is 16 mm for all pipe sizes over 110 mm.

The bedding material used must not be frozen.

If the native soil meets the above requirements, no additional bedding is required. Depressions must be made in the bedding as necessary, to accommodate the pipe sockets.

C. Initial backfill

The function of initial backfill is to give the pipe sufficient support on all sides and to prevent point loading. In the initial backfill zone, the distance between the pipe and the edge of the trench must be at least 0.4 m, to enable the use of the appropriate compaction equipment. Compaction is carried out in 0.2 m deep layers (compacted depth). It is continued until the pipe crown is covered by at least a 0.30 metre layer or, for small pipes ($d_e > 160$ mm), at least a 0.15 m deep layer. The same material requirements apply to initial backfill as to bedding.

D. Final backfill

In traffic loading areas, the final backfill material must be compactable. In non-traffic areas 'as-dug' material (both non-cohesive and cohesive) can generally be used. Cohesive soils typically cause greater deformation than non-cohesive ones. The presence of stones in the initial backfill can cause point loading, and thus pipe deformation. If the as-dug material meets the above criteria and is compactable, it can be used as backfill. Installation quality must nevertheless be maintained in every respect. Uponor products are designed to withstand point loading deflection of a higher level than the standardmaximum tolerances.

Compactor type	Weight t	Optimum layer thickness	No. of compactions*	NB!
Vibratory rollers, manual	< 5	≤ 0,40	3-6	Not suitable for highly cohesive soils
	5-8	≤ 0,60	3-6	
	> 8	≤ 0,80	3-6	
Vibratory rollers – self-driven	6-8	≤ 0,60	4-8	
	8-10	≤ 0,80	4-8	
	> 10	≤ 1,00	4-8	
Rubber wheel rollers	< 20	≤ 0,30	8-12	Tyre pressure for sandy soils 300 kPa, gravelly soils 600 kPa
	> 20	≤ 0,50	8-12	
Smooth-wheel rollers	approx. 10	≤ 0,20	5-8	Used mainly for load-bearing layer compaction and finishing
Sheepsfoot rollers	< 10	≤ 0,30	6-12	Used for compaction of highly cohesive soils
	> 10	≤ 0,50	3-6	
Plate compactors	≥ 0,05	0,10-0,15	3-6	Normally used only on non-cohesive soils
	≥ 0,10	0,10-0,20	3-6	
	≥ 0,40	0,15-0,40	3-6	

*If the layer depths are reduced, fewer compactions are necessary. The compaction speed is chosen according to the compactor manufacturer's recommendation. Source KT 02.

Table 5.1.12. Use of mechanical compactors

Installation control and monitoring

In order to avoid pipe deformation, quality control monitoring is essential with regard to sufficient soil load-bearing capacity, bedding depth, gradient, initial backfill and proper compaction. Quality control of gravity sewer installation is carried out by monitoring ± deviations from elevation and alignment limits, and through the approval and monitoring of tightness testing. In addition, flushing and camera inspections are increasingly used in post-installation inspection.

Gravity sewer tightness testing

Water tightness testing is carried out at sites where air tightness cannot be tested due to the groundwater level. These tests are not aimed at testing material or joint strengths.

In a water tightness test, the closed network is filled with water and low pressure is applied. The tightness is determined based on the volume of water at the inspection end of the network. Air tightness testing follows the same principle as water tightness, but using air instead of water. The network's tightness is determined based on the pressure loss over a set time period. Pressure test values and rejection and approval limits are specified in detail in the above standard.

Records are made of the tightness tests. These include, for example, the developer and/or contractor, test conditions, test equipment, pipe gradient, test pressures, test duration, the date and the signatures of all parties.

Freeze protection and thermal insulation

The purpose of freeze protection and/or thermal insulation is to prevent the water in pipes and chambers from freezing, and thereby causing pipe system damage, during periods of ground frost. Water freezing can cause blockages and damage pipes and chambers.

The depth of installation of pipelines depends, for example, on

- the frost susceptibility of the soil
- the groundwater level
- the degree of pipe heat loss
- the locality (extent of freezing)

Pipe system freezing can be prevented by installing thermal insulation and/or freeze protection, such as ground frost insulation boards and/or lightweight aggregate, or by using pre-insulated systems such as Uponor’s pre-insulated sewer system.

In locations where the ground does not freeze, such as in rock, wrap-around thermal insulation is installed around the pipes. In frost-susceptible ground, freeze protection is installed on the upper part of the pipes. This also prevents the ground underneath the pipes from freezing. In both cases, heating cables can be installed for additional protection.

The planning and design of freeze protection is influenced by the following key factors:

- thermal properties of the oil or rock
- quantity and temperature of water in the pipe
- minimum allowable temperature of the conveyed fluid
- local climatic conditions
- installation depth.

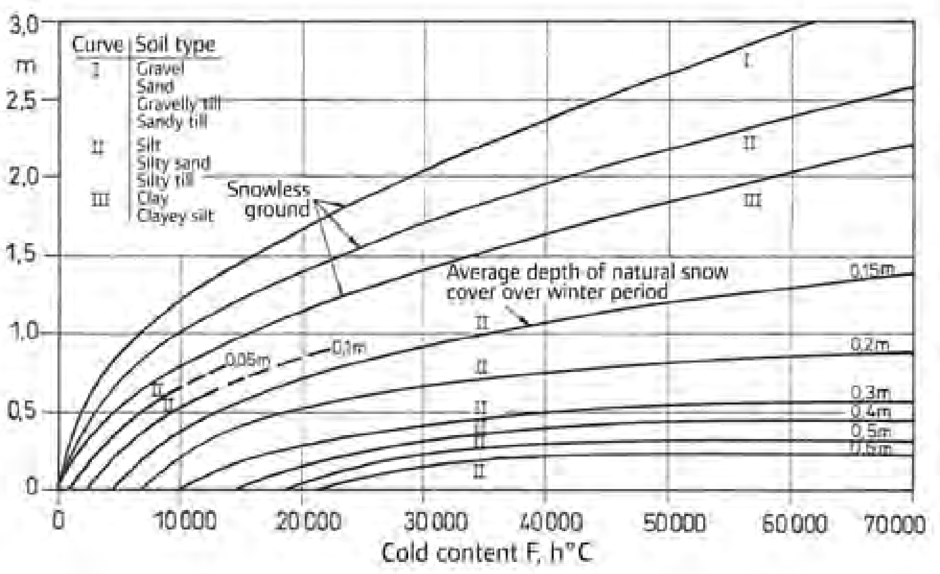
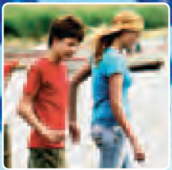


Figure 5.1.13. Correlation between cold content (maximum cold content per 50 years, in hours) and average ground frost penetration depth in different soil strata and different conditions.



UPONOR INFRASTRUCTURE

UPONOR GRAVITY SEWER SYSTEM ULTRA RIB 2

> The Ultra Rib 2 system is designed to meet the strictest tightness, durability and strength requirements.

5.2 Uponor Sewer System Ultra Rib 2

The Uponor Ultra Rib 2 Gravity Sewer System offers the optimal solution for wastewater drainage. Ultra Rib 2, commercially available since 1999, is the only sewer system on the market with rib-stiffened pipes and fittings made entirely from seamless SN 8 class polypropylene (PP).

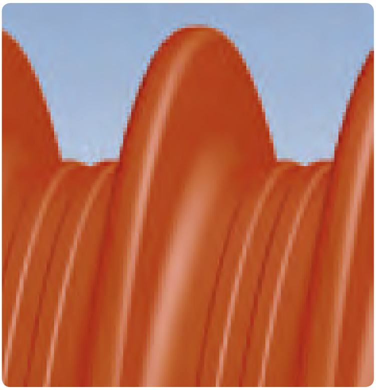
In the development of the Ultra Rib 2 system, close attention has been paid to maximising the service life of the system. Key features of Ultra Rib 2 include:

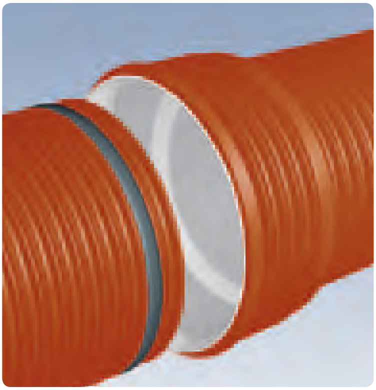
- durable long-life materials
- rib-stiffened structure designed for maximum stiffness, strength and lightness
- jointing methods for easy and ultra-reliable installation
- outstanding mechanical properties including at low temperatures

Ultra Rib 2 considerably outperforms all current Nordic and European standards for underground sewer systems. The system's reliability is further enhanced by our tightened safety performance requirements, which are verified by deflection, impact resistance and Strohhalm testing. Strict in-house material and process requirements, combined with external quality controls, guarantee a system service life of over 100 years when the Uponor installation instructions are followed.

Uponor Ultra Rib 2 Gravity Sewer System – sealing

The system's sealing rings are designed to withstand both internal and external pressure. To ensure protection from sand and gravel, the seals are set deep within the socket. As required, the system can be delivered with standard seals or oil/petrol resistant seals. Standard sealing rings are made from styrene butadiene rubber (SBR). Oil and petrol resistant seals are made from nitrile rubber (NBR) and are marked yellow for easy identification. The seals are fitted in the second rib groove from the spigot end of the pipe.





The Uponor Ultra Rib 2 pipes and fittings provide a comprehensive sewer pipe system. The pipe is coloured terra cotta on the outside, and has a light grey inner surface for optimum visibility during camera inspection.

Pipe dimensions

Outside diameter (mm)	Inside diameter (mm)
200	175
250	220
315	277
450	396
560	493

Table 5.2.1

System and material specifications

Properties		PP	Unit	Standard/test method
Density		900	kg/m^3	ISO 1183
Ring stiffness	Pipes	SN8	kN/m^2	ISO 9969
	Fittings	SN8	kN/m^2	ISO 9969
Long-term elastic modulus E_{50}		425	MPa	ISO 527-2
Short-term elastic modulus E_0		1650	MPa	ISO 527-2
Thermal expansion factor		0,18	mm/m · °C	
Thermal conductivity		0,22	W/m · °C	DIN 52 612 (23 °C)
Maximum continuous operating temperature		85	°C	
Maximum momentary operating temperature		100	°C	
Max. angle of joint deflection		2	°	

Table 5.2.2

Approvals & Markings

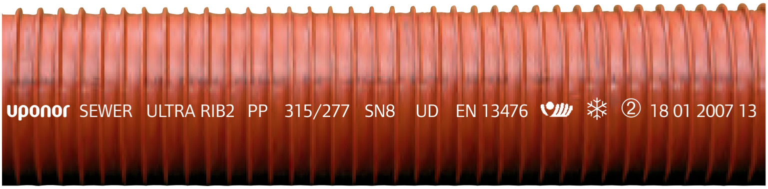
Approvals

The Ultra Rib 2 system carries the Nordic Poly Mark and is INSTA-CERT certified and approved in the Nordic countries (Finland, Sweden, Norway and Denmark).

The INSTA-CERT certificates for all Uponor products can be viewed on our website at www.uponor.fi.

Ultra Rib 2 pipe markings

The figure below shows the markings for Uponor Ultra Rib piping. Explanations for the markings are given in the following table.



Example markings on Ultra Rib 2 pipe

uponor	**SEWER**	**ULTRA RIB 2**	**PP**	**315/277**	**SN8**
Manufacturer	Application	Product	Material: polypropylene	Outer and inner diameter	Stiffness class

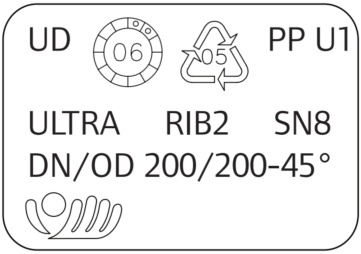
UD	**EN 13476**		**❄**	**②**	**18 01 2007 13**
Application area, UD = underground drainage and sewer within the building structure and outside the building	Product standard	Nordic Poly Mark	Snowflake symbol. Pipe can be handled in low temperatures	Production unit ② = Hadsund	Production date: day/month/year/hour

Table 5.2.3

Markings for Ultra Rib 2 fittings

Explanations of the markings for Ultra Rib 2 fittings are given below.

Sample markings for Ultra Rib 2 branch sockets



UD	06	♲05	PP	U1
Application area UD = underground drainage and sewerage within the building structure and outside the building	Production date: month/year	Recyclable/raw material 05 = polypropylene	Material: polypropylene	Production unit U1 = Nastola, Finland

ULTRA RIB 2	SN8	DN/OD 200/200	45SDgr	
Product	Stiffness class	Nominal outer diameter	Socket branch 45°	Nordic Poly Mark

Table 5.2.4

Ultra Rib 2 Sewer System Design

Structural design

The “Structural design” section of the Wastewater Systems chapter specifies a number of design criteria, for which generally applicable experience-based data exists. If these criteria are met, no additional design calculations are required.

Flow design

When determining the pipe system’s dimensions, it is important to ensure that the system has sufficient flow and self-cleaning capacity to ensure trouble-free operation. The main design principles are presented in the introductory section of the Gravity Sewers chapter. Flow charts for the Ultra Rib 2 pipe systems, which use a roughness coefficient value of 0.25 mm, are presented in appendices 1.1, 1.2 and 1.3. The coefficient takes account of the branches and inspection chambers typically incorporated in wastewater sewer systems. The charts are based on the inside pipe diameter, although pipe size is expressed according to the outside diameter. References are made in the various charts to the flow design examples presented in the Wastewater Systems introductory section.

After pipe design, the self-cleaning capacity and pipe gradient need to be determined, based on the chosen pipe size and design flow rate, for which purpose self-cleaning diagrams for different sized Ultra Rib 2 gravity sewer pipes are presented in appendices 2.1 – 2.5.

Ultra Rib 2 Sewer System Installation

Next, the structural adjustment and jointing of Ultra Rib 2 pipes and fittings is described. This section covers
- Ultra Rib 2 pipe installation
- jointing with Ultra Rib 2 socket bends, branches and slip couplers
- installing Ultra Rib 2 adaptors for concrete pipe
- joints and spigot/socket base clearance

The fittings of the Ultra Rib 2 sewer system are also used in Uponor's Dupplex sewer system and PP stormwater system.

2. Fit the seal in the second rib groove from the spigot end of the pipe.

Ultra Rib 2 pipe installation

1. Cut the pipe along the rib groove using a fine-tooth saw. Deburr the cut edges with a blade or file.

3. Apply lubricant on the inside of the socket. To facilitate jointing, also apply the lubricant on the spigot end sealing ring.

4. The joint is complete when the pipe end is pushed all the way into the base of the socket. The pipes can also be slotted together by levering against the rearmost socket, e.g. with a spade. When doing so, to avoid damaging the socket position a piece of wood between the socket and the spade.

Joints and clearances

To ensure a sound joint, Ultra Rib 2 pipe must be sawn as true as possible along the rib groove. A well-fitted joint should leave no gap between the spigot end and socket base. This will not be achieved if the pipe is cut unevenly. Final inspection of the completed pipeline is carried out by the developer or the developer's agent.

Joining an Ultra Rib 2 pipe branch to an existing pipeline

1. Branching off or onto an existing pipeline is performed using a branch fitting, into which the existing line is inserted at both ends and couplers are fitted over the joints. Begin by marking off the length of the branch fitting on the existing pipe.

2. Cut the pipe along the rib groove using a fine-tooth saw. Deburr the cut edges with a blade or file.

3. Apply lubricant inside the socket ends of the couplers. Fit a seal into the second groove on each spigot end of the branch fitting. Slot the branch fitting and the couplings together, by pushing firmly all the way to the base of the coupling.

4. Cut the equivalent length of the branch fitting (as previously marked off) from the existing pipe and install the branch assembly into place.

Installing an Ultra Rib 2 pipe adaptor for coupling to a concrete pipe socket

Coupling to a concrete pipe socket is performed using a spigot adaptor, with a sealing ring fitted onto the adaptor's collar. Push the adaptor all the way to the base of the concrete pipe socket; the sealing ring will roll into place, sealing the joint. No lubricant is used in the concrete pipe joint.

Installing an Ultra Rib 2 pipe adaptor for coupling to a concrete pipe spigot end

Coupling to the spigot end of a concrete pipe is performed using a socket adaptor. Fit a seal onto the spigot end of the concrete pipe. Push the adaptor into place over the seal and carefully apply heat to the adaptor's flange; the flange will shrink onto the concrete pipe, forming a tight joint. No lubricant is used in the concrete pipe joint.

UPONOR INFRASTRUCTURE

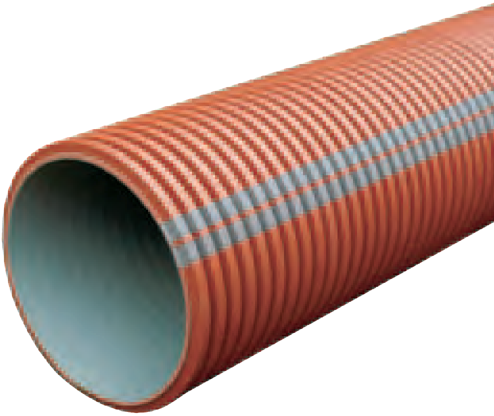
UPONOR DUPPLEX
SEWER SYSTEM

Dupplex - robust double-wall piping system for sewer drainage

5.3 Uponor Dupplex Sewer System

The Uponor Dupplex Sewer System is designed for gravity sewerage applications. Dupplex is a polypropylene (PP) double-wall sewer pipe with a smooth inner wall and a corrugated outer wall. The system's ring stiffness is SN 8.

The Uponor Dupplex and Uponor Ultra Rib 2 sewer systems both use the same fittings range. These fittings are also used with the Uponor PP Stormwater System. The entire system meets SN 8 ring stiffness requirements and all components are made uniformly from PP. Coloured terra cotta on the outside, the pipe has a light grey inner surface, providing optimum visibility during camera inspection.



Pipe dimensions

Outside diameter (mm)	Inside diameter (mm)
160	142
200	174
250	216
315	277
400	351

Table 5.3.1

The Dupplex pipe outperforms all current European standard requirements for underground sewer systems. In addition, Dupplex's strict quality requirements further enhance the system's reliability.

Dupplex pipes are equipped with fixed sockets which, together with a sealing ring, ensure easy and secure coupling.

After socket welding, all pipes are tested for tightness as part of continuous production quality control inspections. The Dupplex system is delivered with standard seals or oil/petrol resistant seals, as required. Its standard sealing rings are made from styrene butadiene rubber (SBR). Oil and petrol resistant seals are made from nitrile rubber (NBR) and marked yellow.

System and material specifications

Properties		PP	Unit	Standard/test method
Density		900	kg/m^3	ISO 1183
Ring stiffness	Pipes	SN8	kN/m^2	ISO 9969
	Fittings	SN8	kN/m^2	ISO 9969
Long-term elastic modulus E_{50}		425	MPa	ISO 527-2
Short-term elastic modulus E_0		1650	MPa	ISO 527-2
Thermal expansion factor		0,18	mm/m · °C	
Thermal conductivity		0,22	W/m · °C	DIN 52 612 / 23 °C
Maximum continuous operating temperature		85	°C	
Maximum momentary operating temperature		100	°C	
Max. angle of joint deflection		2	°	

Table 5.3.2

Approvals & Markings

Approvals

The Dupplex system carries the Nordic Poly Mark and is INSTA-CERT certified and approved in the Nordic countries (Finland, Sweden, Norway and Denmark).

INSTA-CERT certificates for all Uponor products can be viewed on our website at www.uponor.fi.

Markings

The markings for Uponor Dupplex piping are explained in the figure and table below.

uponor	**SEWER**	**DUPPLEX**	**PP**	**DN/ON 200**	**SN8**	**UD**
Manufacturer	Application	Product	Material: polypropylene	Nominal outside diameter	Stiffness class	Application area, UD = underground drainage and sewerage within the building structure and outside the building

	EN 13476	❄	④	2007 ☐☐☐☐☐☐☐☐☐☐☐☐
Nordic Poly Mark	Product standard	Snowflake symbol. Pipe can be handled at low temperatures	Production unit ④ = Forssa, Finland	Production date: month/year

Table 5.3.3

Dupplex Sewer System Design

Structural design

The "Structural design" section of the Drainage and Sewer Systems chapter specifies a number of design criteria for which generally applicable experience-based data exists. If these criteria are met, no additional design calculations are required.

Flow design

When determining the pipe system's dimensions, to ensure trouble-free operation it is important to ensure that the system has sufficient flow and self-cleaning capacity. The main design principles are presented in the introduction section of the Drainage and Sewer Systems chapter. Based on a roughness coefficient value of 0.25 mm, flow charts for Dupplex pipe systems are presented in appendices 3.1, 3.2 and 3.3.

Although pipe size is expressed using the outside diameter, the charts are based on the inside diameter.

After the pipe design phase, the self-cleaning capacity and pipe gradient must be determined based on the chosen pipe size and design flow rate. For this purpose, self-cleaning diagrams of different-sized Dupplex gravity sewer pipes are presented in appendices 4.1 – 4.5.

Dupplex Sewer System Installation

This section gives step-by-step instructions on the jointing and coupling of Dupplex pipes and fittings.

Dupplex pipes use the same fittings as the PP Stormwater System and the Ultra Rib 2 sewer system.

Coupling Dupplex sewer pipes

1. Using a fine-tooth saw, cut the pipe between the ribs. Deburr the cut edges with a blade or file.

2. To ensure optimal tightness, fit a seal into the first groove from the pipe end.

3. Apply lubricant to the inside of the socket. To facilitate jointing, also apply lubricant to the spigot end sealing ring. Ensure that no sand or grit adheres to the lubricated areas.

4. The joint is complete when the pipe end is pushed all the way to the base of the socket.

5. The pipes can also be slotted together by levering against the rearmost socket, e.g. with a crowbar. When doing so, to avoid damaging the socket position a piece of wood between the socket and crowbar.

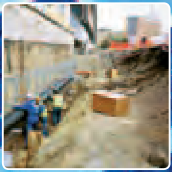
6. Uponor Sewer System
A correctly coupled Dupplex joint.

Coupling a Dupplex spigot end with a concrete spigot end

Fit the sealing ring onto the spigot end of the concrete pipe. Align the adaptor and push it fully home, so that the concrete pipe sits against the base of the adaptor. Carefully (do not use gas torch) apply heat to the coupling, to form a tight joint. No lubricant is used in the joint.

Coupling a Dupplex spigot end with a concrete pipe socket

Fit the seal onto the adaptor so that the spigot end of the seal is towards the concrete pipe socket. Push the adapter into the pipe socket; the seal will roll into place. No lubricant is used in the joint.



UPONOR INFRASTRUCTURE

UPONOR PRE-INSULATED SEWER SYSTEM

Piping systems for controlled storm- and sewer drainage

03 I 2011
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5.4 Uponor Pre-Insulated Sewer System

Pre-insulated pipes are intended for pipeline sections that are susceptible to subzero temperatures, or where rare instances of freezing could cause serious damage or disruption, such as:

- bridges and above-water pipelines
- rocky terrain
- under-road pipes
- culverts
- sites with limited trench depth or width
- surface installations and temporary piping

The sewer system's carrier pipe is the Polypropylene Dupplex pipe, which is coated with resilient and flexible PEX foam. These are enclosed within an Uponor PP Stormwater System SN 8 pipe which serves as a protective jacket. This combined structure can withstand loads many times higher than normal pipe systems, enabling the system to be installed at shallow depths and in heavy traffic zones.

These pipes and fittings come fitted, as standard, with an aluminium conduit which accommodates a heating cable. Self-regulating or series resistance heating cables are available for all pipe sizes. Pre-insulated pipes are available in size classes 110-315 mm.

Pipe dimensions

Carrier pipe	Jacket pipe
110	250
160	315
200	315
250	400
315	450

Table 5.4.1

Special performance characteristics of pre-insulated sewer systems

Uponor pre-insulated pipes are designed to meet the following key needs of the user:

- Efficient PEX foam insulation manufactured without using environmentally harmful substances.
- Strong protective jacket and insulation provide efficient additional protection against external stress.
- Durable at shallow installation depths, as well as in traffic areas.
- Flexible structure allows minor alignment changes, with no need for special parts.
- Trouble-free transition between insulated and uninsulated pipeline sections.
- Accurate thermal conductivity values for precision pipeline design.
- Cost savings from shallow trench depths and easy installation.
- Straightforward, familiar installation techniques: carrier pipe jointing using electric welding or sockets; protective jackets with double sockets or heat-shrink joints.

Self-regulating or series resistance heating cable, with joints available for all pipe types.

Heat loss calculation

Heat loss Ø (W/m) in Uponor pre-insulated sewer pipes is determined on the basis of pipe conductance (G) and heat difference (ΔT):

$Ø = G \times \Delta T$

Carrier pipe diameter	Jacket pipe diameter	Element conductance G (W/m° C)
110	250	0,365
160	315	0,462
200	315	0,784
250	400	0,585
315	450	1,269

Table 5.4.2

The conductance is indicated in the above table, while the heat difference is the difference in temperature (ºC) between the ambient ground or air temperature and the temperature of the water flowing through the pipe. The heat loss value also indicates the minimum capacity of any heating cable installed.

Cooling time of water in the pipe

The graphs below show the time taken for water to cool from +4 °C to 0 °C in a full pipe, with external temperatures of -2 °C, -6 °C or -10° C. For comparison, the lowest curve represents an uninsulated pipe at a temperature of -2 °C. No account is taken of water flow in cooling time calculations.

In Finland, at a depth of one metre (sand, no snow cover) the lowest ground temperatures vary from -3 °C on the south coast, to -6 °C in central Finland and -10° C in the northernmost areas of Lapland.

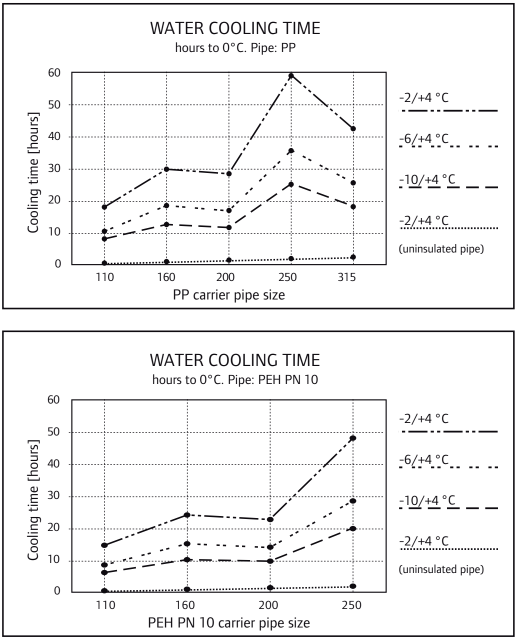


Table 5.4.3

Pre-Insulated Sewer System Design

Structural design

The “Structural design” section of the Gravity Sewer Systems chapter specifies a number of design criteria, based on current guidelines and standards. If these criteria are met, no further design calculations are required.

Flow design

When determining the pipe system’s dimensions, to ensure trouble-free operation it is important to ensure that the system has sufficient flow and self-cleaning capacity. The design principles are presented in the Flow design section for gravity sewers.

Pre-Insulated Sewer System Installation

When installing pre-insulated sewer pipes and fittings, the same general rules apply as for uninsulated sewers. The pipe ends to be jointed, and the joint seals, are cleaned as necessary. Lubricant is applied to the spigot pipe end and to the front edges of the jacket pipe's double socket. Do not lubricate the seals.

Jointing pre-insulated sewer pipes

Fit the seals into the first groove from the spigot end of the jacket pipe. Fit the foam ring onto the spigot end of the carrier pipe. Apply lubricant to the end of the carrier pipe and to the double socket. First, push the double socket into the pipe end that has a socket. Then, simultaneously push the carrier pipe and jacket pipe into their sockets. The joint is complete when both pipes are pushed all the way to the base of their sockets.

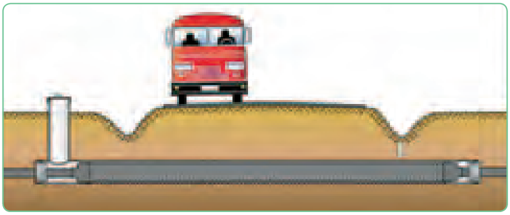
The spigot ends of the carrier pipes are coupled using a double socket. The joint is insulated with insulating sheathing of the same length as the double socket, and sealed with a shrink sleeve. Ready-made double socket joint units are also available to order.

Installation of insulated reducer

Fit the shrink sleeve into place over the jacket of the pipe to be jointed. Attach the reducer fitting to the carrier pipes. If necessary, install foam rings over the reducer fitting. Fit the insulating sheaths into place over the joint. Centre the shrink sleeve over the joint and, in order to shrink it tightly into place, heat the sleeve carefully.

Insulated bend installation

At the socket end of the pipe, cut the jacket pipe back by the same length as the carrier pipe socket. Also cut the insulation off the socket. If necessary, install foam rings around the carrier pipe. Slide the shrink sleeve onto the jacket pipe. Attach the bend fitting to the carrier pipe. Apply lubricant if necessary. Fit the insulating sheaths into place over the joint. Centre the shrink sleeve over the joint and, in order to shrink it tightly into place, heat the sleeve carefully.



Shortening a pre-insulated pipe

To shorten an insulated pipe, begin by cross-cutting the pipe at the required point. After this, create a new spigot end for the carrier pipe, by cutting the jacket and insulation back to the same length as on a normal spigot end.

Terminating the pipeline

The end of a pre-insulated pipe section must be sealed to prevent water from penetrating the insulation layers. This is done by installing a watertight heat-shrink cap on the end of the insulated pipe. Start the shrinking from the end that is around the jacket pipe. Once this is tightened, continue shrinking from the carrier pipe end until it is also tightly in place.

Pressure testing

The joints must be shrunk and sealed only after the conclusion of any pressure tests to be performed on the pipeline.

Heating cable

Uponor's pre-insulated pipes come equipped with an aluminium conduit, which can accommodate a heating cable. The appropriate heating cable type – either self-regulating or series resistance – is chosen according to the purpose of use. In most cases, the heating cable is pulled through each completed pipe section prior to insulating the joints. At least 50 cm of heating cable must be left at the pipe ends and branches, for pipe connections. The circuit diagrams are provided with the pipe package.

UPONOR INFRASTRUCTURE

UPONOR PVC
SEWER SYSTEM

Uponor Smooth-Walled PVC Sewer System

5.5 Uponor PVC Sewer System

The Uponor PVC Sewer System is designed for standard storm- and wastewater gravity sewer applications. Its smooth, single-wall pipes are made of polyvinyl chloride (PVC) and have a ring stiffness class of SN 8. The pipes have terra cotta colouration for easy identification as sewer pipes.

Pipes and fittings are made of terra cotta coloured polypropylene (PP). Fittings for pipes with a diameter greater than 200 mm are made of terra cotta coloured PVC. All pipe fittings have a ring stiffness of SN 8.

All pipes and fittings come equipped with pre-installed seals for guaranteed joint tightness.

System and material specifications

Properties		PVC	Unit	Standard/test method
Density		1410	kg/m^3	ISO 1183
Ring stiffness	Pipes	SN 4 or 8	kN/m^2	ISO 9969
	Fittings	SN 8	kN/m^2	ISO 9969
Long-term elastic modulus E_{50}	1000	MPa	ISO 527-2	
Short-term elastic modulus E_0	3000	MPa	ISO 527-2	
Thermal expansion factor		0,08	mm/m · °C	
Thermal conductivity		0,16	W/m · °C	DIN 52 612 / 23
Maximum continuous operating temperature		75	°C	
Maximum momentary operating temperature		95	°C	
Max. angle of joint deflection	2	°		

Table 5.5.1

Approvals

The Uponor PVC Sewer System bears the Nordic Poly Mark and is INSTA-CERT certified and approved in the Nordic countries (Finland, Sweden, Norway and Denmark). Its pipes and fittings are certified according to their designated application areas.

Application areas of the Uponor PVC Sewer System:

Ring stiffness	**Pipe dimensions**	**Application**
SN 8	110, 160, 200	U and D
SN 8	250, 315	U

U: Application area code U means that the application area for the pipes and fittings is more than 1 m from the building to which the sewer system connects.

D: Application area code D means that the application area for the pipes and fittings is below the building, or more than 1 m from the building, to which the sewer system connects.

Table 5.5.2

The latest INSTA CERT certificates can be viewed online at www.uponor.fi.

Markings

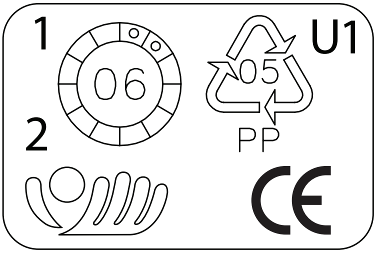
The figure and tables below show the Uponor PVC Sewer System markings and their explanations.

uponor	**SEWER**	**PVC-U**	**200 x 5.9**	**SN8**	**UD**
Manufacturer	Application	Material: polyvinyl chloride (un-plasticised)	Diameter and min. wall thickness	Stiffness class	Application area UD = underground drainage and sewerage within the building structure and outside the building

	EN 1401	❄	①	**18 01 2007 13**
Nordic Poly Mark	Product standard	Snowflake symbol. Pipe can be handled at low temperatures	Production unit ① = Nastola, Finland	Production time: day/month/year/hour

Table 5.5.3

Examples of markings on fittings:



1	2	06	05 PP	U1		CE
Manufacturing code	Manufacturing code	Month/year of manufacture	Recyclable/raw material 05 = polypropylene	Production unit	Nordic Poly Mark	CE marking

Table 5.5.4

uponor UGD
200/200-88,5°
PP S-16
EN 1852 UD

uponor	UGD	200/200	88,5°	PP	S-16	EN 1852	UD
Manufacturer	Underground drainage pipe	Size	Bending angle	Material: polypropylene	Wall thickness	Product standard	Application area UD = underground drainage and sewerage within the building structure and outside the building

Table 5.5.5

PVC Gravity Sewer System Installation

This section gives step-by-step instructions for the jointing and coupling of Uponor PVC sewer pipes and fittings.

1. Cut the pipe perpendicularly with a fine-tooth saw or pipe cutter.

2. Clean any sawdust and burrs off the cut end.
Spigot end bevelling is always required.

3. Draw a joint mark at the same distance from the pipe end as on a normal spigot end. Check that the socket and spigot end are undamaged and that the seal is correctly fitted. Apply an approved lubricant to the spigot ends.

4. Before joining the pipes, check that the sockets and spigot ends are free of soil and sand. Then push the socket on, all the way up to the joint mark. The mark must remain visible, to ensure that the joint has sufficient give for thermal expansion or angular deflection.

5. The completed joint.

PVC/concrete adaptor

Fit a seal onto the spigot end of the concrete pipe. Align the adaptor and carefully push it fully home, so that the concrete pipe sits against the base of the adaptor socket.

When pushing the adapter into place, do not push directly against the adapter fitting, but use a plank for leverage.

If gaps remain around the fitted joint, heat the fitting evenly to tighten it into place. Do not lubricate the joint.

PVC spigot/concrete socket adaptor

Fit the seal onto the adaptor so that the spigot end of the seal is towards the concrete pipe socket.

Push the adaptor fully home to the base of the concrete pipe socket and heat carefully. No lubricant is used in the joint.

PVC spigot/cast iron socket adaptor

Install the O-ring seal and cup seal on the spigot end of the PVC pipe.

Push the PVC pipe with its seals into the cast iron pipe's socket. No lubricant is used in the joint.

Joints and clearances

To ensure a sound joint, the PVC pipe must be sawn as squarely as possible. A properly fitted joint should have a clearance of approx. 20 mm between the pipe end and the socket base. Final inspection of the completed pipeline is the responsibility of the developer.

UPONOR INFRASTRUCTURE

UPONOR PE STORMWATER SYSTEM

The heavy-duty stormwater drainage solution

5.6 Uponor PE Stormwater System

The Uponor PE Stormwater System meets the majority of requirements related to the storage and drainage of high stormwater volumes.

The system consists of gravity sewer pipes used primarily:

- for stormwater drainage
- as stormwater harvesting tanks
- for ventilation
- as culverts
- as stormwater attenuation tanks

The system and its inspection chambers can be connected to all known sewer system brands.

The PE stormwater system forms a comprehensive and flexible system, comprising standard components with a 800–1,600 mm diameter, as well as fittings and special inspection chambers.

The pipe delivery length is 3 m and 6 m, although these can be supplemented with 1.5 m fitting pipes for optimal fitting on site.

Uponor PE Stormwater System pipes are double-wall pipes with a smooth inner surface. These pipes are designed for maximum durability.

The inside smoothness of the pipe guarantees optimal flow properties.

For a guaranteed long service life and maximum strength, the system's components are made of abrasion resistant polyethylene. The material has high impact resistance, even at –20 °C, and is resistant to hydrogen sulphide and similar corrosive substances.

The pipe sockets are equipped with a fixed EPDM rubber seal. Once installed, this guarantees high sealing pressure and 100% joint tightness.

The system comprises lightweight pipes that are easy to transport and handle.

The pipes come in two stiffness classes: – SN 4 and SN 8 – making them ideal for a wide range of applications.

Jointing is quick and simple: the spigot end slots directly into a socket containing a fixed seal.

The Uponor PE Stormwater System is highly resistant to most solvents, acids, oils and alkalis. A detailed description of the system's chemical resistance is given in the chapter Materials and Service Life.

Sample pipe profile

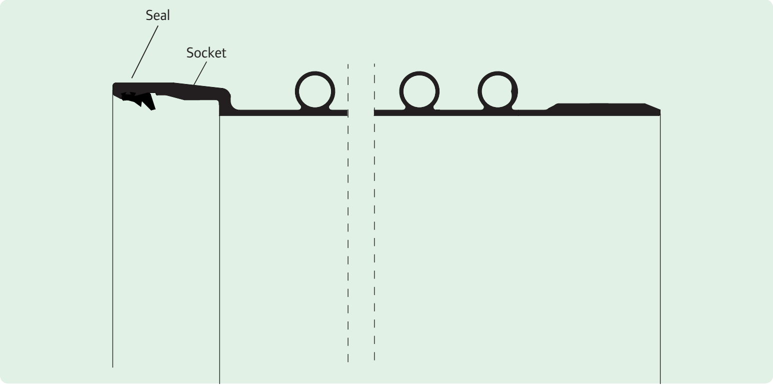


Figure 5.6.1

Pipe dimensions

		SN 4 pipes		SN 8 pipes	
Inside diameter	**Volume**	**Outside diameter**	**Weight**	**Outside diameter**	**Weight**
mm	m^3/m	mm	kg/m	mm	kg/m
800	0,50	920	32,4	920	42,8
1000	0,79	1120	56,1	1140	106,8
1200	1,13	1320	97,2	1340	134,4
1400	1,54	1640	133,3	1640	193,3
1600	2,01	1840	225,0	1840	275,0

Table 5.6.2

System and material specifications

Properties	**PE100**	**Unit**	**Standard/test method**
Density	≥ 940	kg/m^3	ISO 1183
Ring stiffness	SN 2-4-8	kN/m^2	ISO 9969
Long-term elastic modulus E_{50}	180	MPa	ISO 527-2
Short-term elastic modulus E_0	800	MPa	ISO 527-2
Thermal expansion factor	0,17	mm/m · °C	
Thermal conductivity	0.4	W/m · °C	DIN 52 612 / 23 °C
Impact resistance test temp.	-20	°C	EN 1411
Maximum continuous operating temperature	45	°C	
Maximum momentary operating temperature	85	°C	
Max. angle of joint deflection ≥ ø800	1	°	

Table 5.6.3

Approvals & Markings

Approvals

The PE stormwater system is manufactured according to Uponor's strict quality requirements. All pipes are produced in compliance with Uponor factory standard 750, which is based on the EN 13476-1 standard.

Markings

The pipes carry the following markings at the socket end:

1000	SN 8	02 2007	PE
Inside diameter	Stiffness class	Production date: month/year	Material: polyethylene

Table 5.6.4

Handling

This section describes how the products are to be loaded, transported, unloaded and stored.

PE stormwater pipe must be stored on wooden racks, to protect the pipe sockets from loading. The maximum stacking height for pipe bundles is shown in the table below.

Pipe storage

Diameter mm	1 bundle	2 bundles	3 bundles
800			x
1000		x	
1200	x		
1400	x		
1600	x		

Table 5.6.5

Storage in direct sunlight/heat must be avoided wherever possible as, due to their material properties, the pipes can bend or lose their roundness.

To prevent damage to pipes and fittings, unloading must be carried out carefully and in the proper manner. Never use chains or cables for fastening down, unloading or handling pipe loads. Never unload by tipping.

The storage site must be properly prepared before receiving pipe deliveries. Stands or racks must be provided for loose pipes, the storage site must be on level ground, and suitable pallets must be provided for storing pipe fittings and similar products.

PE Stormwater System Design

Structural design

For suitable installation conditions for the pipe, refer to the table in the introduction section of the Drainage and Sewer Systems chapter.

Flow design

When determining the pipe system's dimensions, it is important to ensure that the system has sufficient flow and self-cleaning capacity to ensure trouble-free operation. The main design principles are presented in the introduction section of the Drainage and Sewer Systems chapter. Flow charts for the PE Stormwater System are presented in appendices 8.1, 8.2 and 8.3. These charts use a roughness coefficient value of 0.25 mm for the whole system, including fittings and inspection chambers. The roughness coefficient of the pipe alone is 0.06 mm.

Protection against hydrostatic uplift

The pipes can be anchored down, for example, with a geotextile or geonet, to protect them against hydrostatic uplift due to rising groundwater levels. An alternative option is to drain the site.

According to experience, hydrostatic uplift is not problematic if the backfill above the pipe crown corresponds to the pipe diameter, and the volume weight of the backfill is 18 kN/m or higher.

The uplift of an empty PE pipe below groundwater level and the ballasting effect of the backfill can be calculated using the chart given below. This calculation is performed per pipe metre. The chart can also be used to calculate the hydrostatic uplift of cylindrical tanks.

The following chart shows the minimum required depth of backfill above the pipe crown, for the SN 4 Uponor PE Stormwater System pipe.

This chart is based on the pipe diameter and backfill depth for three different backfill soil types.

Minimum required depth of cover for SN 4 class Uponor PE Stormwater System pipe to prevent hydrostatic uplift in groundwater areas

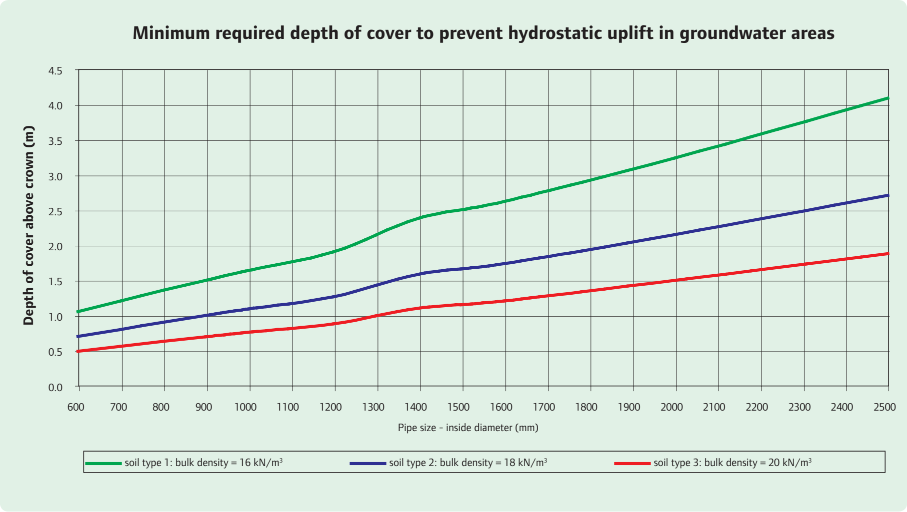


Diagram 5.6.6

As the chart shows, the bulk density of the backfill is crucial with respect to how deep the pipe must be laid to prevent hydrostatic uplift.

The chart is based on the use of SN 4 stiffness class pipes, but can also be applied to SN 8 pipes.

Geotextiles and geonets are used to increase pipe ballast and prevent uplift. After the pipe or tank is laid, the trench is filled with a suitable initial backfill material (haunching) up to the pipe's centerline.

The geotextile or geonet is wound over the pipe (in most cases transversely across the pipe, although the direction depends on the roll width and which direction has the highest tensile strength). When laying the textile or net, it is important to ensure that the anchorage length meets minimum requirements on both sides of the pipe. This requires a separate calculation. Initial backfilling and compacting is then continued.

The geotextile or geonet should be covered with non-cohesive soil as, due to superior interaction between non-cohesive soil and geotextiles/nets, the anchorage length of the textile/net can normally be shortened.

If the geotextile or geonet is used to stabilise the pipe, the width of the textile/net must be calculated separately.

Geotextile or geonet installation for increased pipe ballast

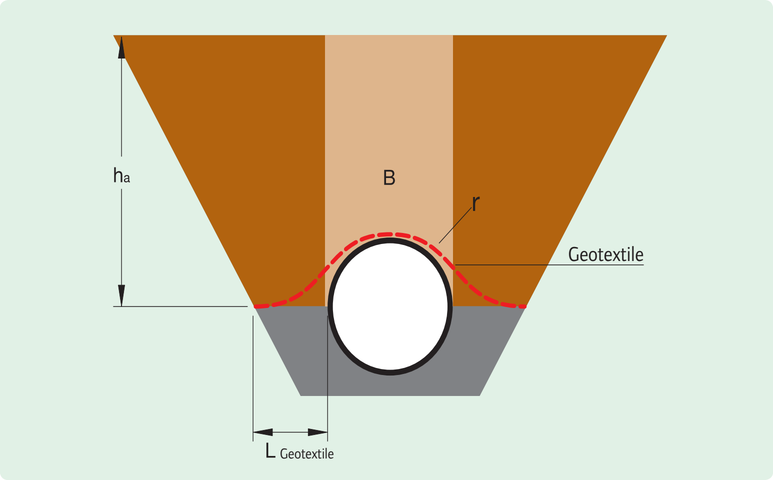


Figure 5.6.7 Laying a geotextile or geonet

PE Stormwater System Installation

The following section describes the handling and jointing of Uponor PE stormwater pipe.

1. The ideal method for unloading PE stormwater pipes is to use two lifting slings on each pipe. This method protects the socket and seal, and the spigot end, from damage.

2. Check each pipe for transport damage or flaws.

3. Remove any sand etc. from the socket and seal.

4. Clean the spigot end and lubricate it with Uponor lubricant.

5. The pipes are coupled by pushing the spigot end fully home to the base of the socket. If an excavator bucket is used to push the pipe into place, always place a block of wood between the bucket and the pipe. **The pipe must not be cut.**

6. Initial backfill must be evenly compacted on both sides of the pipe. Uneven compaction can result in the transverse displacement and deformation of the pipe.

7. After final backfill and compaction, the pipe interior is inspected as necessary, for any deformation and for angular deflection of the joints.

In the case of deeper trenches, a pipe grapple can be used as an excavator attachment for safer pipe placement.

Pipeline direction changes are achieved using socket bends. The maximum allowable angular deflection of the joints is 1 °.

NOTE: The length of standard pipes and fittings cannot be changed. Special-length fitting pipes are used for fine-tuning the pipeline length.

Max. allowable angular deflection

Angular deflection, degrees	3 m pipe displacement	6 m pipe displacement
SDgr	mm	mm
1	52	105

Table 5.6.8

Jointing with other pipe types

The Uponor PE Stormwater System, including all inspection chambers, fittings and adaptors, is fully compatible with all known piping systems on the market.

1. Uponor PE Stormwater System – concrete chambers or structures

The PE pipe can be connected to a concrete chamber using a concrete-cast PE socket.

Installation and casting of a concrete-cast PE socket:

- An expansion sealing strip is installed alongside the fixed collar of the PE socket to be cast, on the water pressure side of the collar.
- The castable PE socket is fastened to a casting form, which is sealed around the socket.
- A 35 MPa strength concrete suitable for harsh environments is then cast around the socket.
- The embedded socket is coupled to the pipeline.

Concrete-cast PE socket installation

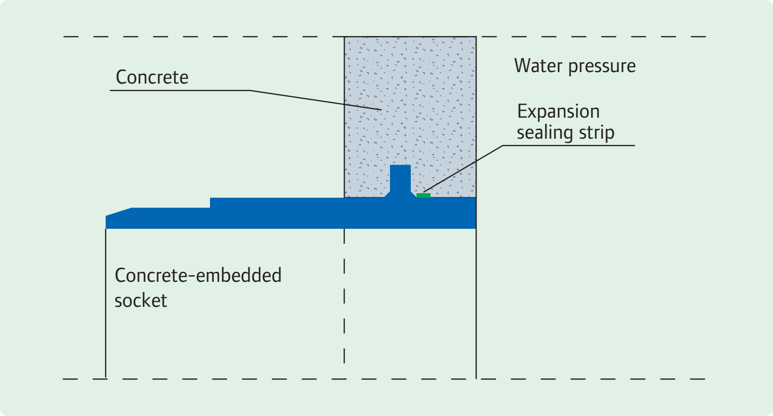


Figure 5.6.9

2. Uponor PE Stormwater System – concrete pipes

Uponor's PE stormwater chambers can be connected to concrete pipelines using, for example, Fernco adaptor couplings. An alternative option is to cast a castable Uponor PE socket onto a concrete socket.

3. Uponor PE Stormwater System – PVC pipes

Smooth PVC pipes are coupled to PE chamber inlets/outlets via a PVC double socket. Uponor also delivers bespoke solutions and joints that require welding.

4. Uponor PE Stormwater System – Ultra Rib 2 and Dupplex pipes

Ultra Rib 2 or Dupplex pipes are connected to PE chamber inlets/outlets with spigot or socket adaptors. Uponor also delivers bespoke solutions and joints that require welding.

5. Uponor PE Stormwater System – PE pipes

Smooth PVC pipes are coupled directly to PE chamber inlets/outlets and the joint is then electrofusion welded. These pipes can also be coupled with a slip coupler.

Coupling with other pipe types can be carried out, either using separate fittings or by using inspection chambers equipped with fixed inlet/outlet connections.

Coupling methods

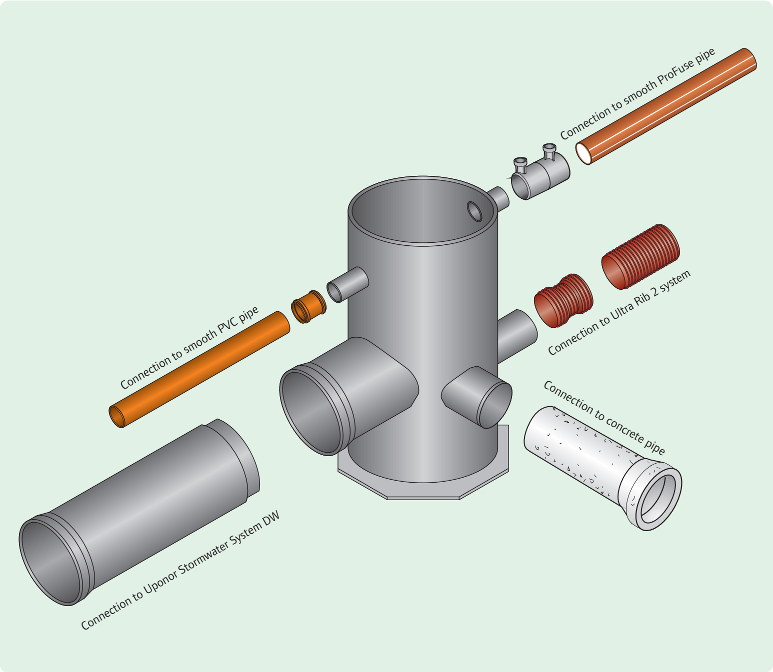


Figure 5.6.10

PE stormwater pipe connections

If, for example, a surface water drain is to be connected to the stormwater sewer, Uponor can deliver pipes or fittings with ready-welded connections.

An alternative option is to use special PE inlets designed for 110 or 160 mm diameter pipes. In such a case, a hole is drilled into the pipe, a PE inlet is installed in the hole, and a short PVC socket pipe or bend is fitted to the inlet.

1. Drill the inlet hole with a hole drill.

2. Install the PE inlet in the hole.

3. Apply lubricant to the socket pipe.

4. Install the socket pipe.

Shortening a fitting pipe

1. Cut the fitting pipe flush with the rib edge using e.g. a circular saw.
2. Bevel the end in accordance with Table 5.6.12 with e.g. an electric plane.
3. To ensure a watertight joint, check the spigot end for cracks or damage.
4. Couple the spigot end with the socket in the normal manner.

Pipe sizes and bevelling

Pipe	Bevel
Width (mm)	**Width (mm)**
800	30
1000	40
1200	40
1400	40
1600	40

Table 5.6.11

Bevel

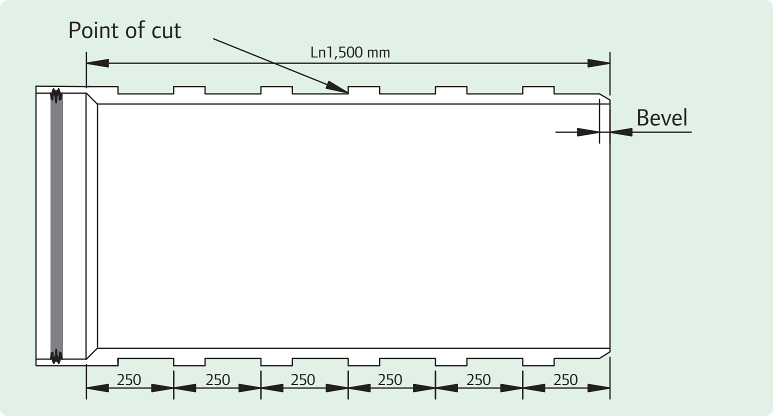
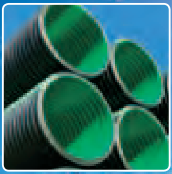


Figure 5.6.12



UPONOR INFRASTRUCTURE

UPONOR PP STORMWATER
SYSTEM

Uponor PP Stormwater System

5.7 Uponor PP Stormwater System

The Uponor PP Stormwater System consists of polypropylene double-wall piping. Its pipes have a smooth green inner surface and a black corrugated outer surface.

The corrugated outer surface makes for a robust, highly durable pipe. This system has a ring stiffness class of SN 8, and is ideally suited to traffic loading zones.

The pipes are equipped with a fixed socket, for easy and secure coupling with a sealing ring.

All pipes are automatically tested for tightness on the manufacturing line.

PP Stormwater System seals are made of styrene butadiene rubber (SBR).

The PP Stormwater System uses the same fittings as the Dupplex and Ultra Rib 2 sewer systems.

Pipe dimensions

Outside diameter	Inside diameter	Length
mm	mm	m
110	95	3/6 m
160	138	6
200	172	6
250	215	6
315	272	6
400	350	6
450	400	6
560	500	6
670	600	6
893	800	6

Table 5.7.1

The robust Uponor PP stormwater drainage system has extremely high resistance to internal grit and gravel erosion. This system is also ideal for highway and paved area drainage, as well as agricultural and forest drainage.

System and material specifications

Properties		PP	Unit	Standard/test method
Density		900	kg/m^3	ISO 1183
Ring stiffness	Pipes	SN 8	kN/m^2	ISO 9969
	Fittings	SN 8	kN/m^2	ISO 9969
Long-term elastic modulus E$_{50}$		425	MPa	ISO 527-2
Short-term elastic modulus E$_0$		1650	MPa	ISO 527-2
Thermal expansion factor		0.18	mm/m · °C	
Thermal conductivity		0.22	W/m · °C	DIN 52 612 / 23 °
Maximum continuous operating temperature			85	°C
Maximum momentary operating temperature		100	°C	
Maximum joint deflection		2	°	

Table 5.7.2

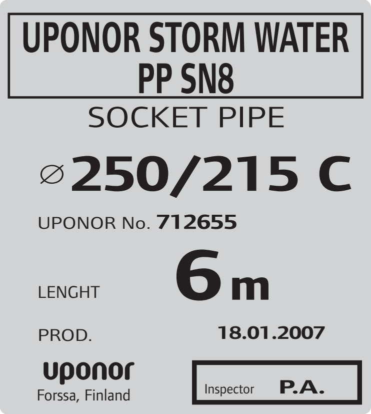
Approvals & Markings

Approvals

Uponor PP Stormwater System production and quality assurance is performed in compliance with Uponor Factory Standard 900.

Markings

The figure on the right gives an example of the markings for Uponor PP Stormwater System piping. Explanations for the markings are given in the table below.



UPONOR STORM WATER
PP SN8
SOCKET PIPE
∅250/215 C
UPONOR No. 712655
LENGHT 6 m
PROD. 18.01.2007
uponor
Forssa, Finland
Inspector P.A.

UPONOR	**STORM WATER**	**PP**	**SN 8**	**SOCKET PIPE**	**ø250/215 C**
Product	Application	Material: polypropylene	Stiffness class	Pipe type	Size

UPONOR NO. 712655	**Length 6 m**	**PROD. 18.01.2007**	**UPONOR Forssa, Finland**	**Inspecor P.A.**
Uponor no.	Pipe length	Production date: day/month/year	Manufacturer, production unit	Inspector, initials

Table 5.7.3

PP Stormwater System Design

Structural design

The "Structural design" section of the Drainage and Sewer Systems chapter specifies a number of design criteria for which generally applicable experience-based data exists. If these criteria are met, no additional design calculations are required.

Flow design

When determining the pipe system's dimensions, it is important to ensure that the system has sufficient flow and self-cleaning capacity to ensure trouble-free operation. The main design principles are presented in the introductory section of the Drainage and Sewer Systems chapter.

The nomogram charts are based on the inside pipe diameter. Flow charts for full PP pipes are presented in Appendix 9.

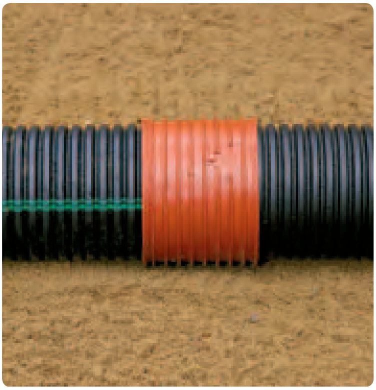
PP Stormwater System Installation

The following section gives step-by-step installation instructions for the Uponor PP Stormwater System.

1. Cut the pipe along the corrugation groove using a saw.

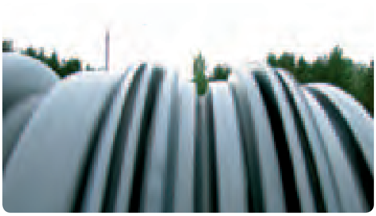
2. Fit the sealing ring onto the first groove from the spigot end.

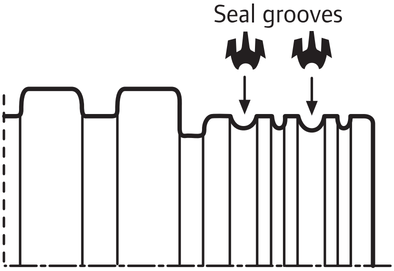
3. Apply lubricant to the inside of the socket.



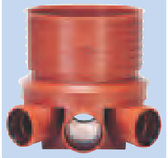
4. Push the spigot end home to the base of the socket. If in doubt, use a visual guide: mark the required insertion depth on the spigot end before inserting, to ensure it is pushed fully into the socket.

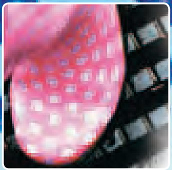
Seal installation on Uponor PP 893 Stormwater System pipe





Joint water tightness is ensured by installing two seals into the 1st and 2nd wide seal grooves from the spigot end.





uponor

UPONOR INFRASTRUCTURE

UPONOR STORMWATER CHAMBER SYSTEMS

Advanced chamber system for ultra-effective environmental protection

5.8 Uponor chambers

Pipe chambers perform a number of vital functions in municipal wastewater, stormwater and land drainage networks. Straight pipeline stretches are normally equipped with inspection chambers or maintenance shafts, spaced every 40 metres or so. Modern pipeline cleaning, clearing and camera inspection technologies have replaced the need for personnel access to pipes. The cost efficiency of pipe chambers has greatly improved as a result. Chambers are also typically built at changes in direction and junctions.

Uponor chamber types

Chamber types are chosen according to the pipeline's purpose of use. Commonly used abbreviations for the different chamber types are given in the table below.

In addition to chambers used in municipal pipe systems, Uponor's chamber range includes different chamber solutions for building stormwater and land drainage systems, and for farm and crop irrigation requirements. Uponor chambers are classed into three main groups, based on the type of delivery.

Abbreviation	Explanation
WWIC	Wastewater inspection chamber, DN ≥ 400 mm
SWIC	Stormwater inspection chamber without silt trap, DN ≥ 400 mm
SWC	Stormwater chamber with silt trap and water trap, DN ≥ 400 mm
SGWC	Storm- and groundwater attenuation chamber: a DN ≥ 560 subclass of the stormwater chamber. The chamber is equipped with a backflow prevention valve.
LDC	Land drain chamber with silt trap DN ≥ 315 mm
IP	Inspection pipe, i.e. smaller version of the wastewater inspection chamber, DN ≥ 200 mm
GH	Rainwater gully hopper for roof water collection

Table 5.8.1. Chamber types

Figure 5.8.2. Chamber types

Chamber packages

- Ready-designed standard model chambers
- Ready-to-install units, suitable for a wide range of applications
- Complete ready-made products, high availability

Modular chambers

- Chambers assembled from the following components delivered as standard parts: a base section, a riser and, welded to the base section and depending on the application, either a cast iron, stainless steel or seal-equipped plastic cover unit.
- Cost-effective solution
- Broad product range
- Quick availability

Bespoke chambers

- Bespoke chamber solutions according to the customer's needs

The chamber packages, delivered ready-made from the warehouse, are easy to adjust on site to the required height and pipe positions. Our versatile chamber range includes

- Wastewater inspection chambers and inspection pipes
- Stormwater chamber packages
- Land drain chambers
- Rainwater gully hoppers

Nearly all chambers used in housing construction are delivered as ready product packages containing a base section, riser and telescopic cover section. Stormwater and land drain chambers are available with either cast iron or stainless steel covers.

Wastewater inspection chambers and inspection pipes
Uponor Pro inspection chamber packages with straight through or intersecting inlets. Connection size range 110..0.315 mm. Connection size range for inspection pipe packages: 110...200 mm.

Stormwater chamber packages
Ready-to-install stormwater chambers with grid cover, and domestic storm- and groundwater attenuation chambers. Connection size range 110...200 mm.

Land drain chambers
Plastic cover land drain inspection chamber with three connection sizes. Height: 800 and 3,000 mm. Connection size 110 mm.

Stormwater gully hoppers
A wide range of gully hoppers for house roof water drainage with an integral connection to a 110 mm stormwater pipe.

Figure 5.8.3. Chamber packages

Modular chambers typically consist of three standard components: a base section, riser and cover section. Each base section includes pipe connections; the customer can select branch fittings for these from Uponor's range. Base sections are made from injection moulded polypropylene.

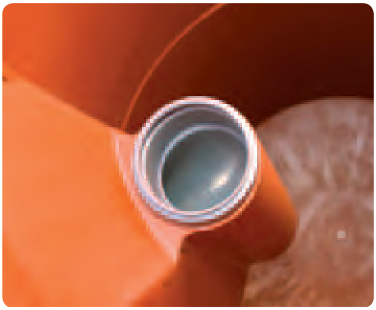


Figure 5.8.4. All modular stormwater chambers are standard equipped with a skim board or water trap. Flushing pipe connection, as shown in the figure above, is also available as optional equipment.

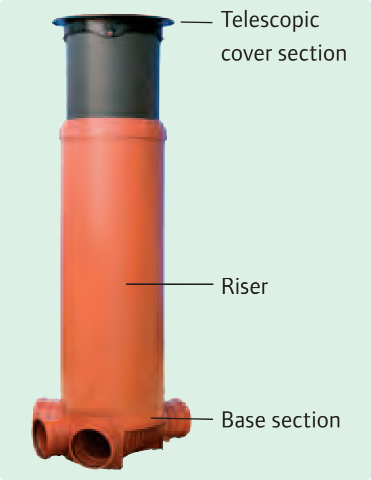


Figure 5.8.5. Modular chamber structure

Due to the base section structure, post-connections can be performed extremely low down, if needed. The base section and riser are factory weld-jointed, to ensure a fully watertight and robust joint. All modular stormwater chambers are standard equipped with a skim board or water trap.

Wastewater inspection chambers (WWIC) and inspection pipes
Inspection chamber with intersecting Uponor Pro base or straight channel base. Riser height: 400 and 560 mm. Connection size range: 110...315 mm.

Stormwater inspection chambers (SWIC)
Inspection chamber with intersecting Uponor Pro base. Riser height: 400 and 560. Connections: 110–315 mm.

Land drain chambers (LDC)
Equipped with a 315 or 400 mm riser and cast iron or stainless steel telescopic cover.

Stormwater chambers (SWC)
Extensive selection of chambers for a range of applications. Silt trap size range from 70 to 300 litres, depending on the chamber model. Equipped with telescopic riser and 40 t cast iron grate cover.

Figure 5.8.6. Modular chambers

Bespoke chambers are made to order according to customer specifications. The type, size, height, branch sizes and location etc. of each chamber are determined in line with the customer's drainage plan. A chamber order form or offer request form provide the best way of notifying Uponor of the required delivery specifications. Bespoke chambers are produced to order from welded PE preforms and delivered on-site numbered and ready-to-install, each to its own specific pipeline location. Bespoke chambers can also be manufactured with a large diameter (up to 1 800 mm) or in line with special height specifications.

Figure 5.8.7

Approvals

There are national regulations and guidelines concerning water supply and drainage installations for buildings. Both the chamber designer and manufacturer operate in complete compliance with these standards, regulations and guidelines. Some of the design and production requirements are listed below.

- Wastewater systems and their joints must be leak-proof, i.e. chambers and chamber joints must be watertight. For wastewater chambers, watertightness is also generally required of the chamber sections above the flow line, to ensure that leakage water is unable to enter the wastewater system.
- Wastewater chambers must be equipped with base channels for flow direction
- Inspection pipes may be one diameter size smaller than the sewer, however at least DN >= 160 mm
- Wastewater inspection chambers must be at least DN 400 mm
- If the outlet pipe from a storm- and groundwater attenuation chamber is lower than the backwater level of the public sewer, the outlet pipe must be equipped with a self-acting non-return valve.
- Stormwater inspection chambers with a flat (non-channelled) base are also generally approved
- A stormwater chamber silt trap must have a minimum volume of 70 litres and a minimum height of 500 mm
- The silt trap height for land drain chambers is min. 200 mm
- No external requirements exist for stormwater gully hoppers.

For the latest updated standards, visit us online at www.uponor.fi.

Chambers in the Drainage Plans

In domestic housing applications, pipe chambers are used in three separate systems: wastewater, stormwater and land drainage. Pipe systems must be made accessible for maintenance and inspection purposes, while pipe chambers used for such a purpose must be totally watertight.

In house drains, either a wastewater inspection chamber or inspection pipe is used. Inspection chambers should be installed at any horizontal or vertical changes in direction, wherever junctions between two or more drains occur, and at intervals of 40 metres on straight pipes. The following structural specifications apply to inspection chambers:

- Inside the chamber, the direction of flow must not change by more than 45°. Sharper direction changes must be carried out by installing a bend prior to the chamber.
- Inspection chambers must have clearly defined flow channels.

In inspection pipes, the flow is always straight. If a direction change is necessary, any bend must be installed prior to the inspection pipe. A diagram of the appropriate chamber type must be included on pipe layout drawings. Joint heights and the cover height and type must also be clearly indicated on the drawings.

Surface waters are collected and channelled into the storm drain via grid-cover stormwater chambers. Stormwater from roofs is collected and channelled into the storm drain via gullies. These roof and surface waters converge in a stormwater inspection chamber, from which they are directed onwards to the main storm drain. Pipe direction changes up to 90° can be made in a stormwater inspection chamber. Flow channels are not required and the sections above the base do not need to be watertight. The following chambers are required for storm drainage:

- Gully hoppers for roof water collection e.g. the Uponor Plus stormwater gully hopper.
- Stormwater chamber for surface water collection SWC400/70 or SWC 560/150
- Stormwater inspection chamber Pro T2 400
- Storm- and groundwater attenuation chamber 560/150 with non-return ball valve.

When needed, land drainage inspection chambers serve as maintenance points for flushing the drainage system. The chamber provides maintenance access for both input and outlet pipes. Designed for building land drainage systems, the Uponor 315 Land Drain Chamber comes equipped with a solid cover, silt trap and easy-to-open connections. The chamber height range is one to three metres. If needed, the chamber can also be manually shortened by sawing to the desired height. Because storm run-off must be kept separate from the land drain, the land drain chamber cover must not be perforated to serve as a grid cover.

For larger land drainage sites, a bigger size class chamber, such as the LDC 400/35, is needed. These larger land drain chambers are normally equipped with a telescopic cover.

Municipal pipe chambers

Municipal sewer networks place higher demands than household systems on pipe chambers. For example, different pipe sizes and tightness requirements apply. Wastewater chambers must be 100% leak-proof and meet high flow performance requirements. Stormwater chambers are less demanding in terms of tightness, but high structural durability is required for both chamber types.

Some municipalities still require direct chamber-to-chamber visibility for optical and laser measurement purposes. This also means that bends must not be installed. Instead, the chamber connections must be ready-installed in the required direction. For such cases, bespoke chambers provide the ideal solution.

Figure 5.8.8. Bespoke chamber

Municipal pipe chambers are normally equipped with a telescopic cast iron cover section. Exceptions may include, for example, sites where the chamber is installed below groundwater level. In such cases, the riser is fitted with a watertight cover.

Suitable inspection chambers for wastewater lines include, for example, Uponor Pro chambers or the standard WWIC model. These models are equipped with a telescopic cast iron cover and integral branch inlets for different pipe diameters. In addition to stormwater inspection chambers, standard stormwater chambers are installed for surface water collection. Such chambers are equipped with a telescopic grid cover, water trap and optional flushing pipe.

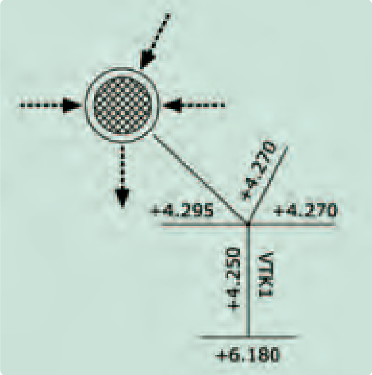


Figure 5.8.9. Chamber location

A schematic diagram of the chamber must be included in the drainage plan. Additionally, the chamber's branch connection heights and the ground level must be shown on the plan drawings. We highly recommend using the enclosed Uponor Chamber Order Form as a simple and effective way of ensuring that all of the required information is provided.

☐ CHAMBER ORDER ☐ OFFER REQUEST ___ / ___ 20____

Customer ______________________ Contact person , tel. ______________________

Order no./ref. ______________________ Wholesaler ______________________

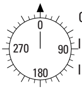
Delivery date ______________________ Wholesaler order no. ______________________

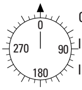
Delivery address ______________________

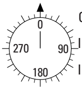
______________________ Freight free ☐ Freight charge ☐ Pick up ☐

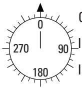
*) Chamber height 'h' measured from flow line to ground level. Note: Seal watertightness guaranteed only for Uponor pipes

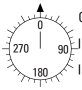
**) Pipe type, e.g. 1 = Ultra Rib 2 2 = Dupplex 2 3 = Uponor PVC 4 = Stormwater DW 5 = Drainage DW 6 = Drainage

CHAMBER No.	OUTLET	**) Pipe type	Connection size	Flow line height (cm)	Angular defl. degs.	Gradient cm/m
	Outlet			0	0	
QUANTITY	 Inlet 1					
	Inlet 2					
	Inlet 3					
SIZE (OD)	Inlet 4					
	Not telescopic ☐	Cover without handle ☐				
HEIGHT *)	Telescopic ring:	Telesc. riser 0.8 m ☐	________ m			
	Bolted ☐	Grate cover 40 t ☐	Freeze protection ☐			
	Welded ☐	Water lock ☐ + flush pipe ☐				
	Solid cover 40 t ☐	Grit trap depth: Standard ☐	________ m			
Further information:						

CHAMBER No.	OUTLET	**) Pipe type	Connection size	Flow line height (cm)	Angular defl. degs.	Gradient cm/m
	Outlet			0	0	
QUANTITY	 Inlet 1					
	Inlet 2					
	Inlet 3					
SIZE (OD)	Inlet 4					
	Not telescopic ☐	Cover without handle ☐				
HEIGHT *)	Telescopic ring:	Telesc. riser 0.8 m ☐	________ m			
	Bolted ☐	Grate cover 40 t ☐	Freeze protection ☐			
	Welded ☐	Water lock ☐ + flush pipe ☐				
	Solid cover 40 t ☐	Grit trap depth: Standard ☐	________ m			
Further information:						

CHAMBER No.	OUTLET	**) Pipe type	Connection size	Flow line height (cm)	Angular defl. degs.	Gradient cm/m
	Outlet			0	0	
QUANTITY	 Inlet 1					
	Inlet 2					
	Inlet 3					
SIZE (OD)	Inlet 4					
	Not telescopic ☐	Cover without handle ☐				
HEIGHT *)	Telescopic ring:	Telesc. riser 0.8 m ☐	________ m			
	Bolted ☐	Grate cover 40 t ☐	Freeze protection ☐			
	Welded ☐	Water lock ☐ + flush pipe ☐				
	Solid cover 40 t ☐	Grit trap depth: Standard ☐	________ m			
Further information:						

CHAMBER No.	OUTLET	**) Pipe type	Connection size	Flow line height (cm)	Angular defl. degs.	Gradient cm/m
	Outlet			0	0	
QUANTITY	 Inlet 1					
	Inlet 2					
	Inlet 3					
SIZE (OD)	Inlet 4					
	Not telescopic ☐	Cover without handle ☐				
HEIGHT *)	Telescopic ring:	Telesc. riser 0.8 m ☐	________ m			
	Bolted ☐	Grate cover 40 t ☐	Freeze protection ☐			
	Welded ☐	Water lock ☐ + flush pipe ☐				
	Solid cover 40 t ☐	Grit trap depth: Standard ☐	________ m			
Further information:						

CHAMBER No.	OUTLET	**) Pipe type	Connection size	Flow line height (cm)	Angular defl. degs.	Gradient cm/m
	Outlet			0	0	
QUANTITY	 Inlet 1					
	Inlet 2					
	Inlet 3					
SIZE (OD)	Inlet 4					
	Not telescopic ☐	Cover without handle ☐				
HEIGHT *)	Telescopic ring:	Telesc. riser 0.8 m ☐	________ m			
	Bolted ☐	Grate cover 40 t ☐	Freeze protection ☐			
	Welded ☐	Water lock ☐ + flush pipe ☐				
	Solid cover 40 t ☐	Grit trap depth: Standard ☐	________ m			
Further information:						

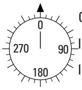
CHAMBER No.	OUTLET	**) Pipe type	Connection size	Flow line height (cm)	Angular defl. degs.	Gradient cm/m
	Outlet			0	0	
QUANTITY	 Inlet 1					
	Inlet 2					
	Inlet 3					
SIZE (OD)	Inlet 4					
	Not telescopic ☐	Cover without handle ☐				
HEIGHT *)	Telescopic ring:	Telesc. riser 0.8 m ☐	________ m			
	Bolted ☐	Grate cover 40 t ☐	Freeze protection ☐			
	Welded ☐	Water lock ☐ + flush pipe ☐				
	Solid cover 40 t ☐	Grit trap depth: Standard ☐	________ m			
Further information:						

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Figure 5.8.10. Uponor Chamber Order Form

Uponor Chamber Range

Uponor offers a versatile range of chambers for waste- and stormwater drainage and land drainage applications. The following section gives a brief overview of the different Uponor chamber types. At the end of the section is a chamber selection table, from which you can easily find the right chamber for the right application.

Figure 5.8.11. Wastewater inspection chamber (WWIC) and inspection pipe

Wastewater inspection chambers and inspection pipes

Wastewater inspection chambers are used in non-pressure drainage and sewerage networks, and can be connected to both smooth and corrugated or rib-stiffened pipes. The base section of the inspection chamber comprises an injection moulded base, attached to a corrugated and seal-equipped riser socket. In addition, it is equipped with either straight (T1) or intersecting (T2) inlets. Base elements equipped with intersecting branch inlets have three inlets set at 45° to one another. The branch inlets and outlet pipe are fitted with universal sockets that are compatible with both smooth and rib-stiffened pipes, eliminating the need for adaptors.

Uponor inspection chamber packages are also available with adjustable Pro-Flex-Joint connections. Their Pro-FlexJoints enable inlet and outlet adjustment by 7.5 degrees in any direction.

Standard chamber packages include a riser, a telescopic riser section, and a 40 t cast iron cover. Within the modular chambers, the base section and riser are welded together.

Drain inspection pipes are inspection and maintenance shafts that are smaller in diameter than inspection chambers. The inspection pipe comprises an inspection line and a riser, which can be either uniform or telescopic, depending on the installation site. Inspection pipes come with either stainless steel or plastic covers. Inspection pipes intended for traffic areas are equipped with a cast iron cover.

Figure 5.8.12. Stormwater chamber and stormwater inspection chamber (SWIC)

Stormwater chambers and inspection chambers

Used for collecting surface and land drainage waters, Uponor's stormwater chambers have an extremely broad scope of application. They can be divided into the following main categories: road and yard area stormwater chambers, and storm- and groundwater attenuation chambers. Stormwater chambers are used to drain runoff from roadways, yard areas or car parks. Chambers equipped with a silt trap are used to prevent grit and other debris from entering and blocking the sewer system. The task of storm- and groundwater attenuation chambers used in domestic applications, is to combine the building's land and storm drainage lines.

Stormwater inspection chambers serve as access points for pipe inspection and maintenance. These chambers are equipped with either a telescopic or fixed riser and are also available with a non-channelled flat base section. Water tightness is not a requirement for all sections of stormwater inspection chambers. Pipe joints must, however, be fully watertight. Inspection chambers are typically equipped with a solid cast-iron cover.

Figure 5.8.13. Land drain chamber

Land drain chambers

Land drain chambers are installed in land drainage systems to which access is required for inspection purposes. These chambers are often also installed at pipe junctions and wherever changes in pipe gradient or pipe size occur. An adjustable land drain chamber is a specialised chamber used for crop irrigation. Such a chamber can be used to regulate soil moisture content according to weather conditions and water demand.

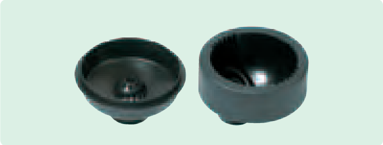


Figure 5.8.14. Stromwater gully hoppers

Stromwater gully hoppers

The function of the stormwater gully hopper is to catch roof stormwater from the drainpipe and channel it into the storm drain. The hopper is equipped with a sieve to prevent leaves and other debris from entering the drain. Its bowl-like shape is specially designed to protect the foundation wall from splashing. The gully hopper also serves as an access point for drain maintenance.

Use the table below to help select the most suitable chamber type for your needs. Schematic diagrams of the chambers are shown in the price list. Detail drawings can be downloaded from www.uponor.fi.

Pipe size	Wastewater inspection chamber	Stormwater inspection chamber	Stormwater chamber	Land drain chamber
110	Inspection pipe 200T *1*2 Pro T2 400 WWIC *1*2 WWIC 400 WWIC 560	Pro T2 400 SWIC *1*2 SWIC 400 SWIC 560	SWC 400/70 *1*2 SWC 400 SWC 560 SWC 560/150 *1*2 Storm- and groundwater attenuation chamber 560/150 *1*2 ISO-SWC 800 *2	LDC 315 *1 High LDC 315 *1 LDC 400/35 *1*2 LDC 400 LDC 560 Adjustable land drain chamber
160-200	Inspection pipe 200T *1*2 Pro T2 400 WWIC *1*2 Pro T2 560 WWIC *2 WWIC 400 WWIC 560	Pro T2 400 SWIC *1*2 SWIC 400 Pro T2 560 SWIC *2 SWIC 560	SWC 400/70 *1*2 SWC 400 SWC 560 SWC 560/150 *1*2 Storm- and groundwater attenuation chamber 560/150 *1*2 ISO-SWC 800 *2	LDC 400/35 *1*2 LDC 400 LDC 560
250-315	Pro T2 560 WWIC *2 WWIC 400 WWIC 560	SWIC 400 Pro T2 560 SWIC *2 SWIC 560	SWC 400 SWC 560 ISO-SWC 800 *2	LDC 400 LDC 560
400-450	WWIC 560 WWIC 800	SWIC 560 SWIC 800	SWC 560 SWC 800	
560-670	WWIC 800	SWIC 800	SWC 800	
800+	WWIC 1000	SWIC 1000 SWIC 1400	SWC 1000 SWC 1400	

WWIC = Wastewater inspection chamber, flow-channel base, fully watertight
SWIC = Stormwater inspection chamber, pipe joints watertight
SWC = Stormwater inspection chamber, silt trap, pipe joints watertight
LDC = Land drain chamber, silt trap

*1 = package chamber
*2 = modular chamber
Please note: All chambers available as bespoke version

Figure 5.8.15. Chamber selection table

Size	Height, metres	Volume, litres
SWC 400/70	0,64	70
SWC 560/150	0,70	150
SWC 400	0,65	70
SWC 560	0,60	130
SWC 800	0,50	230
ISO-SWC 800	0,90	300

Figure 5.8.16. Stormwater chamber silt trap volumes

70-300 l

Chamber Installation

Setting the chamber height

The chamber height (h) is the distance between the outlet flow line and ground level. If the chamber has a silt trap, add the trap depth to the total chamber height.

The height of the base section represents the effective chamber height: i.e. the distance from the flow line to the base of the vertical socket. If a telescopic cover section is installed, its proportion of the total height is normally 500 mm. The remaining height is accounted for by the riser.

The riser height options for the modular chambers are 600, 1,000, 1,500 or 2,000 mm, to which a standard-size telescopic cover section is added for fine height adjustment, giving the total riser height. If necessary, the riser can be cut to length on site. The cut end of the riser pipe must be bevelled to match the original end of the riser. Install the groundwater seal on the bevelled end and brush lubricant over the seal. Next, fit the telescopic ring into place and screw it onto the riser.

The bespoke chamber's height is measured from the flow line to ground level. Unless otherwise specified by the customer, the telescopic cover section will account for a default height of around 500 mm of the total chamber height.

Chamber embedment

The chamber must be laid in frost-resistant embedment soil. The maximum grain size is the same as for the equivalent plastic pipe diameter. If, however, the surround material is susceptible to freezing, at least two layers of friction-reducing plastic membrane must be wound around the chamber, covering the top of the base section, the riser and the telescopic seal. This ensures that possible freezing moves only the topmost membrane layer, without raising the riser or telescopic seal out of position.

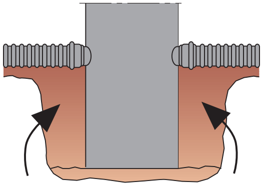


Figure 5.8.17. The material surrounding the grit trap must be compacted to the same bearing capacity as the trench bottom.

Spade the embedment material around the chamber and compact in approx. 20 cm layers. Check the straightness of the chamber as backfilling proceeds.

In the case of stormwater chambers with a grit trap, the pit dug to accommodate the trap breaks the uniform trench foundation. To prevent sinking, special care must be taken to ensure proper compaction of the backfill material beneath the pipe–chamber joints.

Adjusting the chamber height

The height of the telescopic chamber + main riser can be regarded as suitable when the top of the main riser pipe is 30...50 cm below the final ground level. Do not leave the final telescopic cover section resting on an over-length riser or on the chamber frame. The riser can be sawn shorter as necessary. Increased height can be achieved by replacing the riser with a longer one.

Raising the cover during repaving

During repaving, the chamber cover must be raised level with the repaved surface. To achieve this, the cover flange must first be chiselled free of the existing paving. If the cover section cannot be moved easily by lifting the flange, fasten a metal or wooden beam to a cable and hoist, and lower it through the turret section of the telescopic riser. It will thereby act as an anchor, when the cover section is hoisted from beneath. If necessary, to make raising easier, the ground around the turret section must be dug away.

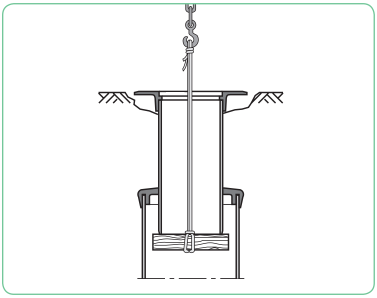


Figure 5.8.18. Raising the cover during repaving

Anchoring the cover section to the paving

During the construction and compaction of the upper road pavement layers, the telescopic cover sections of the chambers are raised level with each construction stage, so that they do not present an obstacle to work machines. During asphalt pavement, the cover section is raised by a few centimetres and asphalt is tamped beneath the cover flange. Finally, the cover is forced down, for example, with an excavator bucket, and rolled level with the paved surface.

Inspection pipe installation

Inspection pipes are installed in the same way as pipe chambers. The base section of the prefabricated inspection pipe is set at a fixed gradient, and the outlet is different to the inlet (universal socket). For this reason, the flow direction is marked with an arrow on the side of the base section.

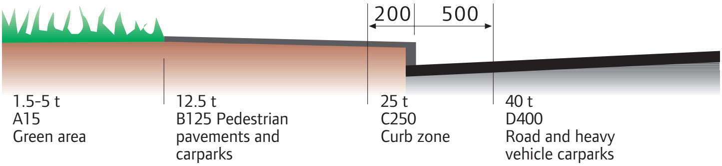


Figure 5.8.19. Strength grades for chamber covers according to the EN 124 standard

Connecting Uponor Ultra Rib 2 and Dupplex pipes

1. Place the chamber in the trench, making sure that the base is level. Check that the inlets/outlet are in the right direction.

2. Remove the sealing ring from the chamber socket.

3. Fit the pipe's own seal into the second groove from the pipe end.

4. Brush the inside of the chamber socket with lubricant.

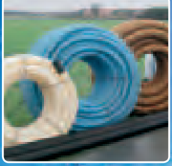
5. Push the pipe home into the base of the chamber socket.

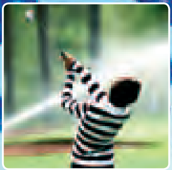
Connecting a smooth PVC pipe

1. Ensure that the pipe is the right length for installation. Bevel the PVC pipe end.

3. Push the pipe home onto the base of the chamber socket.

2. Brush lubricant onto the pipe end.





UPONOR INFRASTRUCTURE

UPONOR DRAINAGE
SYSTEMS

Building and land drainage system

5.9 Uponor Drainage System DW

The Uponor Drainage System DW is designed for specialist land drainage applications. The pipe material is polyethylene. These pipes are double walled, with a corrugated outer surface for high load carrying capacity and a smooth inner surface for enhanced flow and self-cleaning. The SN 8 class piping system is used for the following land drainage applications:

- roads and paved areas
- house foundations
- playing fields and other urban green areas

The Uponor Drainage System uses the same fittings as the Ultra Rib 2, Dupplex and Uponor Storm Water DW systems, in addition to which flexible Ø 110 and 160 fittings are available. These fittings have the same load carrying capacity as the pipe.

Figure 5.9.2

Pipe dimensions

Outside diameter	Inside diameter	Length
110	95	3 m
110	95	6 m
160	138	6 m
200	172	6 m
250	215	6 m
315	271	6 m

Table 5.9.1

The 110 land drainage pipe has a perforated circumference with four hole-rows spaced evenly at 3, 6, 9 and 12 o'clock. Other land drainage pipes have three hole-rows at 10, 12, and 2 o'clock.

Key features of the Uponor Drainage System DW:

- excellent flow characteristics
- smooth inside wall keeps the pipe clean and free of build-up, easy to clean when needed
- robust SN 8 pipe withstands demanding site conditions
- large perforation area guarantees good drainage capacity.

Water collection and carrying capacity

For example, the 110/95 double-wall drainage pipe has a perforated area of 80 cm^2/m, whereas an equivalent PVC drainage pipe has 10–30 cm^2/m. In addition to the perforated area of the pipe, the grain size and density of the drainage gravel affects the water collection capacity. The double-wall pipe's flow capacity is approximately 20% higher than that of an equivalent size PVC drainage pipe. In addition, the pipe's superior flow velocity guarantees less silting.

Precipitation from iron-rich drainage water can be prevented, for example, by installing the drainage network below groundwater level.

Land Drainage Principles

The purpose of land drainage is to manage soil water conditions, in order to eliminate the damaging effects of water and moisture on buildings and structures and their use, and to control water levels in trafficable areas, special sites and areas under cultivation.

The potential environmental impacts of land drainage measures must always be assessed.

Ordinary gravity drainage usually represents such a small share of overall project costs that, in borderline cases, its implementation from the outset is warranted on balance.

However, after the completion of a construction project, installing, adding to or repairing land drains can be both difficult and expensive.

Approvals

Below is mentioned some of the requirements for drainage pipes from design aspect:

- pipe sizes
- water collection and carrying capacity
- service life
- chemical and mechanical durability
- storage, handling, installation and maintenance.

Figure 5.9.3

Land Drain Inspection Chambers

Uponor offers a wide range of drain inspection chambers. The key general criteria for the choice of chamber are:

- location, ground surface type, and purpose of use
- depth
- loads
- worksite size and conditions

More specific chamber selection criteria include:

- suitability for progressive backfilling (telescopic cover section)
- inspection and maintenance requirements (cover type and location)
- size of adjoining pipes (chamber diameter)
- backflow valve requirement (storm- and groundwater attenuation chambers)

Plastic chamber types with cover section

Due to developments in inspection and maintenance technologies, modern pipe chambers no longer need to accommodate maintenance personnel. Plastic pipe chambers are therefore an ideal solution, due their ease of installation and maintenance. Plastic pipe chambers and inspection pipes used in land drainage systems have a typical diameter range of 200…600 mm. The most common drain chamber size is 315 mm.

Figure 5.9.4

If required, inspection pipes can be used as the land drain outlet chamber, for example in road and paved areas.

Use of telescopic covers is recommended, in order to facilitate the adjustment of the cover height to make it level with the ground or a paved surface, and to ensure easy maintenance access. The cover's load-bearing capacity must meet the requirements of the installation location.

The Uponor product range includes 40 t cast iron covers.

Land Drainage Design

Land drainage requirement

The land drainage requirement depends on the soil conditions, the planned building elevations and the moisture and load-bearing requirements of the site. Land drainage is intended to keep floor and wall structures dry, to improve the ground's carrying capacity in traffic areas and, in certain cases, to minimise frost heave.

Essential factors involved in the drainage requirement are the groundwater level and external ground level with respect to floor levels, water conditions in traffic areas, and the soil's water permeability.

Environmental impact

Land drainage can have a number of effects on local water conditions. Potential detrimental effects include the following:

- drying of water wells
- subsidence in soft soil areas
- induced decay of wooden pilings and wooden foundation structures
- groundwater erosion
- damage to vegetation

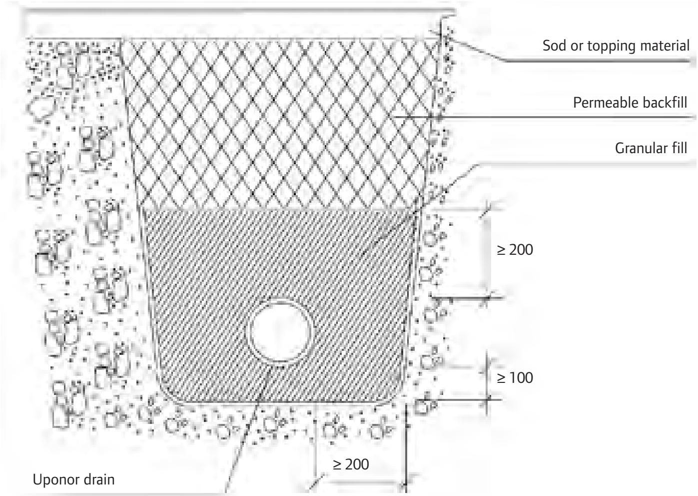


Figure 5.9.5. Land drain structure

Land Drainage Plan – Drawings

Content of pipe layout drawings

The Drainage Plan includes the following drawings, project-specifically:

- Surface Water Plan (1:200, 1:500)
- ground levels as surveyed
- surface water management systems (roof water drainage; stormwater chamber locations; gullies, curbs and other special structures; green area drainage; land drains, ditches and drainage pipes outside buildings)
- pipe layout drawings (1:100, 1:200)
- building foundation drawings showing ground conditions
- drainage pipes, by type and level
- drain inspection chambers, by type and numbered
- connection to storm drain system or discharge arrangement
- sectional drawings (1:50, 1:100, 1:200)
- longitudinal and cross sections
- drawings at least at the schematic level, showing drainage structures and their structural layers
- standard detail drawings (1:5, 1:10, 1:20)
- schematic drawings of all drainage structures.

A Building Drainage

Drainage system

As no two projects are the same in terms of local conditions and drainage requirements, no standard formula can be given for building drainage design. Certain general key principles do, however, apply to the design of drainage systems as a whole.

Drainage systems for building foundations comprise a filter layer and/or filter fabric, drainage gravel and drains.

The purpose of the filter layer is to maintain drain function by preventing fine material from entering the drain.

The purpose of the drainage fill (see Figure 5.9.6) is to convey water to the drainage pipes. For the system to function, it is essential that the drainage fill forms a continuous layer in direct contact with the drainage pipes. The drainage system is designed to function by gravity.

The system can be supplemented with watertight structures and materials that improve drainage efficiency.

Drainage around buildings

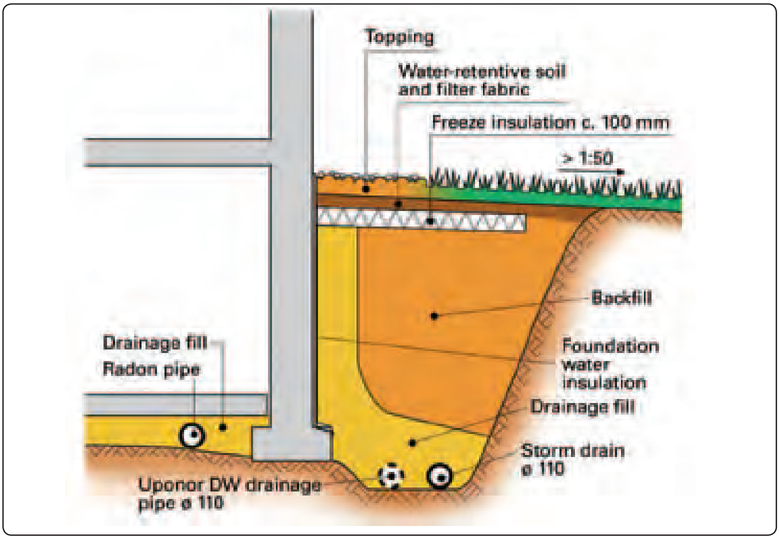
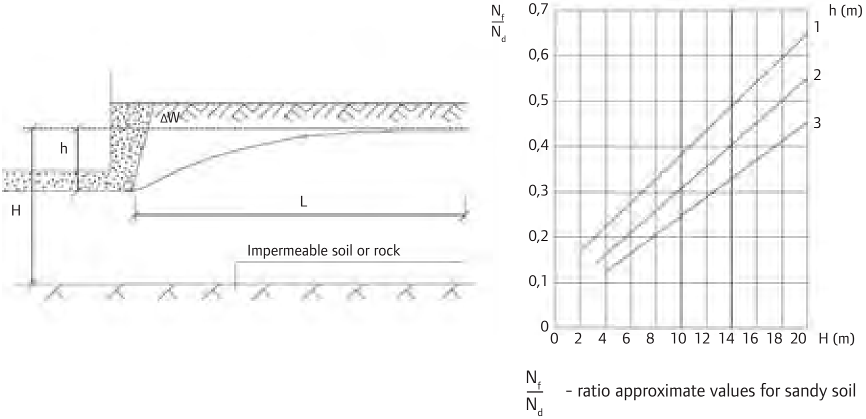


Figure 5.9.6

Design

The groundwater flow rate is evaluated based on the water permeability of the soil, the degree of groundwater level reduction and the thickness of the permeable soil layer (see Figure 5.9.7).



Reduction in the groundwater level due to drainage in a land drain (on the foundation pit border) in homogenous soil can be evaluated using the empirical formula

$$L = 2,000 \text{ x } h \text{ x } \sqrt{k}$$

and the water quantity at the wall line per unit length using the approximation formula

$$q = k \text{ x } h \text{ x } \frac{N_f}{N_d}$$

k = water permeability coefficient of foundation soil (m/s)
h = design groundwater level reduction (m)
H = thickness of permeable soil layer (m)
L = extent of groundwater level reduction (m)
q = water quantity per unit length (m^3/s x m)

$\frac{N_f}{N_d}$ = ratio obtained from the flowline/equipotential chart.
The lines in the chart above give approximate values for sandy soil.

Figure 5.9.7. Effective drainage distance and flow rate determination.

Table 5.9.8 shows the water permeability and capillarity properties of different soil types.

In addition to water flow, drain system design is also based on the combined water conducting capacity of the drainage gravel and drainage pipe, and sufficient carrying capacity in the drainage line.

The recommended pipe size for land drains is 110 mm. If design specifications require, two pipes can be used in parallel. The minimum flow velocity for land drains is 0.20 m/s (0.40 m/s in fine, silty soils).

The minimum gradient for land drains outside buildings is 0.5 %, the recommended gradient is 1.0 %.

Soil type	Water permeability, m/s	Capillary rise height, m
Highly water permeable:		
Gravel	19^{-2}…10^{-4}	< 0,05
Course sand	10^{-3}…10^{-4}	0,03…0,3
Gravelly till	0^{-4}…10^{-5}	1…2
Moderately permeable:		
Fine sand	10^{-4}…10^{-5}	0,3…3
Course silt	10^{-4}…10^{-6}	0,3…4
Sandy till	10^{-5}…10^{-8}	1…6
Silty till	10^{-6}…10^{-8}	2…6
Impermeable:		
Fine silt	10^{-6}…10^{-9}	3…10
Clay	> 10^{-9}	> 10

Table 5.9.8. Water permeability and capillary rise height for typical soil types (according to the Finnish "Geo-luokitus" soil classification system)

Location of land drains and chambers

Land drains can be located inside or outside the building footprint. When choosing the location, account must be taken of accessibility for inspection. There must be a distance of at least 200 mm between the drain and the building, as measured from the trench wall or trench structures.

If the drains or trench bottom lie lower than the bottom surface of the adjacent, ground-supported foundations, this distance is determined by a 1/3 gradient. If insufficient space is available to achieve this, then alternative drainage options should be considered.

The distance between drains depends on the site's building layout and geotechnical conditions.

The drains must run in a straight line between chambers. In exceptional cases, a single bend may be installed between chambers.

Pipe chambers should be located near the corners of the building at pipe junctions and gradient changes. The location of chambers outside the building must be verified against the Surface Water Plan. That of chambers within the building footprint must be negotiated with the other project designers.

Chambers should be located at least 5–10 m apart. For maintenance purposes, the maximum distance between chambers is approximately 20 m.

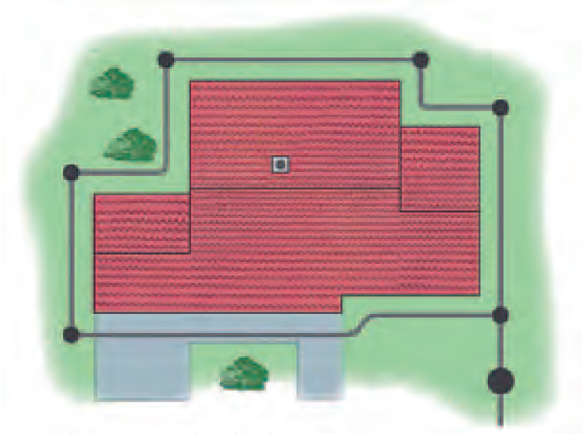


Figure 5.9.9. Example inspection chamber location

Drain depth

The minimum depth of coverage for land drains located outside heated buildings is 0.8 m in southern Finland, 1.0 m in central Finland and 1.2 m in northern Finland. In traffic areas, a further 0.5 m is added to the coverage depth. In shallow foundations, the minimum depth of coverage beneath freeze protection is 0.5 m. Coverage depths for the drains of non-heated buildings are determined case-specifically.

The maximum coverage depth for land drains depends on the pipe type. Uponor plastic drainage pipes are in the SN8 class and their maximum depth of coverage is 6m.

Drainage with different foundation types

In the case of below-floor land drain installations, the flow line must be at least 0.4 m below floor level. In addition, a layer of drainage gravel at least 0.2 m in depth must be accommodated above the drain. The required drain depth must be separately determined for heavily loaded floors.

Crossings beneath footings are carried out case-specifically, for example, using high load carrying capacity pipe.

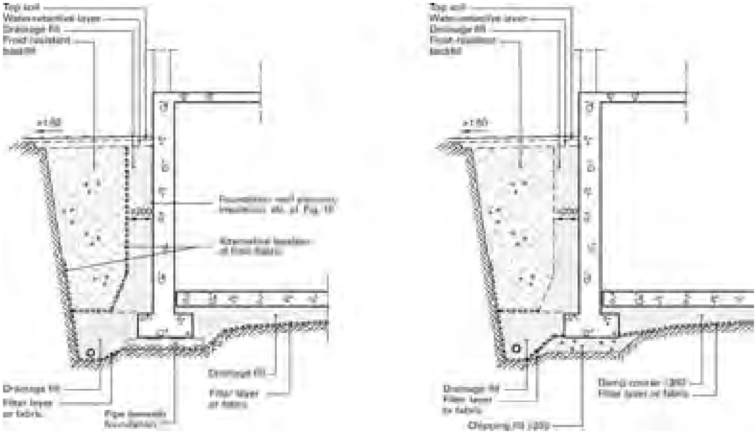


Figure 5.9.10. Land drain embedment

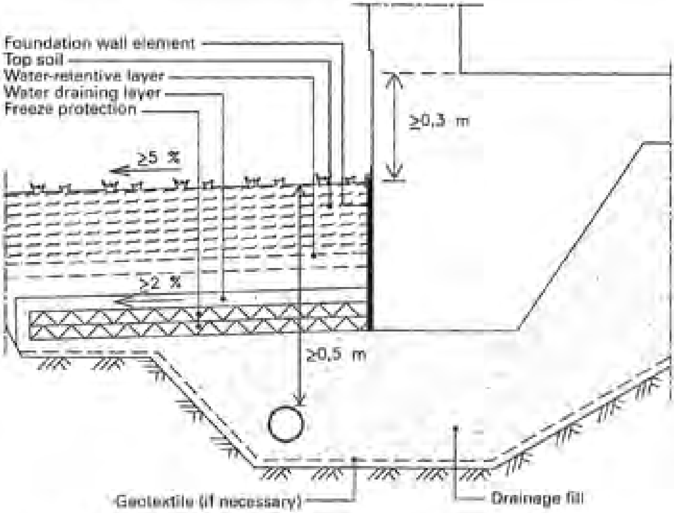


Figure 5.9.11. Land drain location in freeze protected shallow foundations

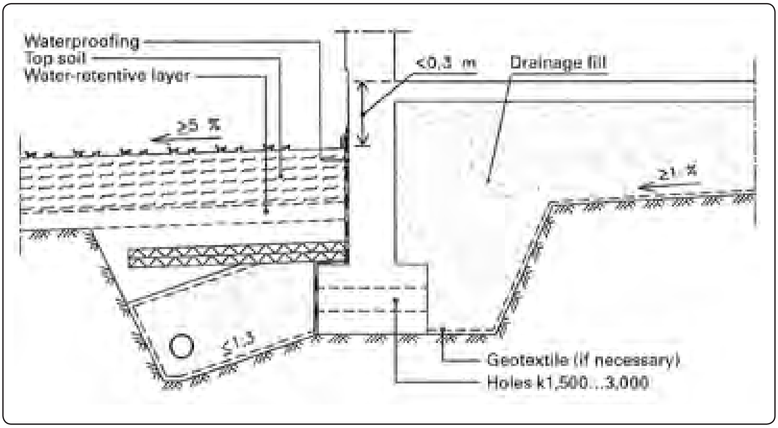


Figure 05.09.12. Location of land drain laid on existing ground

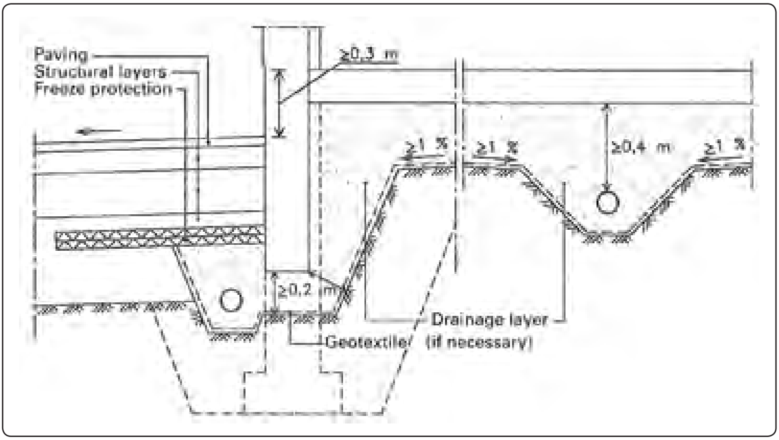


Figure 5.9.13. Location of land drain laid on existing ground

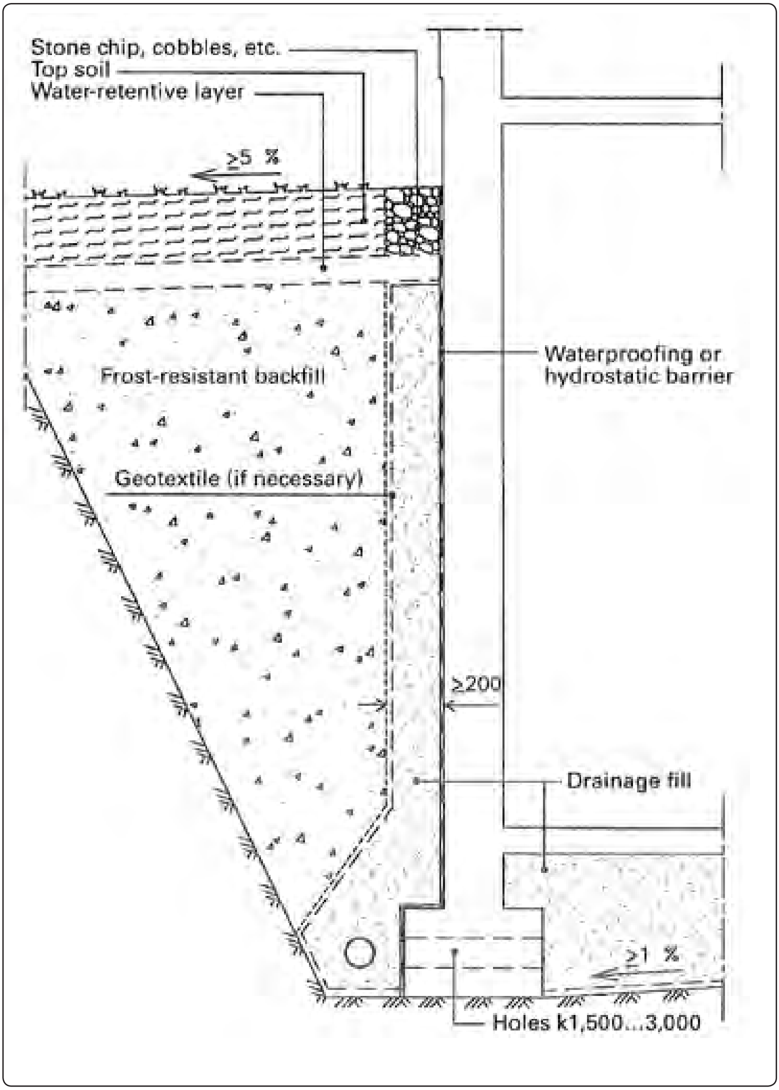


Figure 5.9.14. Land drain location for basement foundations

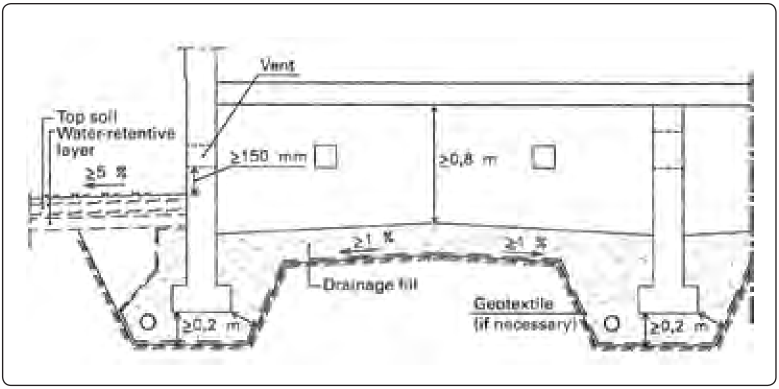


Figure 5.9.15. Land drainage of a suspended ground floor construction

B Green Area Drainage

Land drainage planning plays a key role in built-up areas. It does so by preventing structural damage from meltwater during the spring period and from heavy showers and persistent rainy spells during the frost-free seasons. Land drainage plans are drawn up as part of local area planning, taking account of issues such as the local topography and soil type. A Drainage Plan is based on a detailed map of the area, showing different terrain elevations. The geotechnical planning stage includes the clarification of official regulations and the determination of existing drainage installations, water discharge locations and groundwater conditions.

In areas covered by a town plan, drainage water is usually discharged into the municipal or city sewer network. In sparsely populated areas, drainage water is conducted to a location where it can be absorbed into the ground, without detriment to the environment or other residents.

Surface water drainage

Surface water drainage denotes the reshaping of the ground surface, in order to drain water at ground level in a required direction and at a required speed. In addition to ground modification, drainage is facilitated using means such as

- curbs
- gullies
- channels

The surface water is conducted to soakaways, open channels or, via stormwater chambers, to the sewer network. Drainage design must ensure that the water flow does not erode paved surfaces or cause flooding.

There are two main methods of ground surface modification: channelling and funnelling. In the case of channelling, the ground surface is sloped in one or two directions (see Figure 5.9.16), while in funnelling the ground is sloped around a central low point containing a stormwater chamber. With respect to channelling, the surface water is absorbed into the soil or channelled to a stormwater chamber or gullies.

The minimum gradient of the ground surface depends on the surface material. Smooth surfaces can be given a shallower gradient than rough surfaces. The minimum gradient requirement also increases as the flow distance increases. The maximum gradient depends on the ground area's purpose of use. The following table gives the minimum and maximum gradients for different pavings.

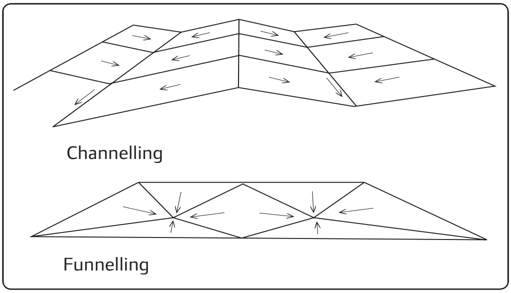


Figure 05.09.16

Paving	Lateral gradient	Line of gradient
Asphalt		
Roads	2,5-3 %	
Pavements	2,0-2,5 %	
Garden/yard areas		1-3 %
Stone paving, slabs		
Roads	2-4 %	
Pavements	2-3 %	
Garden/yard areas		1-4 %
Gravel		
Roads	4-5 %	
Garden/yard areas		2-4 %

Table 5.9.17. Minimum gradients for ground surfaces

Structure	Maximum gradient (recommended)	Exceptional cases
Road areas		
Heavy traffic	5 %	8-10 %
Light vehicle traffic	8 %	13-15 %
Parking areas	4 %	
Ramps		
Pedestrian	8-10 %	15 %
Wheelchair	5 %	8 %
Pram	8-10 %	15-20%
Steps	30 % (1:3)	50 % (1:2)

Table 5.9.18 Maximum gradients for ground surfaces

The lateral gradient refers to the slopes running sideways from a central high point. Similarly, the lengthwise slope is referred to as the longitudinal gradient. The line of maximum slope describes the gradient in the actual direction of flow created by lateral and longitudinal gradients.

Land drains

Land drains have the purpose of collecting water in intake drains and delivering it to conveyor drains, which drain via connecting chambers into the sewer network or a discharge outlet. In built-up areas, drainage water is normally directed to a storm drain or open channel.

When designing a drainage system, the amount of water flow must be determined from the area to be drained. This calculation is performed using a flow chart, from which the required nominal pipe diameter and the flow velocity of the water are derived. To obtain these values, the estimated flow rate and pipe gradient are needed as initial data. The smallest pipe size for garden and yard areas is considered 50 mm. Minimum flow velocity is 0.2 m/s, or 0.4 m/s in silty soils.

Surface type	Runoff l/s/ha
Hard-paved/roofed areas, drains with gravel fill	10-20
Sand and gravel areas, 5-10 drains with gravel fill	
Lawn and garden	
drains with intermittent gravel fill	3-5
no gravel fill	2-3
Drains beneath hard-paving	1-2

Table 5.9.19. Runoff to land drains from plot surfaces, southern Finland.

In parks and green areas, land drains are installed with a spacing of 10–30 metres depending on the soil type, the required drainage efficiency and topology of the site. For special locations, such as football fields or golf courses, the spacing can be increased to 4–8 metres. For household garden and yard areas, even closer pipe spacing (approx. 30–50% closer) is recommended.

Soil type	Pipe spacing, metres
Course silt	20-25
Medium coarse silt	16-20
Clay or fine silt	12-15
Silty till	15-20
Gyttja mud	25-30
Peat	18-20

Table 5.9.20. Recommended drainage pipe spacing for different soil types

Drains should be spaced as evenly as possible within the drainage area. Typical locations for land drains include low ground and the bottoms of slopes, banks and ramps. Intake drains are positioned either perpendicular to, or angled towards, the drainage direction. Pipes are most commonly angled towards the conveyor drain. If the flow velocity within the pipes is not too high, intake drains can also be positioned diagonally with respect to the slope direction. The recommended pipe gradient is 0.2–0.3%. Too low a gradient causes silting and clogging, while too high a gradient can cause pipe corrosion.

Storm drainage

Storm- and meltwaters are conducted via stormwater chambers to an underground storm sewer. Stormwater drainage is standard practice within urban environments.

The storm system design depends on the amount of water to be carried and the required flow velocity. Water volumes basically depend on the anticipated rainfall intensity and duration, ground surface quality (water permeability), pipeline length, and the number of stormwater chambers included in the line.

The stormwater quantity for garden and yard areas is determined using the following formula:

$$Q = q \times \alpha \times A$$

Q = sewer flow rate (l/s)
q = design rainfall intensity
α = runoff coefficient
A = catchment surface area

A rainfall intensity, of 10 min of heavy rainfall once every two years, is assumed. Sewer design is based on the design rainfall intensity, with cost factors and potential drawbacks caused by flooding factored in. While the design rainfall intensity varies according to local climate conditions, the runoff coefficient varies according to the ground surface or paving type (see Table 5.9.21 in the following page).

Surface type	Runoff coefficient
Roofs	0,90
Concrete, asphalt	0,80
Tight-jointed stone paving/slabs	0,80
Sand-jointed stone paving/slabs	0,70
Gravel roads	0,50
Grassed slopes	0,50
Exposed rock	0,40
Gravel yards/pitches/paths	0,30
Park-like green areas	0,20
Parks/green areas, high vegetation	0,15
Rocky woodland	0,15
Lawns, cultivated areas	0,10
Meadows, fields, gardens	0,10
Woodland	0,05

Table 5.9.21. Runoff coefficients per surface type

Area type	Runoff coefficient
Continuous high-rise blocks (hard-paved yard areas)	0,80
Continuous high-rise blocks (gravel-paved, greenery)	0,70
Non-continuous high-rise blocks	0,60-0,40
Terraced house areas	0,35
Detached house areas, small plots	0,25-0,30
Detached house areas, large plots	0,20-0,25
Sports and playing fields	0,20
Medium-sized parks and greens	0,05-0,10

Table 5.9.22. Runoff coefficients per area type

The runoff coefficient represents the amount of water estimated to be entering the sewer. The remainder either evaporates or is ground absorbed.

Either area coefficients or ground surface type coefficients are used.

Sample design calculation

The total surface area comprises 1,000 m^2 of asphalt, 300 m^2 of lawn, and 300 m^2 of concrete paving. The design flow rate is calculated as follows:

Q = 150 l/s/ha x (0.8 x 0.1 ha + 0.1 x 0.03 ha + 0.7 x 0.03 ha) = 15.61 l/s

Pipe gradient: 1:50 = Using the design chart, we can determine that, at a 15.6 l/s/ha flow rate and 2% gradient, the required PP stormwater pipe diameter is 160 mm, 160 mm and the flow velocity is 1.6.

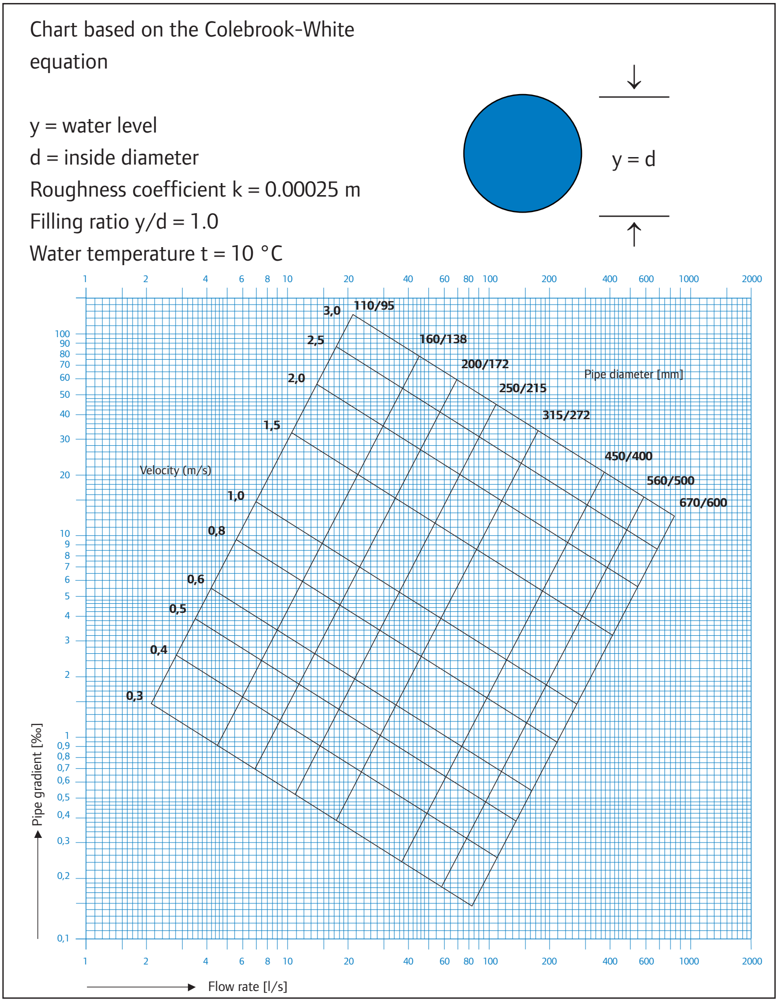


Chart based on the Colebrook-White equation

y = water level
d = inside diameter
Roughness coefficient k = 0.00025 m
Filling ratio y/d = 1.0
Water temperature t = 10 °C

Table 5.9.23. Design chart for full Uponor Stormwater System DW pipe

C Highway Drainage

Trafficable yard areas and driveways

Trafficable yards and driveways are drained for the following purposes:

- to improve load carrying capacity
- to enhance overall plot drainage
- in special ground conditions, such as in connection with slopes and to divert water flow from bedrock surfaces
- for surface drainage via runoff interceptor pits or drainage sheets.

Drainage is carried out where applicable, using the same principles as building drainage.

Special consideration must be given to the load carrying capacity of pipes, trenches and chamber covers and to freeze protection. A degree of freeze protection can be achieved without a high coverage depth, by locating the pipes around the edges of the drainage area where cleared snow is banked, thus utilising the insulating effect of deep snow. If drains are also required to function during sub-zero periods, they can be insulated, or equipped with heating cables situated at critical points in the drain system.

Roads

Road and street drainage has the primary objective of improving load carrying capacity and, in special cases, reducing freezing and improving surface drainage efficiency. The aim is to drain the road's surface structure as effectively as possible, unless drainage is unnecessary due to the soil's high water permeability or the road's height and water conditions of the road location.

Pipe Laying and Backfilling

Foundation

Land drains are normally ground supported.

Effective drainage in soft soil areas can be ensured by carefully selecting the pipe location, so that sharp variations in gradient are avoided. If required, pipe foundation or suspension structures can be used.

In exceptional cases, drains can be laid on piled reinforced concrete slabs, e.g. together with other pipeline structures.

Installation

The pipes are laid on a levelled bed of drainage gravel in a dry trench.

The maximum drain line displacement is 200 mm from the position specified in the drawings. The maximum straightness deviation between chambers is 50 mm horizontally and 20 mm vertically.

To avoid potential negative consequences, any pipe alignment changes, particularly near foundation structures, must be discussed with the designer.

Product-specific installation instructions must be followed.

Initial backfill

If necessary, a filter layer or filter fabric is installed in the pipe trench. The filter requirement can be determined from Figure 5.9.26.

The pipe must be laid on at least 200 mm of drainage gravel. Figure 5.9.25. gives the grain size specification for the gravel.

After laying the pipe, the trench must be backfilled with drainage gravel, to at least 200 mm above the pipe crown. Tamp the backfill on both sides, taking care not to dislodge the pipe.

Other backfilling

The final backfill is carried out according to the project-specific drawings. Key requirements include ensuring that the drainage fill forms a continuous envelope around the pipe, and that at least a 200 mm layer of drainage fill comes between the pipe and the basement wall.

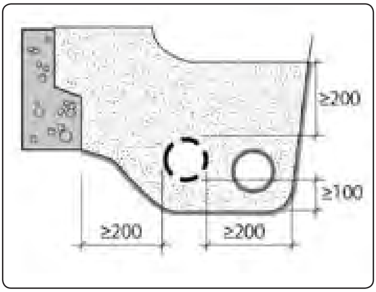
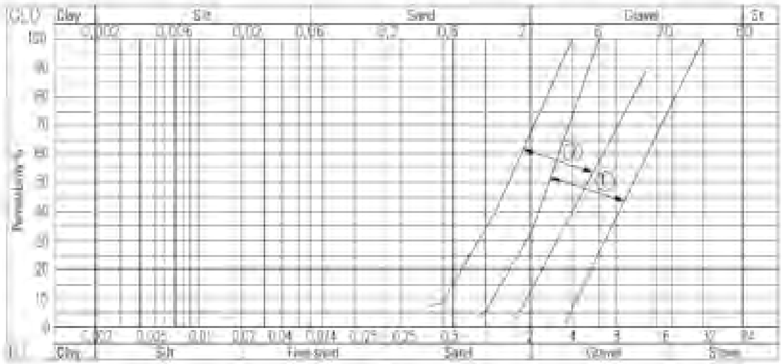


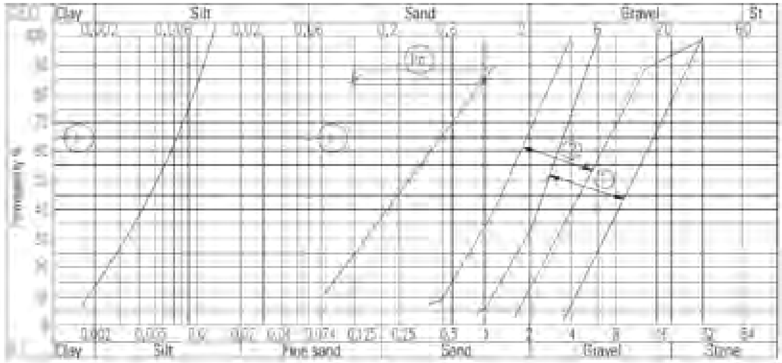
Figure 5.9.24



1. The grain size curve of the fill material should be within this range if groundwater level reduction is required or where considerable water flow is anticipated from the trench sides into the backfill. The maximum <1 mm grain size material content is 5 %.

2. The grain size range for backfill above groundwater level, in normal conditions.
   - 10 % permeability = grain size range of 0.5 …2.0 mm
   - 90 % permeability = grain size range of 3 …12 mm

Figure 5.9.25. Grain size specifications for drainage fill (RIL 126).



Grain size range of subsoil

I. No filter required, or special cases only

II. Filter required if curve fully within this range

IIa. If grain size curve within this range (d^P_{85} = 0.125 … 1.0), filter requirement depends on the grain size of the drainage fill. If $d^s_{15} / d^P_{85} > 5$, a filter is required.

1 = drainage fill grain size range 1

2 = drainage fill grain size range 2

Figure 5.9.26. Filter layer/fabric requirement (RIL 126).

Around buildings, to prevent surface water from entering the drain the top backfill must consist of water-retentive material. Elsewhere, the final backfill should consist of the same material as the surrounding drainage area, with the exception of surface water soakaways.

Land Drainage Discharge

Discharge into a storm drain

Drainage water is delivered via a storm- and groundwater attenuation chamber to the storm drain, if such a drain is located near the site.

If the backwater level of the storm drain is such that sewer water backflow into the land drainage network is possible during flooding, the attenuation chamber must be equipped with a backflow valve. To perform this extremely important function, a non-return ball valve has been developed for Uponor’s plastic pipe chambers.

Where shallow installations are a necessity, discharge during sub-zero periods is enabled by installing thermal insulation. This is particularly important at sites with demanding drainage conditions, where drainage continues during the sub-zero winter period.

Discharge into the ground, open channel, or watercourse

Where the land gradient allows, for example at sloping sites, drainage water can be discharged directly into the ground or an open channel, if doing so is not detrimental to the local environment.

When discharging into a watercourse or open channel, the outlet height must be 0.20 m above the high water level or channel bottom. If the discharge outlet height is below this level, floor levels and design factors related to silting and freezing must be considered with respect to the high water level.

The functioning and maintenance of drainage discharge arrangements must also be ensured. Outlet pipes must be of the solid variety and must extend at least 0.5 m from the bank. The end should be fitted with an animal screen. Landslip, erosion, silting and overgrowth must be prevented at the point of discharge. The discharge site must be inspected at least twice a year and restored as necessary.

Soakaways

If the ground conditions and gradient permit, land drainage water can be drained into soakaways. The discharge arrangement should be safeguarded with an overflow pipe.

Pumping

Drainage systems are designed to function by gravity. Where this is not possible, the water must be pumped into the storm drain or discharge outlet.

Pump design is based on the volumetric flow rate, which is in turn determined by the soil conditions, pumping trials, or the system's maximum flow rate. The pumping system must comprise at least two pumps, each with sufficient capacity to meet the design requirements independently.

5.10 Uponor Field Drainage System

Quality requirements

Uponor field drainage pipes (formerly Veto pipe) are flexible corrugated PVC pipes, used primarily for the drainage of fields, parks and green areas. In addition to standard perforated coiled and straight pipes, the range also includes coconut fibre filter coated pipes and non-perforated pipes.

Pipe sizes and types

Uponor field drainage pipes are size-classed according to their outside diameter.

New size marking DN/ø 0	Outside/ inside diameter	Former size marking DN (NS)	Ring stiffness
50	50/44	40	SN 8
65	65/57	50	SN 8
80	80/71	65	SN 8
100	100/88	80	SN 8
125	125/112	100	SN 4
160	160/144	130	SN 4
200	200/174	160	SN 4

Uponor PVC coiled field drainage pipes are available in the range DN 50–DN 160, and Uponor PVC straight field drainage pipes in the range DN 50–DN 200.

Table 5.10.1

Figure 5.10.2

Water collection and carrying capacity

Field drainage installations must be based on a drainage plan drawn up by a qualified expert, showing the topography, soil quality, groundwater conditions, possible discharge outlets, and the location of collection pipes, trunk drainage lines and maintenance shafts.

Field drainage chambers

The inspection chamber and silt trap layout is specified by the design engineer responsible for the field drainage plan.

Field Drainage Principles

The objective of agricultural field drainage is to manage soil water conditions, in order to prevent crop damage due to waterlogging.

Use of underground drainage enables open ditches to be reclaimed as productive land, increasing the total cultivable land area by an average of 10–20%. Other benefits include more efficient machine use and reduced man-hours in tilling, sowing and harvesting operations.

In addition, drainage increases the spring growing season and improves the soil's machine carrying capacity in the autumn.

The net result is higher yields per acre and better crop quality.

UPONOR INFRASTRUCTURE

PRESSURE SYSTEMS

Uponor Infrastructure Solutions Pressure Systems

6.1 Introduction

Uponor pressure systems are designed for water and gas supply, and sewerage applications. These plastic pipe systems are used to build extremely robust and flexible long-life networks, making them the smart choice in terms of overall cost effectiveness.

Uponor pressure pipes are made of PE 80, PE 100 and PVC. Primarily, the delivery pipes are mainly of ProFuse PE 100. This is supplemented by smaller PE 80, larger PE 100 and PVC pressure pipes.

Uponor pressure pipes are colour-coded according to their intended application. Small black pipes with blue-stripes, blue ProFuse pipes and grey PVC pipes are used for water supply. Small black pipes with terracotta-stripes, reddish-brown ProFuse pipes are used for sewerage. Black pipes with yellow stripes and yellow ProFuse pipes are used for gas supply.

This introductory section gives general rules for the structural and hydraulic design of pressure pipes. A working example of water pipe hydraulic design calculation is also given.

In the following sections, the system and material characteristics of the individual pipe systems are described and the corresponding product ranges are presented.

The table below shows the relationship between the system type and pipe size, and the area of application.

Systems and pipe sizes	**Application**		
	Water supply	**Wastewater drainage**	**Gas distribution**
Uponor PE 80 SDR 17		40 – 63 mm	
Uponor PE 80 SDR 11	20 – 63 mm		
Uponor Puriton	25 – 110 mm		
Uponor ProFuse SDR 17	90 – 400 mm	90 – 400 mm	90 – 400 mm
Uponor ProFuse SDR 11	90 – 400 mm	90 – 400 mm	90 – 400 mm
Uponor PE 100	450 – 800 mm	450 – 800 mm	32 – 90 mm
Uponor PVC	110 – 400 mm		

Table 6.1.1

Uponor Pressure System – Structural design

The degree of pipe deformation, i.e. deflection, during pipe laying and backfilling is influenced by the following factors:

- bearing capacity of the soil
- installation quality
- embedment and backfill material quality
- compaction
- traffic load

Plastic pipes are flexible and function interactively with the surrounding soil. Such pipe flexibility reduces the load on the pipe.

Over-excavation and replacement or embankment installation

Trench over-excavation replacement or embankment installation must be carried out in accordance with the drawings. Riprap (stone size ≤ 400 mm) or compactable load-bearing soil must be used as backfill.

In embankment installations, the density of the compacted backfill layers must meet the following density requirements:

- density level (improved Proctor) ≥ 90% or
- density ratio (portable falling weight deflectometer) ≤ 2.8

Over-excavation and backfill quality control is based primarily on on-site supervision. If embankment filling is carried out on soft silty soil, a filter layer of sand or a non-woven fabric approved for application area 4 must be installed beneath the fill.

If the trench cannot be kept dry during over-excavation and replacement, crushed aggregate or fine chippings must be used as the replacement fill material. The riprap bed surface must be filled over with smaller grade rock or coarse aggregate.

If the pipes are to be laid in an embankment, the fill beneath them must be compacted to the same density as the surrounding embankment material. Riprap embankments must be filled over with smaller grade rock and crushed aggregate or gravel.

In the case of natural aggregates used for plastic pipe bedding, the maximum allowable grain size is 10% of the nominal diameter of the pipe. However, the maximum grain size for DN < 200 pipes and DN > 600 pipes is 20 mm and 60 mm respectively. Use of crushed aggregate is permitted for bedding DN > 100 plastic pipes. The maximum grain size for this purpose is 16 mm. A bedding layer at least 150 mm in depth, as measured from the pipe wall, must be laid on the trench bottom or over the over-excavation fill, embankment fill or foundation.

The bedding compaction must meet the following density requirements:

- density level (improved Proctor) ≥ 90% or
- density ratio (portable falling weight deflectometer) ≤ 2.8

The bedding materials' fitness for purpose is verified by grain size distribution testing, with one sample tested from each 50 m^3 or part thereof. Bedding density is determined through measurements taken at 50m intervals, with at least one measurement taken per job site. The density ratio of the bedding is determined through measurements taken every 10 m. If more measurements than required are made, the measurement average must meet the density requirement. The minimum allowable individual measurement result is 88% (Proctor) for density level measurements, and 3.0 for density ratio measurements (portable falling weight deflectometer). In off-street areas, the bedding may be omitted in accordance with the drawings or by separate agreement. In such a case, the trench is excavated to the level of the pipe's placement. This is done carefully, avoiding over-excavation, to ensure a level trench bottom. Depressions are made in the bottom to accommodate the pipe sockets.

If more than one pipe is to be installed on the bed, the bedding material must meet the requirements specified for all pipes. If the trench subsoil is suitable as bedding material, it can be used for the bedding layer.

Initial backfill

Material requirements

The materials used for the initial backfill must be appropriate for all pipes installed in the trench (Figure 6.1.2). Backfill material must not be of a type likely to damage pipe coatings and must not contain substances that might damage the pipes or pipe joints. In trenches housing metal pipes, power plant ash or slag, or other materials damaging to pipes, must not be used. Use of frozen material is also forbidden.

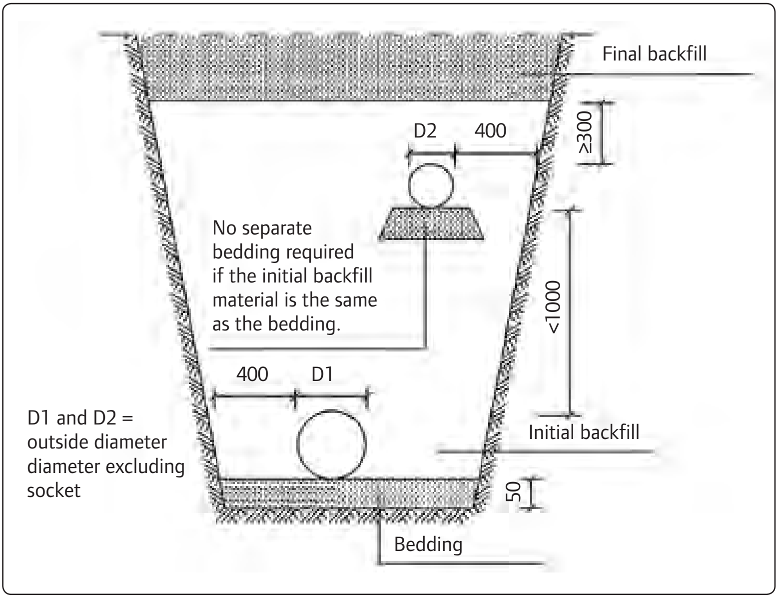


Figure 6.1.2. Pipe trench bedding and initial backfill, with a vertical free distance of < 1,000 mm between pipes.

The initial backfill primarily consists of sand, gravel or crushed aggregate that meets the same requirements set for the pipe bedding material, compacted to the required density.

In non-trafficable areas, sand, gravel, crushed aggregate, clay, silt or moraine materials, with a grain size not exceeding the maximum values specified for the bedding, are suitable as initial backfill.

Initial backfill compaction must meet the following density requirements:

- density level (Proctor) ≥ 95 % or
- density ratio (portable falling weight deflectometer) ≤ 2.5

The initial backfill on each side of the plastic pipe (i.e. haunching) must be laid and compacted in uniform layers that are also homogenous in the longitudinal pipe direction. Mechanical compaction above the pipe may be carried out only at a backfill depth of at least 0.3 m above the pipe crown.

The fitness for purpose of the initial backfill materials is verified by grain size distribution testing, with one sample tested from each 200 m^3 or part thereof.

The initial backfill density is determined by measurements taken at 50m intervals, with at least one measurement per job site. The density ratio of the initial backfill is determined by measurements taken every 20 m. Density is measured at pipe crown height on one side of the pipe. If more measurements than required are made, the measurement average must meet the density requirement. The minimum allowable individual measurement result is 93 % (Proctor) for density level measurements and 2.75 for density ratio measurements (portable falling weight deflectometer).

In non-trafficable areas, the initial backfill for pressure class PN ≥ 10 plastic pipes can be carried out without compaction, if so specified in the drawings.

Where the free vertical distance between pipes is at least 1,000 mm, different initial backfill materials can be used at each pipe level according to the pipe type. In such a case, the initial backfill of the lower pipe must extend 300 mm above the pipe crown (Figure 6.1.3).

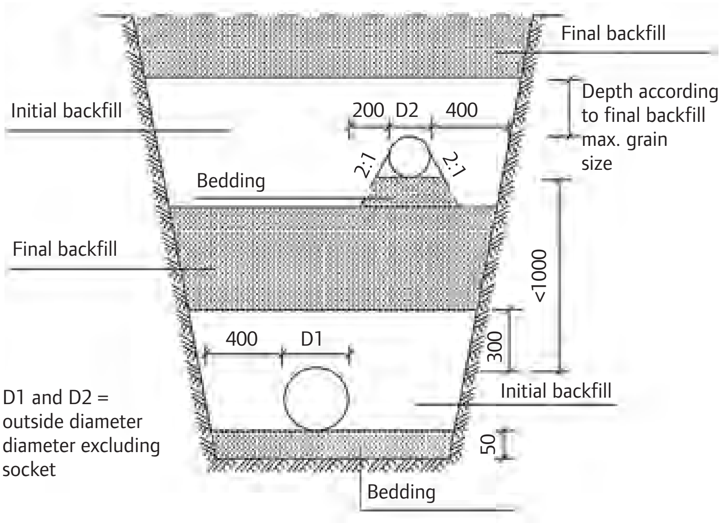


Figure 6.1.3. Pipe trench bedding and initial backfill, with a vertical free distance of ≥ 1,000 mm between pipes.

During all backfilling stages, the backfill thickness must be about equal on both sides of the pipe. The minimum initial backfill depth above the crown of the uppermost pipe must be equal to the maximum stone size of the final backfill material, however at least 300 mm.

Trench dams

If the trench is in low-permeability soil, water flow through the trench bedding and backfill must be prevented. In such cases, approx. 1 m long dams of a material, equivalent to the surrounding soil in terms of water permeability, must be built in the trench as shown in Figure 6.1.4.

The water-retentive dam can be built out of clay or fine silt moraine. To meet the density requirements of the initial backfill, the dam section must be compacted as thoroughly as possible.

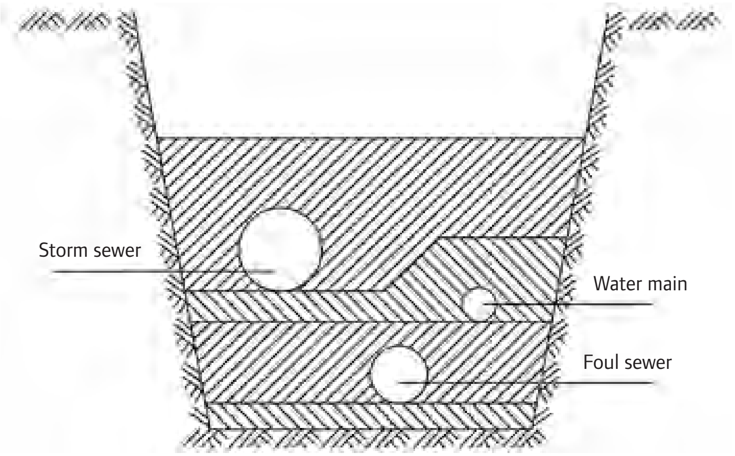


Figure 6.1.4. Water-retentive trench dam construction using as-dug material.

Alternatively, the water-retentive dam can be built by installing a 6 mm thick bentonite mat, while using bentonite powder or sand for sealing around the pipes and trench borders, as shown in Figure 6.1.5. The water permeability of the bentonite mat must be equivalent to at least that of a 1-metre thick dam made of the ambient soil.

The positions of the water-retentive dams must be shown in the drawings.

In rock trenches, the need for trench dams must be considered case-specifically.

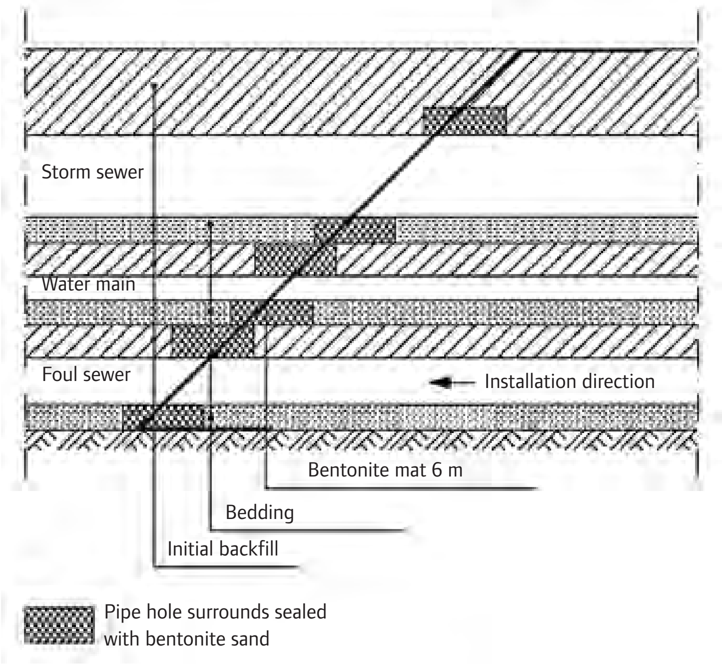


Figure 6.1.5. Water-retentive trench dam construction using a bentonite mat.

Before backfilling, the pipes must be checked to ensure that they are undamaged, in the correct positions and correctly installed. Trench structures must be checked to ensure that they have sufficient strength for backfilling. Any ice or snow must be removed from the trench. The trench bottom must not be frozen or exposed to freezing. The initial backfill material must be carefully placed into the trench, evenly on both sides of the pipes.

To ensure that the pipes are not dislodged or damaged, the first backfilling stage (haunching) must be carried out as spade work or using an equivalent method. The initial backfill must be carefully tamped beneath and along the sides of the pipes, so that the pipe height is not changed.

The initial backfill must be laid and compacted in layers. Each compaction layer's depth depends on the size of the installed pipe, on the pipe material and on the type of compactor used.

Thermal insulation

Thermal insulation is carried out in accordance with the drawings, using either factory pre-insulated pipes or on site using insulating boards or other insulating materials.

Unless otherwise specified in the drawings, extruded plastic insulation board of at least 35 kg/m^3 bulk density must be used. Lightweight aggregate insulation must have a 8–20 mm grain size.

Final backfill

Backfill must not contain substances that are damaging to pipes or pipe joints.

Final backfill in trafficable areas

The final backfill material must consist of a compactable mineral soil. If the native as-dug soil is compactable and freezable, it may be used for the top backfill. With respect to freezing properties, imported backfill must correspond to the as-dug material. The maximum stone size is 2/3 of the depth of each compacted layer, and no more than 400 mm. If the final backfill depth is too shallow for riprap to be used, road sub-base material is used for the final backfill.

In most cases, as-dug material is used for final backfill. The maximum grain size of final backfill material is the same as for trafficable areas.

Recycled materials such as ash and slag can be used for backfill in accordance with the plan specifications. The materials used must not damage equipment or structures in or near the trench.

If reinforcing recycled materials are used, the chosen material strength must enable subsequent re-excavation of the trench.

Final backfill in trafficable areas

The compaction of final backfill, carried out using mineral soil in trafficable areas, must meet the following density requirements:

- density level (Proctor) ≥ 90 % or
- density ratio (portable falling weight deflectometer) ≤ 2.8

In trafficable areas, the final backfill layer extends to the road's bottom structural layer.

The surface of riprap final backfill must be filled and compacted to the same specifications as a riprap embankment surface. If the traffic area has a riprap pavement structure, the final backfill and surface layer are carried out to the same specifications as a riprap embankment.

Final backfill in non-trafficable areas

In non-trafficable areas, final backfilling can be carried out without compaction, if so specified in the drawings. The trench must be filled to the height required to ensure that the backfill material will settle, upon subsequent compaction, at the height specified in the drawings or, if no such height is specified, to the height of the surrounding soil.

The fitness for purpose of the final backfill materials used is verified by grain size distribution testing, using the specified sampling frequency, or by visually monitoring the number of compactions and layer depths.

The final backfill density is determined by measurements taken at intervals of 50 m, with at least one measurement per job site.

The density ratio of the final backfill is determined by measurements taken every 20 m.

If more measurements than required are made, the measurement average must meet the density requirement. The minimum allowable individual measurement result may be 88% (Proctor) for density level measurements, and 3.0 for density ratio measurements (portable falling weight deflectometer).

Chamber embedment

Final backfilling at the sides of chambers, fire hydrants and check valves is performed at least 0.4 m from their outer surface, using frost-resistant material. Filling around soakaways is done using a highly water-permeable material (e.g. 8–32 mm chipping). If necessary, a nonwoven fabric (operating class 2) must be installed against the trench walls.

In the case of supported trenches, the trench shoring must be removed as the final backfill proceeds, taking care to prevent wall collapse, the loosening of compacted backfill and the displacement of the bedding or pipes.

Uponor Pressure Systems – Hydraulic Design

This section describes the general rules for the hydraulic design of pressure pipes. Hydraulic design is intended to achieve the most economic pipe installation possible, in terms of construction and operating costs.

In hydraulic design, a head loss (or pressure drop) chart is used for pipe sizing, according to different operating conditions. Use of a head loss chart requires that the design flow rate is known. A line is traced from the selected pipe size to the design flow rate value line, from which point the pressure drop (head loss) value, given in Pascal per metre, can be read off. For technical reasons, the recommended flow velocity for pressure sewers is 0.5–1.7 m/s. No recommended flow velocity is specified for water pipes.

Sample head loss calculation

The design water flow rate is: 12 l/s
The inside diameter of the chosen 160 X 9.5 mm PN 10 ProFuse pressure pipe is 150 mm. From the head loss chart, we can therefore determine that
the flow velocity will be 0.70 m/s
the head loss will be 3 ‰ (3 mWc/km)

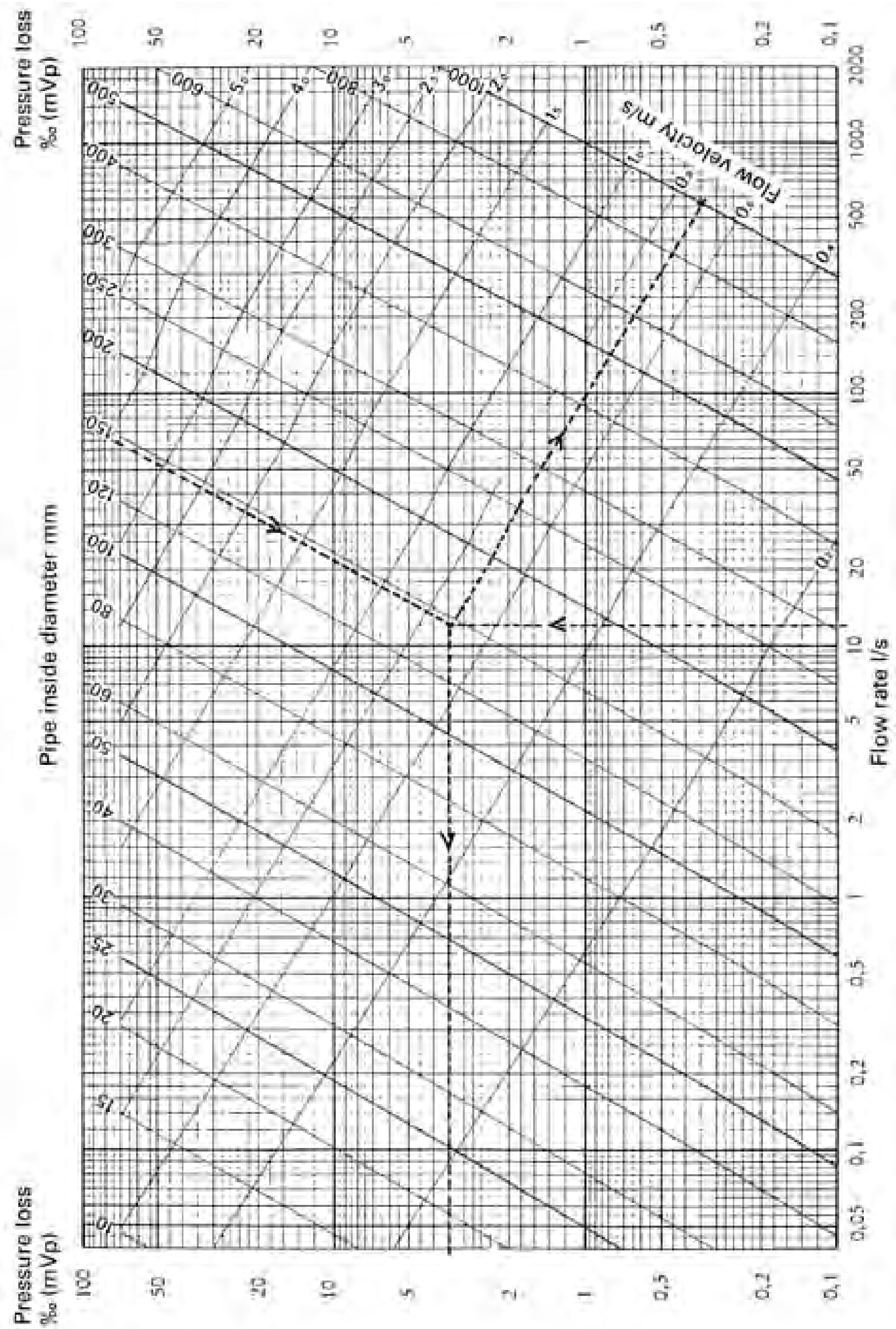


Figure 6.1.6. Head loss chart for +10 0C water, based on the Prandtl-Colebrook formula. Roughness coefficient values: k = 0.01 for $d_i \leq 200$ pipes and k = 0.05 for $d_i > 200$ mm pipes.

Pressure class selection

The choice of pipe pressure class depends on the operating pressure of the fluid flow in the pipe. Possible negative pressure must also be taken into account in the choice of pressure sewer. The recommended wall thickness for polythene pressure sewers is SDR 17, corresponding to a pressure class of PN 10 for PE 100.

Unit conversion table

	Pa	**bar**	**mWc**
1 Pa	1	10^{-5}	$1{,}02 \cdot 10^{-4}$
1 bar	10^{5}	1	10,2
1 mWc	$0{,}981 \cdot 10^{4}$	0,0981	1

Pa = Pascal

mWc = water column metres

Table 6.1.7

Uponor Gas System Design

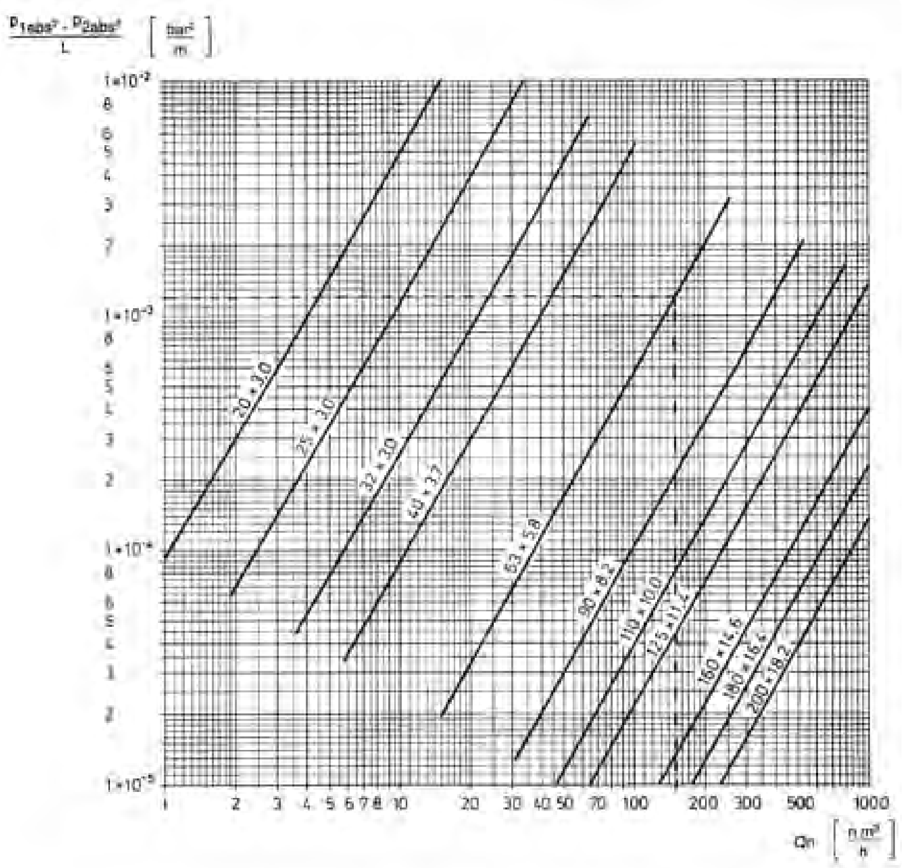


Figure 6.1.8. Head loss chart for gas pipes

Example gas system design calculation

Gas flow rate Qn	= 150 nm^3/h
Pipeline length	= 5,000 m
Inlet pressure (overpressure)	= 4 bar
Pipe size	= 63 mm

Drawing a line up from 150 nm3/h to the pipe in question on the head loss chart gives a value on the vertical '$p1_{abs}2 - p2_{abs}2$ per unit' scale of 1.2×10^{-3}

This value is then multiplied by the pipeline length:

$$p1_{abs}2 - p2_{abs}2 = 5{,}000 \times 1.2 \times 10^{-3} = 6.0\ bar^2$$

The outlet pressure is calculated using the following formula:

$p2_{abs} = \surd\ p1_{abs}{}^{2} -$ calculated value

where $p1_{abs}$ = overpressure + atmospheric pressure

$p1_{abs}$ = 4 bar + 0.981 bar = 4.981 bar

$p2_{abs} = \surd\ 4.981^2 - 6.0$

= 4.34 bar

The head loss for 63 mm PEH gas pipe is calculated using the formula

$p = p2_{abs} - p1_{abs}$

= 4.981 bar – 4.34 bar

= 0.64 bar

Uponor Pressure Pipe System Installation – General Instructions and Supervision

Pressure pipe installation follows largely the same installation principles as for gravity systems, for example with respect to trench construction and backfilling, as described in Chapter 5.1. However, there are a number of instructions specific to pressure pipes; these are presented in this chapter. Installation must always be carried out according to the drawings. The designer must be informed of any changes in the assumed conditions that might affect installation in accordance with the drawings.

Longitudinal expansion

Account must be taken of longitudinal expansion and contraction, when handling and installing PE pipes. PE pipes have a relatively high heat expansion coefficient. For this reason, a pipe laid on a hot day can shorten by several centimetres by the following morning.

Longitudinal expansion formula:

$$\Delta L = \Delta t \cdot L \cdot \alpha$$

where

ΔL = Longitudinal expansion or contraction [m]

Δt = T2 - T1

T1 = Temperature upon installation

T2 = Temperature after installation

L = Pipe length [m]

α = Thermal expansion coefficient; cf. System and Material Specifications Table 2.2

Pipe and joint reinforcement

Pressure pipe socket joints, segment-welded fittings, and pressure lines of over 225 mm in diameter, must be effectively reinforced or restrained, to eliminate the risk of pullout due to thermal expansion and contraction. Injection moulded fittings and max. 225 mm pipes do not require reinforcement.

PE pipe systems and fittings are reinforced by concrete encasement. PVC systems and fittings are strengthened with mechanical socket locks. Reinforcement is carried out before pressure testing the system.

Concrete reinforcement

Concrete reinforcement specifications are determined according to the pipeline pressure and surge pressure, and the maximum bearing capacity of the soil. Concrete reinforcements must be built and steel reinforced in accordance with the plan specifications, and cast so that no additional load is exerted on the pipe system. As necessary, the reinforcement foundations must be thoroughly compacted. Figures 6.1.9 and 6.1.10 illustrate some of the most commonly used concrete reinforcements.

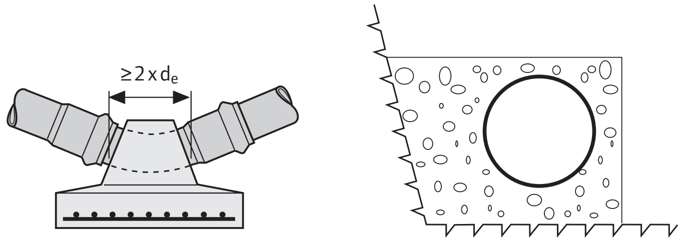


Figure 6.1.9

Segment-welded fittings for pressure systems must always be encased in concrete. The size of the concrete reinforcement is determined by the welded joints, so that the distance between the outermost joint weld and the edge of the reinforcement is as follows:

- at bends Be = min. 150 mm
- at junctions Be_1 and Be_2 = min. 200 mm

The reinforcement thickness from the pipe surface is min. 150 mm.

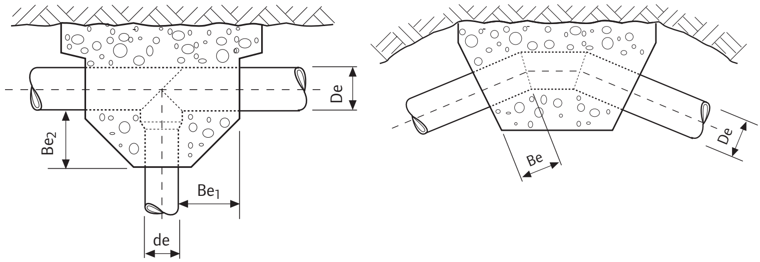


Figure 06.01.10

Socket lock reinforcement

Socket locks are used with PVC pipes and fittings. The operating principle of socket locks is based on transferring thrust forces past the joint, so that the forces are resisted by the friction between the pipe and soil.

PVC fittings must always be locked to prevent pullout. Bend fittings are locked at both ends. The number of PVC pipe socket locks depends on the installation depth and pipe diameter. The required number of socket locks is shown in the following table.

Depth of cover	**Pipe diameter**					
	110	160	225	280	315	400
< 2 m	-	1	1	2	2	3
2 – 3 m	-	-	1	1	1	2
3 – 4 m	-	-	-	-	1	1
> 4 m	-	-	-	-	-	-

Table 6.1.11. Number of socket locks required per fitting joint (pipe length 6 m)

Pipe bending

Direction changes in PVC pressure pipes are normally carried out using bend fittings. Although small directional changes can be made by bending the pipe, it is important to remember that any resulting kinks in the line can cause increased angular deflection.

The internal pressure of the pipe also increases the risk of angular deflection at bends. The maximum allowable angular deflection at socket joints is ≤ 2°.

In PE pipes, gradual directional changes can easily be achieved by bending. No concrete reinforcement of the bend is required.

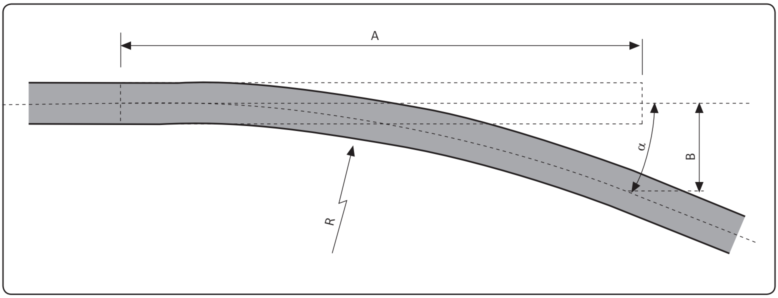


Figure 6.1.12. Pipe bending

		α = 15°		α = 30°		α = 45°		α = 60°	
d_e	R (m)	A (m)	B (m)	A (m)	B (m)	A (m)	B (m)	A (m)	B (m)
90	4.50	1.18	0.15	2.36	0.60	3.53	1.32	4.71	2.25
110	5.50	1.44	0.19	2.88	0.74	4.32	1.61	5.76	2.75
125	6.25	1.64	0.21	3.27	0.84	4.91	1.83	6.54	3.13
140	7.00	1.83	0.24	3.66	0.94	5.50	2.05	7.33	3.50
160	8.00	2.09	0.27	4.19	1.07	6.28	2.34	8.37	4.00
180	9.00	2.36	0.31	4.71	1.21	7.07	2.64	9.24	4.40
200	10.00	2.62	0.34	5.23	1.43	7.85	2.93	10.47	5.00
225	11.25	2.94	0.38	5.89	1.51	8.83	3.30	11.78	5.63
250	12.50	3.27	0.43	6.54	1.68	9.81	3.66	13.08	6.25
280	14.00	3.66	0.48	7.33	1.88	10.99	4.10	14.65	7.00
315	15.75	4.12	0.54	8.24	2.11	12.36	4.61	16.49	7.88
355	17.75	4.65	0.61	9.29	2.38	13.93	5.20	18.58	8.88
400	20.00	5.23	0.68	10.47	2.68	15.70	5.86	20.93	10.00
450	22.50	5.89	0.77	11.77	3.01	17.66	6.59	23.55	11.25
500	25.00	6.54	0.85	13.08	3.35	19.63	7.32	26.17	12.50
560	28.00	7.33	0.95	14.65	3.75	21.98	8.20	29.31	14.00
630	31.50	8.24	1.07	16.48	4.22	24.73	9.23	32.97	15.75
710	35.50	9.29	1.21	18.58	4.76	27.87	10.40	37.16	17.75
800	40.00	10.47	1.36	20.93	5.36	31.40	11.72	41.87	20.00

Table 6.1.13. Bending values for Upoten PEH pipe. Bending radius $R = 50 \times d_e$. *Bending values are universal for all pressure classes.*

Subsurface road and rail crossings

Pipeline installation under public roads and railways must be performed in compliance with the guidelines and regulations of the relevant road and rail authorities. A detailed plan for the subsurface crossing must also be drawn up and approved by the authorities concerned.

Subsurface crossings are normally positioned perpendicular to a road or railway. At subsurface rail crossings, the distance between the pipe crown and the railtrack must be at least 1 metre.

Pipe system design must take account of the structure, durability and deflection of the pipeline in demanding conditions. In the case of installations carried out by pipe jacking, steel or concrete pipe is normally used. In open trench installations, SN 8 class plastic pipe can be used as a casing pipe. Pressure pipes must always be installed in a casing pipe. At subsurface rail crossings, the casing pipe must extend at least three metres from the embankment.

The casing pipe must be designed so as to facilitate pipe maintenance. At subsurface road and rail crossings, an inspection chamber must be installed on one side of the crossing. At subsurface crossings for pressure pipes, one end of the casing pipe is plugged and a chamber is installed at the other end as a safeguard. This ensures that, in the event of a leak, any leakage water discharges via the chamber into the ground, away from the road or rail structure.

In addition, the pressure pipeline must be equipped with a check valve on both sides of the road/railway, as a safeguard in the event of a pressure build-up at both ends of the crossing.

Pipe support spacing

When supporting PE pipes, the distance between brackets must not be too great, as this might cause the pipe to bend. The following tables give the bracket spacing for Uponor’s systems.

Pipe support design must take different load factors, such as water pressure testing and pressure surges, into account.

Only use brackets specially designed for use with plastic pipes. Loose brackets allow axial thermal movement of the pipe. Fixed brackets lock the pipe firmly into place. Use fixed brackets on sockets and branch sections. Fastenings and brackets beneath load-bearing base floors must be made of acid-proof steel.

Outdoor pipes

	Maximum bracket interval (guideline)	
Pipe type	**Horizontal sewer**	**Vertical sewer**
Uponor Sewer System PVC	10 x de (max. 3.0 m)	30 x de (max. 3.0 m)
Ultra Rib 2	10 x de (max. 2.0 m)	30 x de (max. 3.0 m)
Dupplex	10 x de (max. 2.0 m)	30 x de (max. 3.0 m)
Uponor Stormwater System DW	10 x de (max. 2.0 m)	30 x de (max. 3.0 m)
Uponor Pre-Insulated Sewer System	10 x de (max. 2.0 m)	30 x de (max. 3.0m)
Uponor Pressure System PVC	12 x de (max. 3.0 m)	30 x de (max. 3.0 m)
Uponor Pressure System PE	10 x de (max. 1.6 m)	30 x de (max. 3.0 m)
Uponor Pressure System ProFuse	10 x de (max. 1.6 m)	25 x de (max. 2.6 m)

Table 06.01.14

When hanging socket pipes, a fixed bracket must be installed at the base of each socket. To allow thermal movement, loose brackets must be used between socket joints. When supporting pressure pipe systems, account should also be taken of the need for support due to pressure loading.

Protection against hydrostatic uplift

The installation conditions, such as bottom conditions, water currents and water level variations, must be determined prior to commencing installation.

Buoyancy of empty pipe (kg/m)

de	PN 10 / SDR 17	PN 16 / SDR 11
90	4,94	4,27
110	7,39	6,40
125	9,60	8,30
140	12,0	10,4
160	15,7	13,6
180	19,8	17,2
200	24,5	21,1
225	31,1	26,7
250	38,4	33,2
280	48,3	41,6
315	61,0	52,7
355	77,3	66,9
400	98,4	85,0

N.B.! The pipe material also has buoyancy. This must be accounted for by adding 5% to the above values.

Table 6.1.15

Pipe weighting

Weighting is performed according to the designer's specifications. The minimum weighting for water pipes is 20% of the buoyancy of the empty pipe (see table above). Due to the increased buoyancy caused by gas formation in the pipe, the required weighting for wastewater pipes is greater, at 100–120% of empty pipe buoyancy.

Concrete ballast weights are generally used for weighting. To prevent the concrete weights from damaging the pipe, a flexible, durable material, such as foamed plastic, should be installed between the weights and the pipe. However, to ensure that the weights are not displaced, the material must not compress under water pressure. The weights must be securely fastened to each other, for example with durable plastic cord or steel cable. The weight spacing is ≤ 15 x de, or max. 4 m.

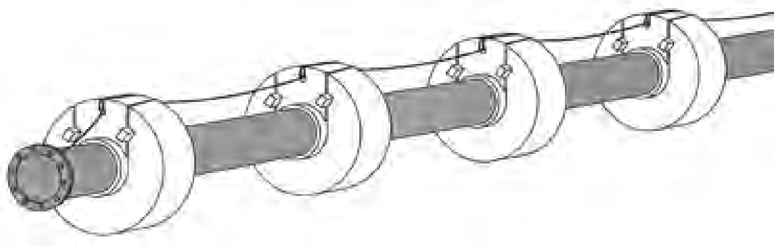


Figure 6.1.16

Example of pipe weighting using concrete ballast weights

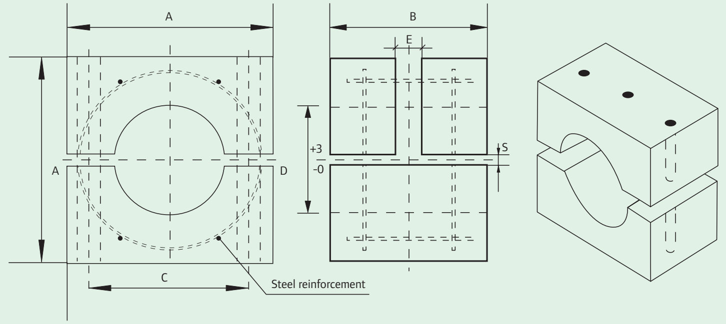


Figure 06.01.17

UPONOR INFRASTRUCTURE

UPONOR PRESSURE
SYSTEM PROFUSE
– FOR POTABLE AND
WASTEWATER APPLICATIONS

Pressure System for potable water supply, pressure sewerage and gas distribution

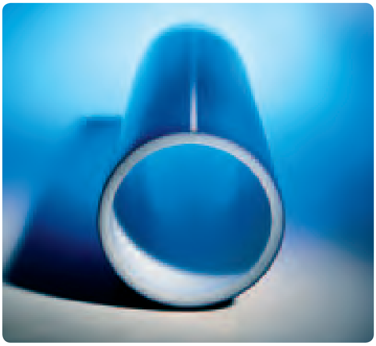
6.2 ProFuse Pressure System – Characteristics

The ProFuse pressure pipe system is used for the distribution of potable water, wastewater, gas and process materials.

The ProFuse pressure system was originally developed for British Gas. The company was seeking a pipe system with better and safer weld characteristics. Uponor produced a unique new pressure pipe with superior welding performance and a peelable protective skin. The new ProFuse pipe was unveiled for British Gas and the UK market in 1998, and subsequently launched on the Nordic and German markets.

ProFuse is made from black PE100 polyethylene and coated with a protective polypropylene skin. This skin is colour-coated according to the pipe application.

Blue ProFuse pipes are intended for potable water, terra cotta coloured pipes for wastewater, and yellow pipes for gas. All of these pipes are grey-striped, which indicates that they have a protective skin.



The PP skin provides several key benefits:
- Protects the PE100 core pipe from scratching, gouging and other damage during transport, handling and installation. This significantly reduces surface notching of the pipe wall, ensuring better long-term protection against pipe fracture.
- The pipe is a superior performer in no-dig installations, such as horizontal directional drilling and pipe bursting.
- The PP skin is removable for electrofusion welding. It is then ready for immediate welding, with no scraping required, as the skin prevents the polyethylene core pipe from oxidising. The pipe must be welded as soon as possible after peeling off the PP skin.
- The pipe can be butt welded without removing the skin.
- The pipe system is highly resistant to mechanical stress.

ProFuse pipes can be jointed through electrofusion and butt fusion. The pipes can also be coupled using mechanical fittings, which requires the removal of the protective skin from beneath the fitting. Weld-jointed ProFuse pipes form a robust, pull-out resistant pipe system. Because gradual direction changes can be easily achieved by bending the pipe, ProFuse pipe systems require minimal bend fittings.

If the pipe's operating temperature is above 20 °C, the operating pressure must be lowered by approx. 15 % per 10 °C rise, to maintain the desired system service life. ProFuse fittings are also highly resistant to corrosion and most solvents, acids, alkalis and oils. For details of the system's chemical resistance, see Table 2.2 of the Materials and Service Life chapter.

Size table

Size	SDR 17	SDR 11
mm	**PN 10**	**PN 16**
63	x	-
75	x	-
90	x	x
110	x	x
125	x	x
140	x	x
160	x	x
180	x	x
200	x	x
225	x	x
250	x	x
280	x	x
315	x	x
355	x	x
400	x	x

Table 6.2.1

The ProFuse pipe is also extremely resistant to wear and to internal abrasion from solids within the pipe flow. Use of the head loss chart presented in this section is recommended for hydraulic design calculations.

Uponor ProFuse pipes are available in the size range 63-400 mm and with pressure grades PN 10 and PN 16.

Temperature

ProFuse has the same temperature resistance as polythene pipe. See the Materials and Service Life chapter for details.

In non-pressure sewer applications, the ProFuse pipe can withstand continuous operating temperatures of up to 80 °C and momentary temperatures of up to 90 °C.

Bending radius of ProFuse pipe

Temperature range	Bending radius (minimum)
-20...-6 °C	28 x Du
-5...+10 °C	25 x Du
11...35 °C	22 x Du

Du = pipe outside diameter

System and material specifications

Properties	PE100	Unit	Standard/test method
Density	950	kg/m^3	ISO 1183
Melt mass-flow rate (MFR)	0,3	g/10 min.	ISO 1133, method 18
Long-term elastic modulus E_{50}	275	MPa	ISO 6259
Short-term elastic modulus E_0	1100	MPa	ISO 6259
Thermal expansion factor	0,17	mm/m · °C	
Thermal conductivity	0,4	W/m · °C	DIN 52 612 (20 °C)
Specific heat	1,9	J/g · °C	
Yield stress	23	MPa	
Maximum tensile stress, short-term	22	MPa	
MRS value	10	MPa	ISO/DIS 4427 / CEN/TC 155 SS20
Safety factor (water pipe and pressure sewer)	1,25		EN ISO 12201 / EN ISO 13243
Safety factor (gas pipe)	Min. 2		EN 1555

Table 6.2.2

Approvals

All Uponor ProFuse pipes are quality certified with the Nordic Poly Mark and manufactured in accordance with application-specific standards. Blue ProFuse water pipes are manufactured in accordance with the EN 12201 standard and Uponor factory standard 800-1.

Terra cotta coloured ProFuse wastewater pipes are manufactured in accordance with the EN 13244 standard and Uponor factory standard 800-2.

Yellow ProFuse gas pipes are manufactured in accordance with the EN 1555 standard and Uponor factory standard 731.

The latest product approvals can be downloaded and viewed online at www.uponor.fi.

Markings

The markings for Uponor potable water, wastewater and gas systems are presented and explained below.

Markings for the Uponor ProFuse Pressure System for wastewater

uponor	PRESSURE	ProFuse	PE100	160 x 14.6	PN 16	SDR 11
Manufacturer	Application	Product	Material: polyethylene	Diameter and min. wall thickness	Pressure grade	Standard Dimensional Ratio

	EN 12201	DS FI	④	14 03 2007 13	1,234 m	...COATED PIPE...
Nordic Poly Mark	Product standard	Potable water approval	Production unit ④ = Forssa, Finland	Production date: day/month/year/hour	Meterage	Indicates that pipe has protective coat/skin

Table 6.2.3

Markings for the Uponor ProFuse Pressure System for wastewater

uponor	PRESSURE	ProFuse	PE100	160 x 14.6	PN 16	SDR 11
Manufacturer	Application pressure sewer	Product	Material: polyethylene	Diameter and min. wall thickness	Pressure grade	Standard Dimensional Ratio

	EN 12201	DS FI	④	14 03 2007 13	1,234 m	...COATED PIPE...
Nordic Poly Mark	Product standard	Potable water approval	Production unit ④ = Forssa, Finland	Production date: day/month/year/hour	Meterage	Indicates that pipe has protective coat/skin

Table 6.2.4

Markings for the Uponor ProFuse Pressure System for gas

uponor	**GAS**	**ProFuse**	**PE100**	**90 x 5.4**	**PN 8**	**SDR 17**	**UPONORM 731**	
Manufacturer	Application	Product	Material: polyethylene	Diameter and min. wall thickness	Pressure grade	Standard Dimensional Ratio	Factory standard	Nordic Poly Mark

EN 1555	**PE/a**	④	**13 2007**	**1,234 m**	**...COATED PIPE...**	**NATURGAS**
Product standard	Material: polyethylene/code	Production unit ④ = Forssa, Finland	Production date: month/year	Meterage	Indicates that pipe has protective coat/skin	Application

Table 6.2.5

ProFuse-Pressure Pipeline Design

Structural design

The Structural design section of the Pressure Systems introduction specifies a number of design criteria based on data derived from experience.

Hydraulic design

When determining the pipe system's dimensions, it is important to ensure that the system has a sufficient pressure rating and flow rate.

The design principles are presented in the above Hydraulic Design section for pressure systems.

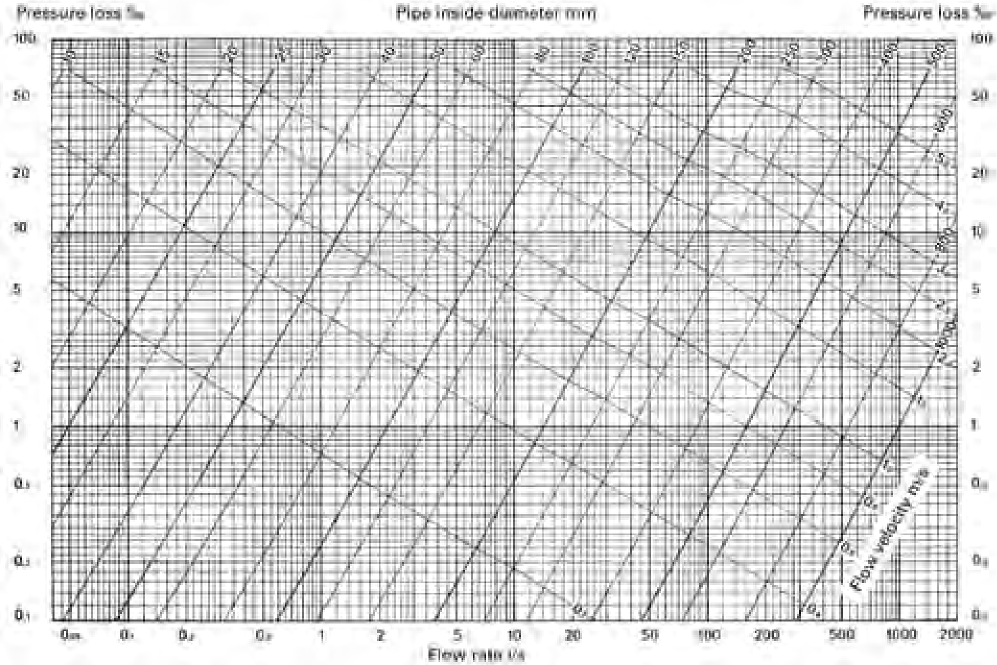


Table 6.2.6. Head loss chart for PVC and PE pressure pipes

The head loss chart is drawn up for +10 0C water, using the Prandtl-Colebrook formula.

Roughness coefficient values: k = 0.01 for $d_i \leq 200$ mm pipes and k = 0.05 for $d_i > 200$ mm pipes.

ProFuse Pressure Pipe Installation

ProFuse pipes are compatible with all standard jointing methods.

Uponor ProFuse pipes do not require scraping prior to electrofusion. Welding quality is improved by the fact that the pipe surface is 100 % oxidised immediately after peeling.

The pipe can be butt welded as normal without peeling.

ProFuse pipes can also be coupled mechanically, which requires the removal of the pipe skin from the area beneath the coupling. ProFuse pipes are compatible with all PE pipe installation, extension and maintenance technologies and methods.

Electrofusion installation of a drilling saddle

1. Mark off the area to be peeled for the drilling saddle.

2. Score over the marked lines with a ProFuse peeler. If using a drilling saddle with a lower section, peel accordingly all the way around the pipe.

3. Peel the PP skin off the marked area immediately before welding. Check that the black pipe surface is clean. Use an approved cleaning fluid if necessary.

4. Bolt the fitting tightly into place on the ProFuse pipe.

5. You can use the drill wrench to fasten the screws.

6. Carry out the electrofusion.

7. After welding and the specified cooling period, drill the branch hole using the drill wrench. Turn the drill wrench back to the stop.

8. Screw the cap tightly into place.

Electrofusion socket welding

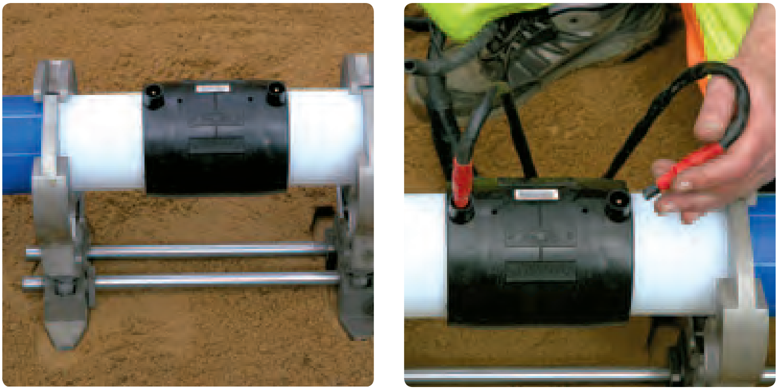
1. Mark off the area to be peeled.

2. Score over the marked lines with a ProFuse peeler.

3. Peel the PP skin off the marked area immediately before welding. If it is soiled, clean the surface to be welded.

4. Measure the required insertion depth from the pipe end. Add 5 mm to this measurement and mark it on the pipe. Push the socket onto the pipe all the way to the stop. Check the insertion mark to ensure that the socket is properly inserted.

5. Fit the jointing clamp into place. Repeat steps 1–5 on the other pipe.



6. Set up the welding cables. The socket is now ready for welding.

7. Enter the welding data using the barcode system.

8. Carry out the electrofusion.

N.B.! During welding, any additional instructions issued by the electrofusion fitting supplier must be followed.

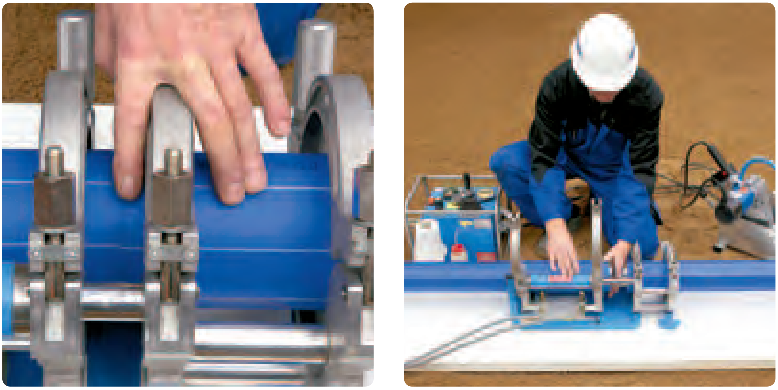
Butt fusion jointing – step-by-step guide

A ProFuse pipe can be joined with any other ProFuse pipe or a PE 100 or PE 80 pipe through butt welding, provided they have the same outer diameter and wall thickness.

The welding machine's operating instructions must always be followed when welding. This is because pressure values given in welding data tables are machine specific, being dependent on the cross-sectional area of the machine's hydraulic cylinders.

In order to achieve a sound weld, the pipe ends and the equipment used must be clean. Clean with a lint-free cloth and an appropriate cleaner for welding work, such as trichloroethylene.

Welding in temperatures below –20°C is not recommended. When welding in wet or windy conditions, a tent or shelter must be used to protect the welding area. Open pipe ends must be plugged to prevent through-draughts from cooling the welding area.



1. Place the welding machine firmly in its working position. Connect the necessary hoses, cables and clamps according to the machine's operating instructions. Check that the pipe ends are clean. Fasten the pipes/fittings, to be welded, firmly to the machine, to ensure they cannot move during welding. When welding long pipes, use pipe supports as necessary to keep the pipe straight.

2. Install the milling cutter on the machine. Mill the ends square and level with each other.

3. Open the welding machine and remove the cutter. Remove all millings from the pipe ends and from beneath, without touching the welding surfaces.

4. Close the welding machine on the pipe and check that the pipe ends fit together. The maximum misalignment or thickness difference between the ends must not exceed 10% of the pipe wall thickness.

5. Wipe the pipe ends clean using an approved cleaning fluid. Wiping also removes static. Make sure the surfaces to be welded are totally free of grease, oil, water, dirt and debris.

6. Check the welding temperature of the heating plate. The temperature must be 220 °C.

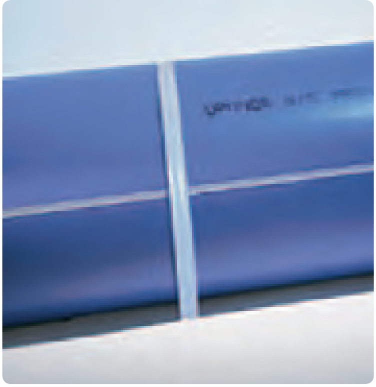
7. Make sure the heating plate is clean by wiping it over with a lint-free paper cloth. Check that the heating plate coating is intact.

8. Mount the heating plate in position between the pipes. Press the ends to be welded against the plate, at the pressure specified in the machine operating instructions, until a visible bead forms at both pipe ends.

9. When the required bead width (depends on the wall thickness) is attained, lower the pressure almost to zero. The pipe ends must remain against the heating plate for post-heating. The post-heating time depends on the material and pipe size.

10. When the post-heating time is complete, open the machine and remove the heating plate. Immediately press the ends together without touching the molten surfaces. Bring the welding pressure back up to full (check the pressure and welding time from the welding machine operating instructions).

11. Keep the joint at the welding pressure, without moving it until the joint has cooled to approx. 40 C. The bead colour changes as it cools.



12. Once the cooling period has elapsed and the joint has cooled, drop the pressure and open the clamps. You can now lift the pipe off the welding machine. Inspect the weld bead for correct formation. Use the table given in the "Visual assessment of welded PE pipe" section below as a guideline for visual inspection of the bead.

Butt-welded PE pipe visual assessment principles

Bead width assessment criteria – pipe-to-pipe

Wall thickness (mm)	Bead width, B (mm)
2	3 - 5
3	4 - 6
4	4 - 7
5	5 - 8
6	6 - 9
8	7 - 10
9	8 - 11
11	9 - 12
13	10 - 14
16	11 - 15
18	12 - 16
19	12 - 18
22	13 - 18
24	14 - 19
27	15 - 20
30	16 - 21
34	17 - 22
40	18 - 23
45	20 - 25
50	22 - 27
55	24 - 30
60	26 - 32
65	28 - 36

Table 6.2.7

A successful joint showing a visible, high bead.

Inspecting the weld

The bead width (B, including pipe skin) must be in accordance with the bead width assessment table for pipe-to-pipe welding. For pipe-to-fitting and fitting-to-fitting welding, the tolerance must be increased by +/- 1 mm.

Example:

Use Table 6.2.7 to determine the required bead width. The nominal wall thickness is 8.2 mm.
Follow the arrow to the nearest whole number (8 mm) and read off the required bead width: in this case 7–10 mm.

Welding temperature

The temperature must be 220 °C ± 10 °.

Welding pressure

Min. 0.2 – Max. 0.15 N/mm^2

The average wall thickness and average diameter are calculated as follows:
average e = 1.05 x nominal e
average d = 1.003 x nominal d

Mechanical fittings

Before coupling a pipe using a mechanical fitting, the pipe's protective skin must be removed from the area onto which the fitting is to be installed. Removing the skin brings the pipe to the required diameter for the mechanical fitting. To prevent deflection, support sleeves should be used on PE pipe joints. In all other respects, mechanical jointing should be carried out in accordance with the instructions provided by the pipe fitting supplier.

Pipe squeeze-off

Squeeze-off techniques are often employed in PE pipe systems where the flow must be temporarily arrested, for example in order to connect service pipes or repair damaged pipe sections. We recommend the replacement of squeezed pipe sections.

Pipe squeeze-off and the standard equipment used for this procedure can also be used with the ProFuse system, without requiring jacket removal. The squeeze-off controls must be set for the specific diameter and SDR of the pipe.

Squeeze-off devices may only be used if the distance between the tool and the nearest fitting or joint is at least four times the diameter of the squeezed pipe.

N.B.! Stones, sand and other debris must be removed from the pipe surface and from the squeeze-off tool at the squeeze-off point.

For ProFuse pipe squeeze-offs, a squeeze-off tool must be used that limits the squeeze to 80% of twice the maximum original wall thickness. To eliminate the risk of permanent pipe damage, the maximum duration per squeeze-off is 24 hours. Squeeze-off may not be carried out more than once at any given point. The squeeze-off point must therefore be clearly marked on the pipe.

UPONOR INFRASTRUCTURE

UPONOR PRESSURE
SYSTEM PVC

Uponor Pressure System PVC for potable water supply

6.3 Uponor Pressure System PVC – Characteristics

The Uponor Pressure System PVC is designed for potable water distribution, pressure sewer and process piping system applications.

The pressure system is made from un-plasticised polyvinyl chloride (PVC), meaning no plasticisers (phthalates) have been added. In addition, the pipes are equipped with integral sockets with seals.

The Uponor Pressure System PVC is ideal for underground pipe network construction. In municipal and industrial applications, the system is highly suitable, for example, for raw water and supply piping, and mains and house connections.

Equipped with pull-resistant joints, this is a safe solution for internal building installations. The system comprises a wide selection of pipes and fittings.

The pressure pipes are delivered in 6-metre lengths. Each pipe is equipped with an integral socket with a ready-installed pressure resistant seal and is delivered with plugs at both ends.

The pressure system is manufactured and designed according to nominal pressure (PN) at +20 °C. PVC is a long-life, odourless and tasteless thermoplastic. The system's chemical resistance is presented in Table 2.2 of the chapter Materials and Service Life.

Due its smooth inner surface, the PVC pipe is low friction. It is also highly resistant to abrasion by solids within the pipe flow. The head loss chart presented in Figure 6.1.8 is used for the hydraulic design of the PVC pressure system.

PVC pressure pipes are lightweight compared to many other pipe materials, making them easy to transport, handle and install.

Key advantages of the Uponor PVC Pressure System:

- Easy to handle
- Minimal jointing force required
- Joint tightness
- High resistance to most chemicals
- Excellent abrasion resistance
- Long service life.

The long service life reputation of PVC pipes is not based on theoretical calculations alone. PVC pipes have been used successfully for water supply and sewer since the 1930s. PVC pipe technologies have since been continuously developed and improved, based on rigorous material and condition tests and long-term hands-on operating experience.

Today, PVC pipes are used for the distribution of potable water and for wastewater sewer in all climate conditions.

Uponor PVC pipes have a size range of 110–630 mm and pressure grade of PN 10.

Size table

Size Outside diameter	Pressure grade
mm	**PN 10**
110	X
160	X
225	X
280	X
315	X
400	X
500	X
630	X

Table 6.3.1

System and material specifications

Properties	PVC	Unit	Standard/test method
Density	1410	kg/m^3	ISO 1183
Long-term elastic modulus E_{50}	1200	MPa	ISO 6259
Short-term elastic modulus E_0	3000	MPa	ISO 6259
Thermal expansion factor	0,08	mm/m · °C	
Thermal conductivity	0,16	W/m · °C	DIN 52 612 (20)
Elongation at break	50 - 100	%	
Maximum tensile stress, short-term	25	MPa	
MRS value	25	MPa	
Safety factor C (ø ≥ 110)	2		EN ISO 1452 / EN ISO 1456

Table 6.3.2

Bending radius of Uponor PVC pipe

Bending radius of Uponor PVC pipe in the temperature range 5-20 °C is 300 x Du, where Du = pipe outside diameter.

Approvals

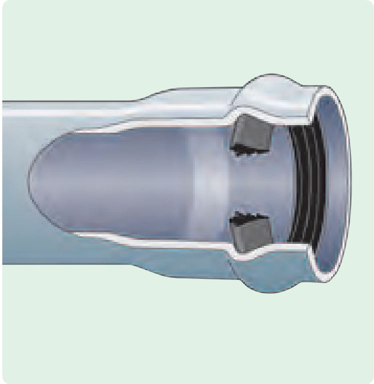
Uponor's grey PVC pipes are quality certified with the Nordic Poly Mark and are manufactured in accordance with the EN 1452-1 standard and Uponor factory standards.

The latest product approvals are presented on the Uponor website.

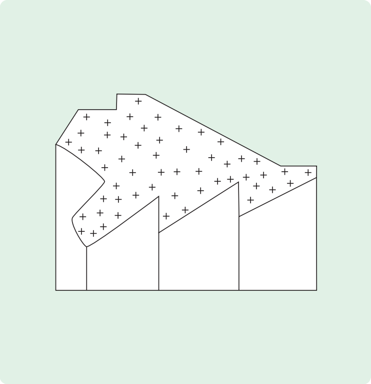
Seals

Uponor pressure pipe seals are made of SBR rubber.

Socket structure

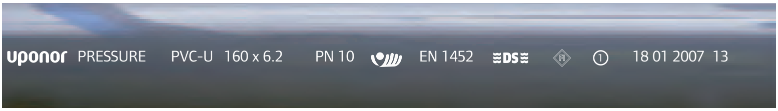


Seal cross-section



Markings

Uponor Pressure System PVC markings



uponor	**PRESSURE**	**PVC-U**	**160 x 6.2**	**PN 10**	
Manufacturer	Application	Material: polyvinyl chloride (un-plasticised)	Diameter and min. wall thickness	Pressure grade	Nordic Poly Mark

EN 1452	**≋DS≋**	①	**18 01 2007 13**
Product standard	Potable water approval	Production unit ① = Nastola, Finland	Production time: day/month/year/hour

Table 6.3.3

Uponor PVC Pressure Pipe Installation

The Uponor PVC pipe system installation instructions must be followed, in order to ensure the long-term hygiene, trouble-free operation and durability of the pressure system.

Jointing

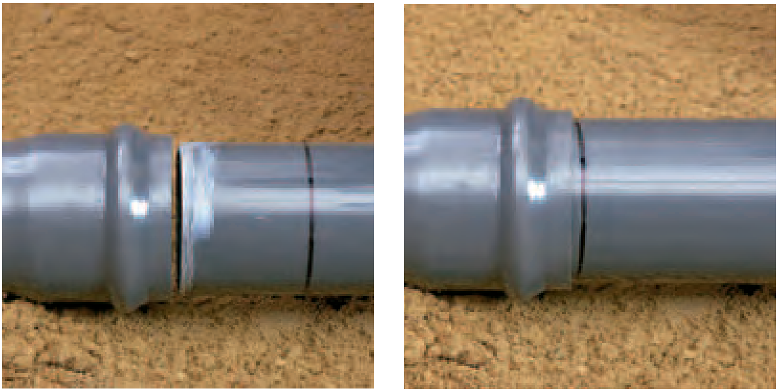
Uponor Pressure System PVC pipes and fittings are delivered with ready-installed seals.

Both ends of each pipe are plugged, to ensure that the pipe interior remains clean from the factory to the pipe trench.

1. Remove the end plugs. Remove any dirt (soil etc.) by carefully wiping the socket end, spigot end and seal.

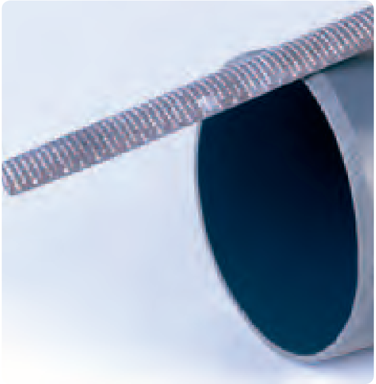
2. Brush a thin coat of lubricant onto the spigot end to facilitate coupling.
Never lubricate the socket or seal.

3. Replacing the seal after cleaning: Squeeze the sealing ring into a heart-shape and fit it into the socket groove so that the ring's thicker edge faces the inside of the pipe. The ridges on the ring should now be facing backwards, towards the inside of the pipe. Check that the ring is tightly installed in the groove.



4. The ends are now ready to be coupled. Push the spigot end into the socket up to the joint mark.

Cutting and bevelling PVC pressure pipes

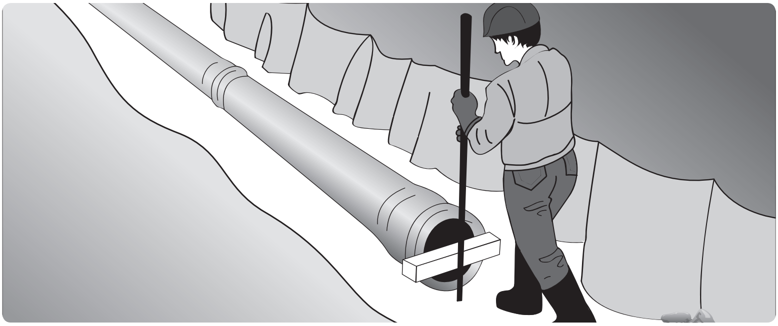


Bevel to approx. 15 degrees

Saw at 90 degrees to the pipe, using a fine-tooth saw. Use of a saw guide is recommended. PVC pipe must be handled carefully in low temperatures (below +5 °C).

After cutting the pipe and cleaning off the cut edges, the cut ends are ready to be bevelled. Bevel the pipe end to an approx. 15 degree angle with a file. The bevelling depth should be around half the pipe wall thickness. Bevel the pipe ends carefully to facilitate coupling. Bevelling can also be done using a pipe beveller.

Auxiliary tools and equipment used for Uponor PVC Pressure System coupling



Push the spigot end of the pipe into the socket up to the joint mark. This must be done manually. If needed, use an iron bar or equivalent to prise the pipes together, levering against a wood block to protect the pipe end.

If the trench bottom does not give enough leverage for the bar, use slings and a ratchet winch…

…or the excavator bucket.

N.B.! To avoid damaging the pipe, always place a block of wood between the excavator bucket and the pipe end.

Direction changes

Direction changes should always be carried out using fittings. Gradual direction changes can, however, be made with long pipes by bending the pipe lengths between the joints. In doing so, it is important to protect the joint sockets from additional loading. The sockets must therefore be held in place by concrete encasement, extremely thorough compaction, or some other embedment hardening method. The bending radius must be at least 300-fold compared to the pipe's outside diameter (see Figure 6.3.4).

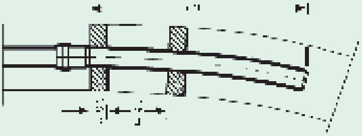
We do not recommend bending pipes that are 225 mm or larger in diameter.

Angular deflection table

Per six metre length of pipe.			
Size **Outside diameter**	**Angular deflection**	**Displacement**	**Radius**
	α	**a**	**r**
mm	**degrees**	**cm**	**m**
110	10,4	54	33,0
160	7,2	37	48,0
225	5,1	27	67,5

Table 6.3.4

Angular deflection of PVC pipes



UPONOR INFRASTRUCTURE

UPONOR PRESSURE SYSTEM PE80

Uponor Pressure System PE80 – a flexible pipe system for potable and wastewater applications

6.4 Uponor Pressure System PE80 – Characteristics

Uponor Pressure System PE80 is designed for potable and wastewater transfer. The pipes are made from black polyethylene and are colour-coded with stripes according to the application: blue stripes for potable water and terra cotta stripes for wastewater.

Polyethylene is highly impact resistant, even at low temperatures. If the pipe's operating temperature is above 20 °C, the operating pressure must be lowered to maintain the desired system service life.

According to its long-term strength, or so-called minimum required strength (MRS), the material is designated PE80. PE80 plastic has a minimum required strength (MRS) of 8.0 MPa over a 50-year period under constant loading.

PE80 pipes are available in size classes 20–63 mm. The main jointing method is electrofusion welding, although mechanical couplers can also be used.

Welded joints are pull-out resistant. Due to the material's high flexibility, system installation requires minimal fittings, since gradual bends can easily be achieved by bending the pipe.

The robust Uponor PE80 pressure system has excellent resistance to high mechanical stresses, such as pressure fluctuations and surges.

The PE80 system is also highly resistant to corrosion and most solvents, acids, alkalis and oils. See Table 2.2 of the Materials and Service Life chapter, for details of the system's chemical resistance characteristics.

The PE80 pipe is low friction due to its smooth inner surface. It is also highly resistant to abrasion by solids in the pipe flow. The head loss chart shown in Figure 6.1.8 is used for the hydraulic design of PE80 pressure systems.

Sizes and pressure grade

Size		Pressure grade
Outside diameter	**Wall thickness**	**SDR 11/PN 10**
20	2,0	x
25	2,3	x
32	2,9	x
40	3,7	x
50	4,6	x
63	5,8	x

Table 6.4.1

System and material specifications

Properties	PE80	Unit	Standard/test method
Density	943	kg/m^3	ISO 1183
Melt mass-flow rate (MFR)	0,47	g/10 min.	ISO 1133 system 18
Long-term elastic modulus E_{50}	190	MPa	ISO 6259
Short-term elastic modulus E_0	750	MPa	ISO 6259
Thermal expansion factor	0,17	mm/m · °C	ASTM D 696 (20 – 90 °C)
Thermal conductivity	0,32	W/m · °C	
Specific heat	1,9	J/g · °C	
Yield stress	21	MPa	
Maximum tensile stress, short-term	8	MPa	
MRS value	8	MPa	ISO/DIS 4427 / CEN/TC 155 SS20

Table 6.4.2

Uponor PE80 pipes have a size range of 20–63 mm and pressure grade of PN 12.5.

Bending radius of Uponor PE80 pipe

Temperature range	Bending radius (minimum)
-20 °C ...-6 °C	28 x Du
-5 °C ...+10 °C	25 x Du
11 °C ...35 °C	22 x Du

Du = pipe outside diameter.

Approvals

Uponor PE80 pipes are quality certified with the Nordic Poly Mark and are manufactured in accordance with the EN 12201 standard and Uponor factory standards.

For the latest product approvals, visit our website at www.uponor.fi.

Markings

A description of Uponor PE80 pressure system markings is presented below.

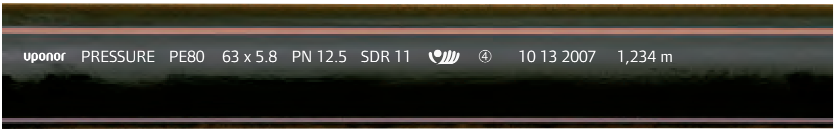
Markings for PE80 pressure systems for potable water applications

uponor	Pressure	PE80	63 x 5.8	PN 12.5	SDR 11
Manufacturer	Application:	Material: polyethylene	Diameter and min. wall thickness	Pressure grade	Standard Dimensional Ratio

	EN 12201	DS	④	13 2007	1,234 m
Nordic Poly Mark	Product standard	Potable water approval	Production unit ④ = Forssa, Finland	Production date: month/year	Meterage

Table 6.4.3

Markings for PE80 pressure systems for wastewater applications



uponor	Pressure	PE80	63 x 5.8	PN 12.5	SDR 11
Manufacturer	Application: pressure sewer	Material: polyethylene	Diameter and min. wall thickness	Pressure grade	Standard Dimensional Ratio

	④	13 2007	1,234 m
Nordic Poly Mark	Production unit ④ = Forssa, Finland	Production date: month/year	Meterage

Table 6.4.4

PE80 Pressure Pipe Installation

Jointing/welding

PE80 pipes are compatible with all common jointing methods, such as electrofusion welding and mechanical couplers.

Due to the size of Uponor PE80 pressure pipes, they are normally jointed primarily by electrofusion.

The oxidised surface layer (approx. 0.1 mm) on PE80 pipe must be scraped off before welding.

The welding surfaces must be cleaned with an approved cleaning fluid, such as 93-percent spirit or PE cleaners.

Electrofusion of sockets, reducers, T-branches and bends

1. Cut the pipes at 90 degrees. Clean the end to be welded. Then scrape the pipe end back to the same depth as the socket, using a rotary pipe scraper or suitable hand scraper.

2. Make sure the surface is scraped all the way around the pipe. Avoid touching the area to be welded.

3. Measure the required joint depth from the pipe end and mark it on the pipe. Check that the width of the scraped area at least matches the socket depth. Just before installing the socket, wipe the scraped ends to be welded, with a lint-free paper cloth and an approved cleaning fluid.

4. Push the pipe home to the base of the socket and check against the joint depth mark. Fit the joint clamp into place. Repeat steps 1–3 on the other pipe end.

5. Set up the welding cables. Welding can be carried out using the barcode or by entering the welding time manually. After welding, check that the welding stud on the socket has been raised and that the welding machine does not display an error message.

Welding – tapping tee

Pipe tapping tees are welded onto PE 80 pipes in the same way as for ProFuse pipes.

N.B.! Tapping tees cannot be re-welded. When pressure testing a service pipe before drilling, the cooling time is 20 min.

Mechanical fittings

To prevent pipe deflection, support sleeves should be installed on joints. When connecting pipes mechanically, the fitting supplier’s instructions must be followed.

Pipe squeeze-off

Squeeze-off techniques are often employed in PE pipe systems where the flow must be temporarily arrested, for example in connecting service pipes or repairing damaged pipe sections. We recommend that squeezed pipe sections be replaced.

Pipe squeeze-off and the standard equipment for this procedure can also be used with the ProFuse system, without requiring jacket removal. The squeeze-off controls must be set for the pipe's specific diameter and SDR.

Squeeze-off devices may only be used if the distance between the tool and the nearest fitting or joint is at least four times the diameter of the squeezed pipe.

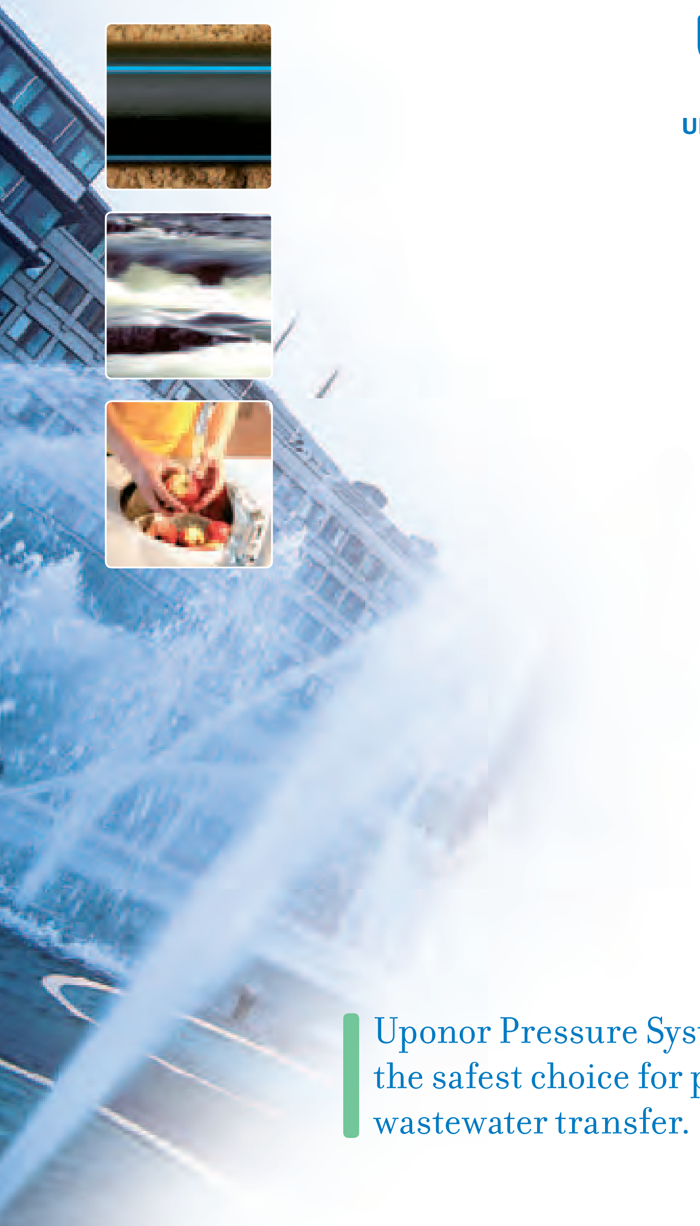
N.B.! Stones, sand and other debris must be removed from the pipe surface and from the squeeze-off tool at the squeeze-off point.

Squeeze limits for PE pipe squeeze-off

PE80 SDR 11			
Size	**Min. wall thickness**	**Max. wall thickness**	**Min. squeeze limit**
mm	**mm**	**mm**	**mm**
20	2,0	2,3	3,5
25	2,3	2,7	4,0
32	3,0	3,4	5,0
40	3,7	4,2	6,5
50	4,6	5,2	8,0

Table 6.4.5

To eliminate the risk of permanent pipe damage, the maximum duration per squeeze-off is 24 hours. Squeeze-off may not be carried out more than once at any given point. The squeeze-off point must therefore be clearly marked on the pipe.



UPONOR INFRASTRUCTURE

UPONOR PRESSURE SYSTEM PE100

Uponor Pressure System PE100 – the safest choice for potable and wastewater transfer.

6.5 Uponor Pressure Pipe System PE100 – Characteristics

The Uponor Pressure System PE100 is designed for potable and wastewater transfer, and gas distribution. The pipes are made of black polyethylene and are colour-coded with stripes according to the application: blue stripes for potable water, terra cotta stripes for wastewater, and yellow stripes for gas.

The system is made of highly flexible and easy-to-handle polyethylene plastic.

Polyethylene is also highly impact resistant, even at low temperatures. If the pipe's operating temperature is above 20 °C, the operating pressure must be lowered to maintain the desired system service life.

The material is designated PE100 according to its long-term strength, or so-called minimum required strength (MRS). PE100 plastic has a minimum required strength (MRS) of 10.0 MPa over a 50-year period, under constant loading.

PE100 pipes are available in size classes 63–75 mm and 450–800 mm. Although mechanical couplers can also be used, the main jointing method is electrofusion welding.

The welded joints are pull-out resistant. Due to the material's high flexibility, system installation requires minimal bend fittings, since gradual bends can be easily achieved by bending the pipe.

The robust Uponor PE100 pressure system has excellent resistance to high mechanical stresses, such as pressure fluctuations and surges.

It is also highly resistant to corrosion and most solvents, acids, alkalis and oils. The system's chemical resistance is presented in Table 2.2 of the chapter Materials and Service Life.

The PE100 pipe is low friction due its smooth inner surface. The pipe is also highly resistant to abrasion by solids in the pipe flow.

Sizes and pressure grade

Size		Pressure grade
Outside diameter	**Wall thickness**	**SDR 17/PN 10**
63	3,8	x
75	4,5	x
90	5,4	x
110	6,6	x
140	8,3	x
160	9,5	x
450	26,7	x
500	29,7	x
560	33,2	x
630	37,4	x
710	42,1	x
800	47,4	x

Table 6.5.1

System and material specifications

Properties	PE100	Unit	Standard/test method
Density	950	kg/m^3	ISO 1183
Melt mass-flow rate (MFR)	0,3	g/10 min.	ISO 1133 method 18
Long-term elasticity modulus E50	1100	MPa	ISO 6259
Short-term elasticity modulus E0	275	MPa	ISO 6259
Thermal expansion factor	0,17	mm/m ·°C	
Thermal conductivity	0,43	W/m ·°C	DIN 52 612 (23)
Specific heat	1,9	J/g ·°C	
Yield stress	23	MPa	
Maximum tensile stress, short-term	10	MPa	
MRS value	10	MPa	ISO/DIS 4427 / CEN/TC 155 SS20

Table 6.5.2

Bending radius of Uponor PE100 pipe

Temperature range	Bending radius (minimum)
-20 °C ...-6 °C	28 x Du
-5 °C ...+10 °C	25 x Du
11 °C ...35 °C	22 x Du

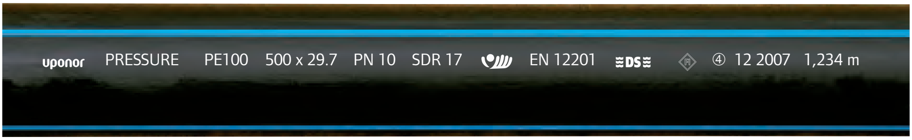
Du = pipe outside diameter.

Approvals

All PE 100 pipes are quality certified with the Nordic Poly Mark. In addition, each pipe is manufactured in accordance with the relevant application-specific standard. Blue-striped pipes for potable water applications are manufactured in accordance with the EN 12201 standard and Uponor factory standard. Terra cotta striped pipes are manufactured in accordance with EN 13244, and yellow-striped gas pipes in accordance with the EN 1555 standard and Uponor factory standard.

Markings

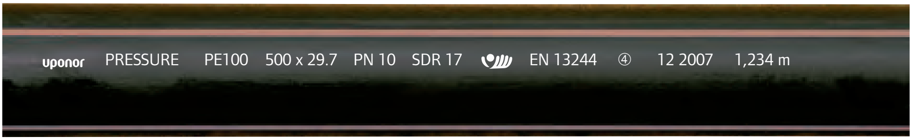
Uponor PE100 Pressure Pipe markings



uponor	**Pressure**	**PE100**	**500 x 29.7**	**PN 10**	**SDR 17**
Manufacturer	Application:	Material: polyethylene	Diameter and min. wall thickness	Pressure grade	Standard Dimensional Ratio

	EN 12201	**DS**	④	**13 2007**	**1,234 m**
Nordic Poly Mark	Product standard	Potable water approval	Production unit ④ = Forssa, Finland	Production date: month/year	Meterage

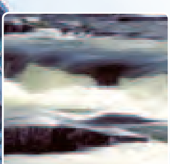
Table 6.5.3



uponor	**Pressure**	**PE80**	**63 x 5.8**	**PN 12.5**	**SDR 11**
Manufacturer	Application: pressure sewer	Material: polyethylene	Diameter and min. wall thickness	Pressure grade	Standard Dimensional Ratio

	EN 13244	④	**13 2007**	**1,234 m**
Nordic Poly Mark	Product standard	Production unit ④ = Forssa, Finland	Production date: month/year	Meterage

Table 6.5.4



UPONOR INFRASTRUCTURE

UPONOR PRESSURE
FITTINGS

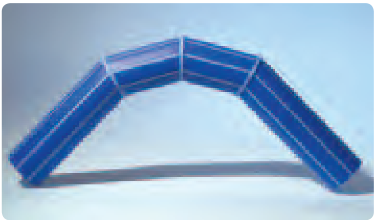
Pressure Fittings for Electrofusion and Butt Fusion

6.6 Uponor Pressure Fittings – Characteristics

Uponor PE pressure system fittings are manufactured in different versions, according to the application and the manufacturing method.

Uponor pipe fittings are made of polyethylene PE100, i.e. the same material as the majority of pipes in use today. PE100 fittings can also be used with PE80 pipes. However, pipes and fittings must have the same wall thickness if they are to be joined by butt welding. Alternatively, if they have different wall thicknesses but are made of the same material, they can be joined by electrofusion welding.

Uponor pressure fittings are either segment-welded or die-cast. The segment-welded fittings range comprises ready-welded socket bends and branches. These fittings can be bespoke manufactured to customer requirements.



The Uponor die-cast fittings range is intended for butt- and electrofusion welding and includes bends, T-branches, and reducers. Most of these are long fittings, which enables them to be welded together using electrofusion sockets and fastened to a standard butt fusion welding machine. The fittings range is supplemented with flanges and plastic collars.

Uponor's electrofusion fittings product range includes sockets, reducers, bends, T-branches, drilling saddles and plugs. These fittings are welded using a electrofusion machine, which passes an electrical current to the fitting via resistance wires, thus heating the fitting and fusing it to the pipe. This method is being increasingly adopted, especially for the jointing of small diameter pipes.

Uponor pressure fittings match all other Uponor pipes and components in strength, and have excellent resistance to high mechanical stresses, including pressure fluctuations and surges.

The fittings are also highly resistant to corrosion and most solvents, acids, alkalis and oils. See Table 2.2 of the introductory section for details of the performance and service life of PE100.

The sizes of Uponor PE100 fittings are the same as those of the Uponor PE pressure system. Segment-welded fittings are available for all SDR classes. Die-cast fittings are available for SDR 17 and SDR 11 pipes, and electrofusion fittings for SDR 11 pipes.

The same electrofusion fittings can be used for both water and gas, with a pressure grade of PN 16 for water and PN 8 for gas.

System and material specifications

Properties	PE100	Unit	Standard/test method
Density	950	kg/m^3	ISO 1183
Melt mass-flow rate (MFR)	0,3 - 0,55	g/10 min.	ISO 1133
Short-term elastic modulus E_0	900 - 1000	MPa	ISO 6259
Long-term elastic modulus E	225 - 250	MPa	ISO 6259
Thermal expansion factor	0,17	mm/m · °C	ASTM D 696 (20 - 90 °C)
Thermal conductivity	0,43	W/m · °C	DIN 52 612 (20)
Specific heat	1,9	J/g · °C	
Yield stress	23	MPa	
Maximum tensile stress, short-term	10	MPa	
MRS value	10	MPa	ISO/DIS 4427 / CEN/TC 155 SS20
Design stress	8	MPa	EN ISO 12201 / EN ISO 13243
Safety factor (water pipe and pressure sewer)	1,25		EN ISO 12201 / EN ISO 13243
Safety factor (gas pipe)	Min. 2		EN 1555

Table 6.6.1

Approvals & markings

Approvals

Uponor PE100 fittings are approved in accordance with the EN 12201 and EN 1555 standards. For the latest product approvals, visit us at www.uponor.fi.

Markings

Because they are made from pipe segments, segment-welded fittings carry the same markings as pipes.

Die-cast butt fusion and electrofusion fittings carry a stamp indicating the material, size and SDR.

Some examples of fitting markings:

Standard Dimension Ratio (SDR)

The SDR indicates the outside diameter to wall thickness ratio.

The SDR and the material type can be used together to obtain a value which gives a better than normal description of the pressure rating, without knowing the safety factors.

$$\text{SDR} = \frac{\text{Nominal diameter}}{\text{Min. wall thickness}}$$

SDR and pressure rating table

The pressure grades apply to potable water pipes and pressure sewers.

Material	σ		**SDR**	
Designation	**MPa**	**26**	**17**	**11**
PE100	8	PN 6,3	PN 10	PN 16

Table 6.6.2

Sigma (σ) is the design stress of the pipe material.

The PN value is the nominal pressure, the maximum operating pressure (bar).

Based on a constant pressure of 20 °C mean temperature for 50 years.

Example for ø110 PE100 PN 10 fittings:

$$\text{SDR} = \frac{Dy}{e} = \frac{110}{6{,}6} \Rightarrow \text{SDR17}$$

PE100 Pressure Fittings, Installation

Jointing/welding

Uponor PE100 fittings are compatible with all standard jointing methods.

Detailed butt fusion are given in the pipe-specific sections of this manual.

Electrofusion instructions are also given in the pipe-specific sections of this manual.

PE100 fittings can also be coupled mechanically.

The fittings are compatible with all standard PE pipe installation, extension and maintenance techniques.

UPONOR INFRASTRUCTURE

WASTE WATER TREATMENT SYSTEM

Uponor waste water treatment system

7.1 Waste water treatment system – Introduction

Uponor's solutions for waste water systems are used for houses and properties which are not connected to the municipal waste sewer network. This applies primarily to holiday home areas as well as houses in the countryside.

The basic principle for an infiltration system is that sewage from a property is transported to a septic tank where the sludge is allowed to settle and from which the water is then transported onwards for subsequent treatment. The sewage is infiltrated through the existing or constructed layer of soil, meaning it is treated naturally.

If the local conditions mean the infiltration principle cannot be used, you can install a small sewage treatment plant which replaces the septic tank and the subsequent treatment.

A traditional infiltration system is robust and easy to set up, either as
- gravitational infiltration
- Infiltration with pumping
  (no gravitation)

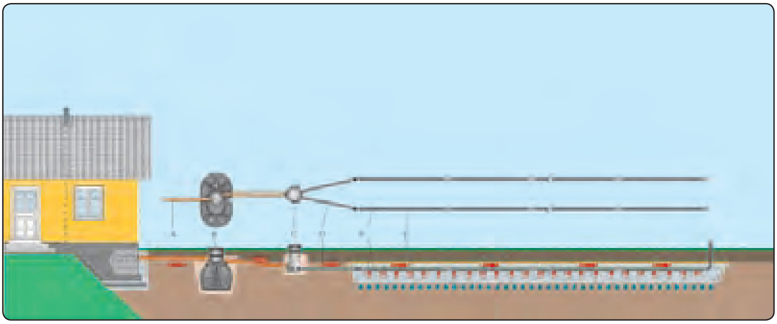
However, there are various local conditions that may impede a traditional infiltration system. For example, the groundwater may be too high, there may be poor soil conditions or areas where particular attention must be paid to protecting the potable water supply.

If it is not possible to set up a traditional infiltration system, there is a range of other solutions to choose from:

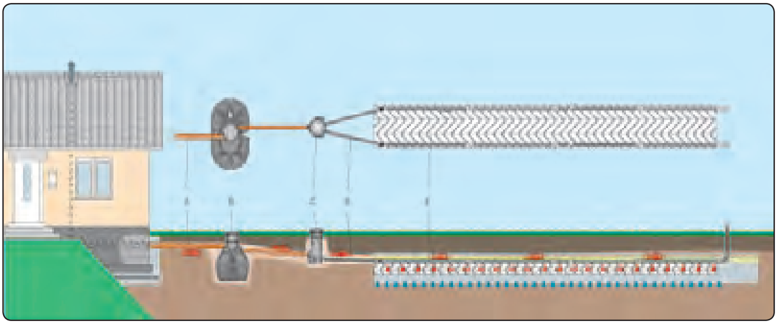
- Sand filter trench with phosphorus trap
- Small sewage treatment plant
- Holding tank
- Dry toilet

- Uponor's extensive product range covers most installation situations.

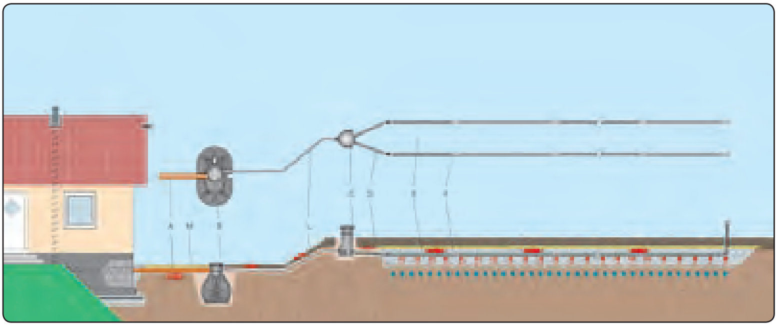
- The complete range is set out in a separate product list/price list in Uponor’s web site.



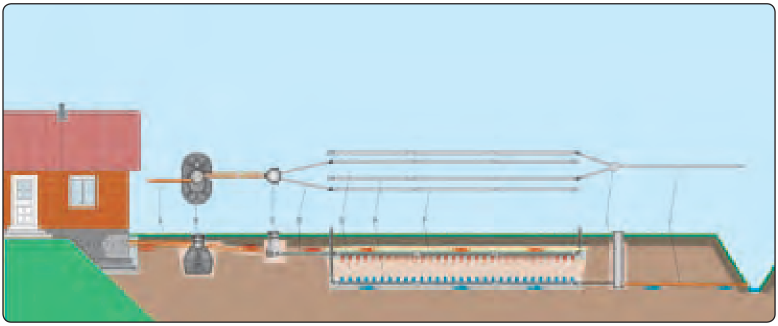
Infiltration.



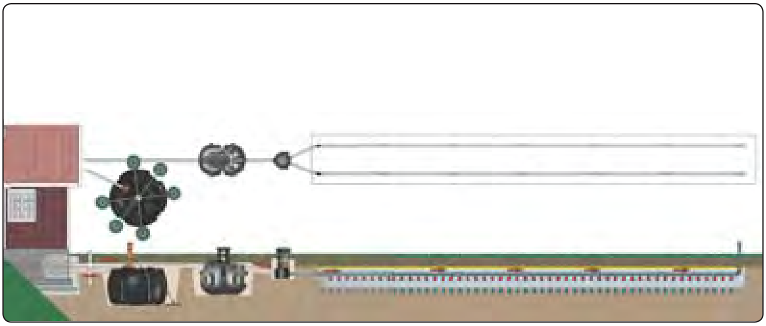
Infiltration with infiltration modules.



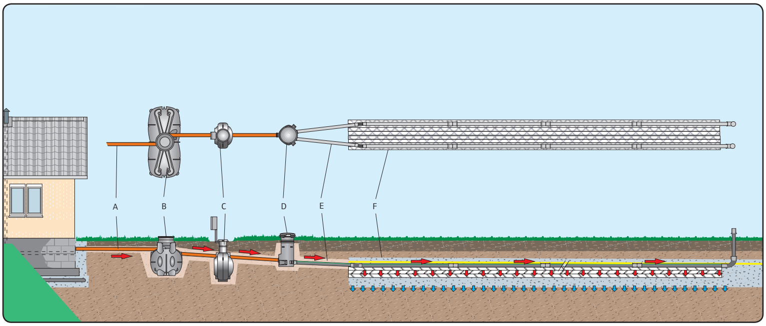
Infiltration with pump system.



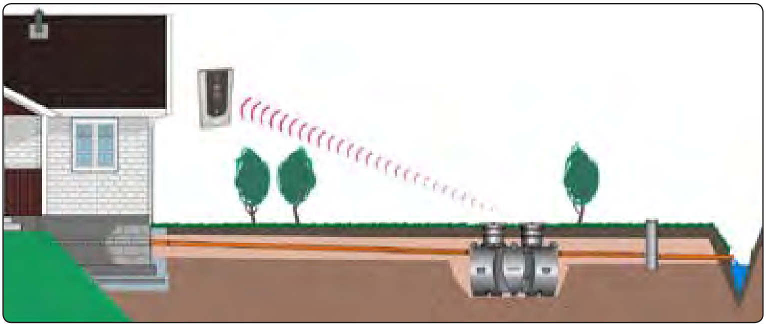
Sand filter trench system.



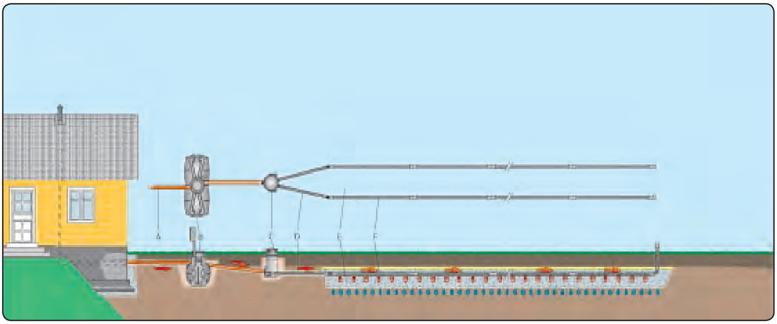
Combined systems



Infiltration system with phosphorus trap.



Small sewage treatment plant



Clean Easy with infiltration.

Dimensioning

In this section we will go through the dimensioning of septic tanks and infiltration/sand filter trenches in general. Uponor's technical support is always on hand for any further assistance concerning the calculation of the system's size.

The size of the septic tank depends on the number of people (PE = person equivalent) that it needs to hold sewage from. Each person (PE) represents a load of 150-200 litres of sewage per day and one household equals five people.

It is important to bear in mind that the general advice consists of recommendations; you should always carry out a thorough calculation/plan of the functionality of the entire system. The tables included in this section are merely intended as directional.

Use the table below for dimensioning according to the number of PE.

Dimensioning of the number of PE in respect of the sewage from the property

Category of activity etc.	**Calculation basis**	**Equivalent number of permanent residents (PE)**
Single family house		5
Workshops	Employed person	1/2
Offices	Employed person	1/2
Shops	Employed person	1/2
Schools	Pupil numbers	1/3
Restaurants	Capacity	1/2
Summer restaurants	Outdoor serving capacity	1/10
Factories	Employed person per shift	1/2
Society and club houses	Capacity	1/10
Meeting premises without a restaurant	Capacity	1/30
Hotels	Number of beds	1 1/2
Care homes	Outdoor serving capacity	2 1/4

Table 7.1.1

General construction of Uponor's septic tanks and infiltration systems

The septic tanks are constructed so that optimal separation of sediment particles and liquid substances can be guaranteed. This is achieved by reducing the water crossflow through the individual chambers. This prevents the infiltration pipes from clogging, something which in the longer term could cause the entire system to cease functioning.

In each infiltration system, the sewage trickles down through the layers of earth. Then the residual elements of the sewage are broken down with the help of oxygen which is supplied via the ventilation pipes and the oxygen that exists in the soil. Uponor's standard septic tanks for 5 and 10 PE are designed to hold waste water sludge from one or two houses respectively with emptying once a year.

The total volume of the tank includes both the settling volume and the sludge volume.

The settling volume is the volume which is always in the tank – even when the tank is filled with sludge, i.e. immediately before it becomes necessary to empty the tank. The settling volume ensures that the retention time in the tank is always sufficient.

The sludge volume is the volume which intended for storing bottom sludge and floating sludge.

Use the table below to calculate the size of the septic tank.

It is possible to reduce the total volume of large septic tanks. You achieve this, for example, by emptying the tanks twice a year so that the volume of sludge is halved. This provides a saving in terms of the main investment in the system but then the tank must also be emptied twice a year.

Infiltration systems should always be installed by an authorised water and waste water engineering company. The pump for pressure infiltration must be connected by a qualified electrician. Then you can be sure that the relevant legal provisions have been fulfilled and that the installation is completed with the necessary expertise.

Designing the septic tank volume

Volume (m^3)	Recommending number of PE
2	1 - 5
3	1 - 5*
4	6 - 10
6	11 - 15
8	16 - 20
10	21 - 25
12	26 - 30
15	31 - 42

* With large amount of sewage

Table 7.1.2

Infiltration with pump systems or gravitational infiltration

Infiltration systems with a pump chamber are used, for example, in areas with a high groundwater table, where the water must be raised to the pressure infiltration trench in order to meet the distance requirements between the groundwater table and the bottom of the infiltration pipe trench. The recommended distance is 2.5 m and the minimum distance 1.0 m.

By pumping the sewage to the infiltration trench, you can be sure that the water is distributed evenly over the entire surface.

Gravity infiltration may be used in situations where the sewage can flow by gravity, i.e. where there is a sufficient incline in the flow pipes between the septic tank and the infiltration trench.

This also requires the distance between the bottom of the infiltration pipe trench and the groundwater table to correspond to the recommended 2.5 m, although at least 1.0 m is necessary.

You must also check case-by-case if a pump or gravity infiltration system is to be laid. This analysis should be performed by a water and waste water engineering company before the installation is begun, in consultation with the local authority.

We recommend that you pump the sewage for large infiltration systems with a capacity >15 PE, since it is then a question of large quantities of water which will be distributed over a large infiltration area. For this purpose, Uponor manufacturers pipes which guarantee optimal distribution over all passes within the infiltration trench.

Choice of purification method

A site survey should be carried out before the application/notification is submitted to the local environmental heath department. The survey will tell whether the intended site of an infiltration system is suitable or if another purification method needs to be chosen.

The soil must possess the necessary capability – infiltration capacity – to absorb the penetrating sewage. The soil also needs to be able to transport away infiltrated water – hydraulic capacity – so that the groundwater table below the system does not rise to an unacceptable level.

To be able to determine the soil's ability to absorb waste water (infiltration capacity), test pits need to be dug in order to take samples of the soil and establish the particle size distribution. For a system meant for a single household, we recommend digging at least two pits in the intended site of the system. If the area is homogeneous, one pit may be sufficient. Dig the pit to a depth of 2-2.5 metres and take soil samples for every layer that the waste water is meant to infiltrate through. The top layer of soil containing lots of organic matter is normally excluded. At least 0.5 litres of matter must be taken from the layer. One sample must be taken in each layer from the level where the infiltration pipe will be laid.

If the layer is unclear or the position of the infiltration pipe difficult to calculate, soil samples can be taken at the 0.5, 0.75, 1.00, 1.50 and 2.00 metre levels below the soil surface. Mark every sample with the name of the pit, the date and the depth. If groundwater is found at a depth of less than 2 metres, the sampling should go down to at least 0.5 m below the groundwater surface for several reasons, including checking for any bedrock. In fine-grained soil especially, the test pit should be left open for several hours or for as long as it takes for the groundwater level to stabilise. These should then be sent for analysis where a particle size analysis will be performed and the lab normally also determines the infiltration capacity of the relevant layer of soil (see the diagram below).

Grading curve drawn after a particle size analysis

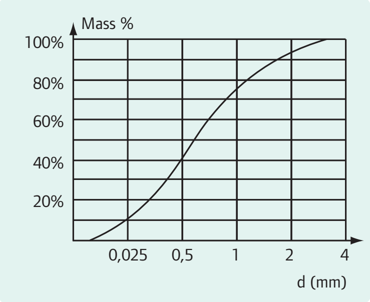
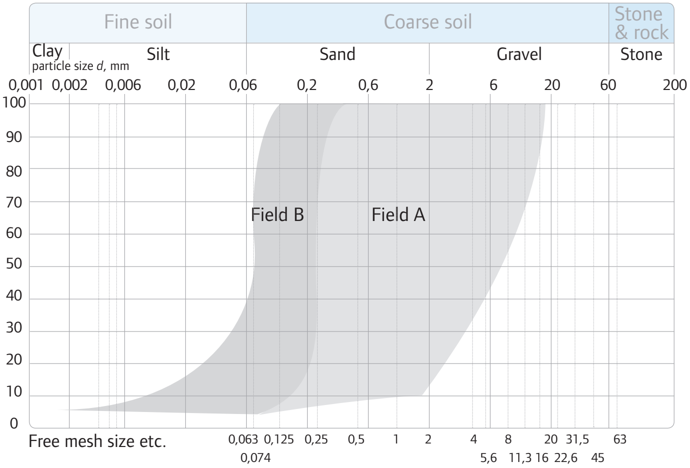


Figure 7.1.3

Examples of results after particle size analysis

1. The grading curve falls entirely within field A. The infiltration system can be chosen. The load is selected as 50-60 l/m²xd (litres per square metre and day). The right-hand value is then selected since the curve mainly falls in the right-hand section of the field.
2. The grading curve mainly falls within field A with a small section in field B. The infiltration system can be chosen. The load should not exceed 40 l/m²Xd.
3. The grading curve mainly falls within field B with a small section in field A or the grading curve falls entirely within field B. The infiltration system can be chosen. The load should not exceed 30 l/m²xd.
4. The grading curve falls to some extent to the right of field A. The matter is too coarse to enable normal infiltration. Possible solutions might be reinforced infiltration or a sand filter trench.
5. The grading curve falls to some extent to the left of field B. The matter is far too fine-grained to be suitable for normal infiltration. A possible solution is a sand filter trench.
6. The grading curve falls to some extent outside both field A and field B. Possible solutions are the same as in point 5.



Generally speaking, the following can be said about the soil's infiltration capacity:

Grading curve within	Infiltration capacity
Field A	50-60 l/m^2 x day
Field B	30-40 l/m^2 x day
Outside fields A and B	Individual evaluation

Table 7.1.4

Dimensioning the infiltration:

Normally 40-60 litres/m^2 and day in good conditions (i.e. all of the grading curve falls within field A. 60 l if the majority of the curve falls within the right-hand section of field A). If the majority of the grading curve falls within field B and a small section in field A, we recommend a maximum of 30 litres/m^2. There are different variants where the infiltration can be improved via a combination of sand filter trench and infiltration.

Dimensioning a sand filter trench:

Normally concrete sand (foundry sand) or 0-8 mm sand filter trench sand is chosen as this gives the right particle size distribution. Washed sand must always be chosen in order to avoid the trench clogging up. Unwashed sand contains far too much fine-grained material. The grading curve for the sand filter trench must fall entirely within field A. The capacity is 50-60 litres/m^2.

Dimensioning the size of an infiltration trench

When laying an infiltration sand filter trench, you should allow for 1 m^2 to be taken up by a infiltration pipe measuring 1 running metre. For standard systems with a capacity of 5-25 PE, we recommend that the dimension tables below be used to work out the area of the trench:

> With gravitational infiltration, the sewage is distributed fairly evenly in an infiltration pipe as long as this is no more than 15 metres in length. Longer infiltration pipes should be avoided. Instead you should split it into two or more passes. If the sewage is distributed by pumping, the length of the infiltration pipe can be extended to 20 metres.

Sewage from toilet water + greywater

Number of PE	60 l m^2*d	50 l m^2*d	40 l m^2*d	30 l m^2*d
5	17m^2	20m^2	25m^2	33m^2
10	33m^2	40m^2	50m^2	67m^2
15	50 m^2	60 m^2	75 m^2	100 m^2
20	67 m^2	80 m^2	100 m^2	133 m^2
25	83 m^2	100 m^2	125 m^2	167 m^2

Greywater

Number of PE	60 l m^2*d	50 l m^2*d	40 l m^2*d	30 l m^2*d
5	13 m^2	25 m^2	19 m^2	25 m^2
10	25m^2	30m^2	38m^2	50m^2
15	38 m^2	45 m^2	56 m^2	75 m^2
20	50 m^2	60 m^2	75 m^2	100 m^2
25	63 m^2	75 m^2	94 m^2	125 m^2

Design flow

Information on the max. daily flow (l/day), i.e. the flow to the septic tank on the day with the heaviest load, is required to calculate the design flow. If there is a water main, this means the flow can be measured and calculated using the equation below.

For a planned system, the max. daily flow must be estimated in order to enable the calculation of the design flow. The information required in this case is:

1. How many people as a maximum are expected to use the system on the day of the year with the heaviest load.
2. How much water is consumed per person and day. For households standard values of 120 l/p for greywater and 170 l/p for toilet water+greywater and day are used. For original systems we can use the data in table 8.1.1 as well as taking into consideration how much water is used to flush toilets or to take showers.
3. The total length of the pipes in the supply system.
4. Leakage per metre of pipe and per day. Newly laid plastic pipes do not leak while existing concrete pipes may leak several litres per metre.

When the flows are extremely large and brief, flow equalisation should be considered before the septic tank. In such cases the size of the septic tank can be reduced.

Once a design flow value has been worked out, the formulae are used to calculate the septic tank's total volume and wet volume (sedimentation volume and sludge storage volume).
Size guidelines for the septic tank are set out on page 7.

The following equation can be used to calculate a planned system with a leak-proof pipe:

$$\text{Design flow, m}^3/\text{h} = \frac{\text{Measured max. daily flow}}{\text{Number of hours per day during which the sewage flow is distributed in h} * 1000}$$

8 h with 26-200 PE and
11 h with 200-500 PE

Design daily average flow

The time over which the daily average flow is calculated varies according to the load's time distribution. When there is an even distribution over a time period of a month or more (e.g. in an area with permanent residents), the average daily flow is calculated for a month (max. month). For brief and intensive load peaks, from a day or so up to just under a month, the average daily flow is calculated during the most intensive week of the year. If flow equalisation is applied, this must be taken into account when calculating the average daily flow.

The parameters design daily average flow and recommended surface load are worked out using:

- Impurities content: BOD, SS, phosphorus and nitrogen
- Which pre-treatment: septic tank, mechanical, biological and/or chemical
- The duration of the load period: summer load, weekend load or permanent load
- Soil type, i.e. infiltration capacity and hydraulic capacity

The design daily average flow with a newly laid leakproof pipe is calculated using the following equation:

$$\begin{array}{l}\text{Design}\\ \text{flow, m}^3\text{/h}\end{array} = \frac{\begin{array}{l}\text{PE * Standard value}\\ \text{per person/day}\\ \text{(170 l toilet water+greywater)}\\ \text{(120 l greywater)}\end{array}}{\begin{array}{l}\text{Number of hours per day}\\ \text{during which the sewage}\\ \text{flow is distributed in h * 1000}\\ \text{8 h with 26-200 PE and}\\ \text{11 h with 200-500 PE}\end{array}}$$

$$\begin{array}{l}\text{Des. daily}\\ \text{flow, m}^3\text{/h}\end{array} = \frac{\begin{array}{l}\text{PE * Standard value PE/d}\\ \text{(170 l toilet water+greywater)}\\ \text{(120 l greywater)}\end{array}}{1000}$$

If you need to make the calculation for an existing water main, the following equation should be used:

$$\text{Des. daily flow m}^3\text{/h} = \frac{\text{Measured daily flow during max. week/max. month, 1/d}}{1000}$$

The following equation can be used to calculate the required infiltration area:

$$\text{Area of infiltration} = \frac{\text{Des. daily flow, m}^3\text{/d*1000}}{\text{l/m}^2\text{ d acc. to grading curve plus consideration of contamination level, pre-treatment and duration of load period}}$$

Estimated degree of treatment with the most common treatment methods

A septic tank is not a treatment function but a pre-treatment which separates larger particles as well as fat and oils from the household. The degree of treatment is usually low.

	BOD	Tot P	Tot N
Septic tank	10–20%	10-20%	10-20%
Infiltration system	> 90%	70%	20-60%
Sand filter trench system	>90	50%	20-60%
Small sewage treatment plant	>90%	> 90%	> 50%

Glossary/explanation of technical terms used for individual drainage systems

Aerobic	Rich in oxygen
Active sludge	Biological sludge for treating waste water consisting of bacteria and other microorganisms which break down the organic matter in the waste water when oxygen is present.
Ammonium	Nitrogen compound with the chemical name NH4+
Anaerobic	Oxygen-free
Greywater	Bathwater, washing-up water and laundry water from households.
Biofilm	Name for the thin layer of microorganisms living in e.g. sand filter trenches, infiltration systems and compact filters where the biological purification takes place. Also called bioskin
Biological purification	Reduction in oxygen-consuming substances and any nitrogen present using microorganisms living in sand filters, sand filter trenches, active sludge, trickling filters, etc.
Biological toilet	Toilet with a container in which excrement and any other organic waste is composted, also known as a composting toilet.
Mixed waste water	Waste water from households that contains both toilet water and greywater.
BOD	Biochemical oxygen demand; parameter that indicates the content of oxygen-consuming organic matter in the water.
Surface water	Rain and meltwater that does not infiltrate groundwater and is not absorbed by vegetation, but instead runs off from hard surfaces such as roofs, roads and car parks.
Denitrification	Bacterial conversion of nitrate nitrogen (NO3-) into aerial nitrogen (N2).
Drainage water	Water that collects below the soil surface and is conducted away, e.g. with draining foundations.
Dual flush toilet	Urine-sorting toilet which flushes both urine and excrement with water.
Single flush toilet	Urine-sorting toilet that only flushes urine with water. Excrement goes directly to a collection vessel for night soil.
Individual drainage system	Drainage system outside of the municipal water supply and sewerage area. Usually for a single household, but can also treat sewage from several households.
Eutrophication	Supply of nutrients (primarily nitrogen and phosphorus) to a water-course, often considered to be the same as excessive fertilisation.
Extremely low flush toilet	Toilet that uses less than 1 litre of water per flush.
Phosphorus	Plant nutrient, chemical symbol P
Phosphorus-binding material	Material with good phosphorus-binding capacity. Often chalky, e.g. Filtralite.

Distribution chamber	Drain that distributes the waste water evenly to all infiltration pipes, which is necessary if more than one infiltration pipe is used.
Pre-precipitation	When chemical precipitation, including sedimentation of precipitated phosphorus, takes place before the biological treatment.
Geohydrological survey	Survey of groundwater conditions, e.g. distance to the groundwater from the surface of the soil.
-	-
Hybrid toilet	Toilet where the waste is flushed away with water to a container for biodegradation.
Sanitisation	Process in which pathogenic microorganisms are killed off so that there is no risk of diseases spreading.
Infiltration	Purification of the waste water by it running through natural layers of soil and being distributed diffusely via the soil to the groundwater.
Potassium	Plant nutrient, chemical symbol K
Chemical precipitation	Addition of precipitation chemical which forms a sparingly soluble chemical compound with phosphate in the waste water.
Toilet water	The waste water from the toilet, i.e. urine, excrement, toilet paper and flushing water.
Compact filter	Prefabricated filter for biological treatment of waste water. Sometimes encased in a box or built with a weatherproofing layer at the bottom.
Diagram of particle size distribution	Results of texture analysis
Cycle	Restoration of the nutrient salts in the waste water to cultivated land.
Nitrogen	Plant nutrient, chemical symbol N
Sand filter trench	Purification of the waste water by filtering through sand and layers of soil; the water is then collected and transported away to a ditch, a river, a lake or to the sea.
Mini purification plant	Prefabricated system based on scaled down technology from large purification plants. Often mechanical, biological and chemical purification, sometimes only biological or only chemical purification.
Earth toilet	Small biological toilet where the waste is collected in a smaller container underneath the toilet; usually needs to be located in a heated room and be connected to an electrical outlet.
Multrum	Biological toilet where the waste is collected in a large container underneath the toilet in which it is broken down biologically; the system can also manage compostable domestic waste.

Nitrate	Nitrogen compound with the chemical name NO3- formed through oxidation of ammonium.
Nitrification	Bacterial conversion of ammonium nitrogen (NH4+) into nitrate nitrogen (NO3-) which takes place in aerated (rich in oxygen) environments.
Norsk Leca	Porous filter material that binds in phosphorus.
Nutrient salts	Plant nutrients such as phosphorus, nitrogen and potassium.
PE	Person equivalent. A person equivalent is the amount of BOD that corresponds to the average daily BOD emissions per person. One PE corresponds to 70 g of BOD7/day.
pH	The acidity level of the water
Recipient	Lake, watercourse or inlet where the waste water is released. The groundwater can also be a recipient.
Resorption	Purification technique where the water is released into a shallow, overgrown ditch which is leakproof in the bottom. The purification consists of both the waste water evaporating into the air and organic matter attaching itself to the ditch and undergoing biodegradation.
SBR	Batchwise biological purification (originally from the English term Sequencing Batch Reactor) of the waste water, e.g. in a mini purification plant.
Grading curve	Results of texture analysis, also called diagram of particle size distribution.
Site layout	Site map or drawing of the plot and the planned system also showing e.g. potable (drinking) water wells, property boundaries and access roads.
Sludge	Solid particles and fat which have been separated from the waste water.
Septic tank	Tank in which solid particles and fat are separated from the waste water.
Holding tank	Tank which collects toilet water; should ideally only be connected to extremely low flush toilets.
Low flush toilet	Toilet that uses less water for flushing than normal toilets. Usually there is an economy flush (2 l) and a large flush (4 l). See also extremely low flush toilet.
Sewage	Collective name for all waste water in a household.
SS	Suspended solids, i.e. particles in the waste water.
Culvert	Very simple infiltration system where uncontrolled infiltration takes place, which leads to insufficient purification. Should only be used for surface water.
Foul water	Another name for toilet water.
Oxygen-consuming substances	Organic substances in waste water that consume oxygen when they are broken down and therefore can cause a lack of oxygen in watercourses.
Tensides	Chemical compounds (e.g. in washing-up and laundry detergents) that reduce the surface tension of water, allowing the water to enter e.g. textiles and stains and make them wet.

Texture analysis	Analysis carried out when a soil sample is graded in order to determine the particle size.
Feed pipe	Pipe that combines all waste water from a household
Three-chamber septic tank	Septic tank in which the water passes through three chambers.
DS	Dry substance, often indicated as a percentage of total weight or volume.
Two-chamber septic tank	Septic tank in which the water passes through two chambers.
Waste water with urine separation	Waste water from households with urine sorting in dual flush urine-sorting toilet, i.e. greywater and excrement + flushing water.
Urine sorting	Separation of urine from excrement in the toilet.
Vacuum toilet	Toilet in which water is not used to transport the waste but only to rinse the bowl; pressure in the pipes is created using vacuum pumps, ejectors or blowers.
Source of water supply	Watercourse (including groundwater) used as raw water for producing drinking water.
Excessive fertilisation	A supply of nutrients (mainly phosphorus and nitrogen) to a water-course which is too high, leading to problems such as algal bloom and oxygen deficit.

Uponor infiltration system

There are a number of different standard system solutions for Uponor's infiltration systems with gravity:

- Infiltration system with infiltration pipe(s)
- Sand filter trench with infiltration pipe(s)
- Integrated pump systems in septic tanks for infiltration and sand filter trenches
- Separate pump systems for infiltration and sand filter trenches
- Combined systems with a holding tank plus infiltration and sand filter trenches
- Infiltration system with infiltration modules
- Sand filter trench system with infiltration modules

In addition, Uponor can customise solutions based on plans or other requests.

Vital to have a properly functioning waste water treatment system

The most common setup tends to be individual drains laid in the plot itself or in directly adjacent land. In other words, the home owner will be the first one to suffer if the system stops working correctly. So it would be wise to ensure that the installation of the drain system is carried out properly. And check that the components have the correct function and the correct materials are used.

With this chapter we want to help to plan the waste water treatment system properly so that the work is done correctly. Get help from experts at the local council too. A problem-free waste water system not only gives a better local environment and greater peace of mind, but also lower costs due to less maintenance and a longer service life. What's more, it will maintain the value of the property if there is a properly functioning waste water treatment system.

It is reassuring to have a waste water treatment system that does not stand out or pollute the environment. The smell from an underperforming system is always a nasty reminder for those passing nearby, just as untreated water leaking out very quickly has a nasty effect on surrounding vegetation and pools of water. Waste water running over the ground can also easily reach sources of water supply and make drinking water insanitary, amongst other things. Groundwater and water in our bathing lakes are also sensitive to pollution and must therefore be protected from contaminated sewage.

Choose the right site

When planning an individual drainage system, it must take into account the size of the household, i.e. the waste water produced as well as the following:

- Ground conditions, terrain and soil types
- Groundwater conditions
- Topography and slope conditions
- Proximity to source of water supply
- Depth to the bedrock
- Topography of the bedrock
- Proximity to lake or watercourse
- Climate and the ground frost conditions
- Local regulations for the area
- Proximity to roads
- Distance to road and property boundaries

Someone from the local authority's environmental health department will come and inspect the intended site for the drainage system. A test pit is often required for a "grading analysis", i.e. measuring the size distribution of the soil particles. This analysis is also performed in order to study the groundwater conditions, which determine the the ability of the sewage to penetrate the surrounding layers of soil. The environmental health department will also advise on whether to opt for infiltration or a sand filter trench, dimensioning, etc.

General advice

Septic tanks, pipes and components

Uponor's infiltration systems contain all components required for sludge separation and infiltration or a sand filter trench. Loose parts, complementary septic tanks, non-woven fabric, etc. can also be ordered separately. Uponor also manufactures ground pipes, i.e. the pipes from the house's drainage system to the site of the septic tank as well as any gully traps and similar components.

Sand and crushed stone

The quality of the sand and crushed stone material used should follow the guidelines. The crushed stone must be washed to avoid the pipes and trench filling up with sludge. If this is not done, the service life of the system may be reduced. The material-separation course between the layers of the trench should consist of finer gravel (garden gravel). Non-woven fabric should be used on top of the trench in order to separate the backfill material (humus) from the crushed stone.

General advice

The drain pipes, septic tank and distribution chamber must be backfilled with sand or fine gravel. Tread down thoroughly. The incline must be levelled out carefully using a spirit level. The infiltration pipes in particular must have an incline as instructed. Make sure that the surface water is drained off above the infiltration and sand filter trench.

Note!
The house’s drains must be ventilated on the building’s roof, above the ridge. A vacuum valve must not be used.

Septic tanks should normally be emptied at least once a year. The infiltration pipe must be connected above ground level to ventilation cowls. This increases the purification capacity and allows for inspection and cleaning.

The purification process

Two-step purification

When an individual drainage system is in place, the sewage is treated in two stages. The first is always sludge separation. This is done in a tank called a septic tank or sludge separator, previously known as a three-chamber septic tank. The second is performed either in an infiltration trench or a sand filter trench.

Picture 1 Septic tank

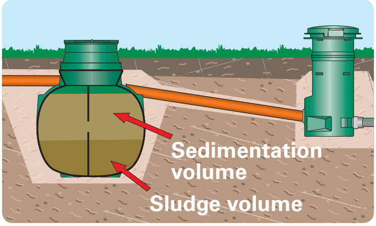
This is a tank in which the waste water passes through different compartments (chambers). In Uponor's septic tanks are positioned so that the flow of the water is as slow as possible so that the coarsest particles sink to the bottom in all of the chambers while fat and oil rise to the surface. The water is then transported away via a distribution chamber for purification in the infiltration trench or sand filter trench.

Picture 2 Infiltration trench

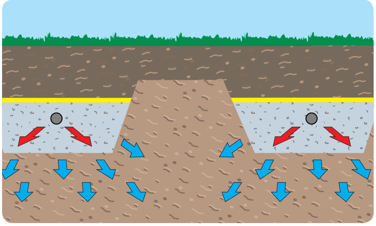
This is the commonest type of post-treatment step. The ground's ability to absorb sewage determines whether such a system can be used. In the infiltration trench the purification takes place in the bottom on the crushed stone layer and in the surrounding soil layers.

Picture 3 Sand filter trench

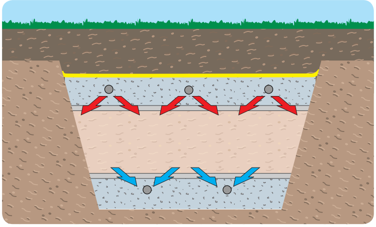
In those cases where the ground's absorption capacity is poor, e.g. due to high groundwater or layers of soil that are too dense such as clay, the water must be treated in a sand filter trench instead and then drained into the natural landscape. The sand filter trench consists of a sand bed in which the waste water is filtered and purified before being drained and transported away.



1. Septic tank

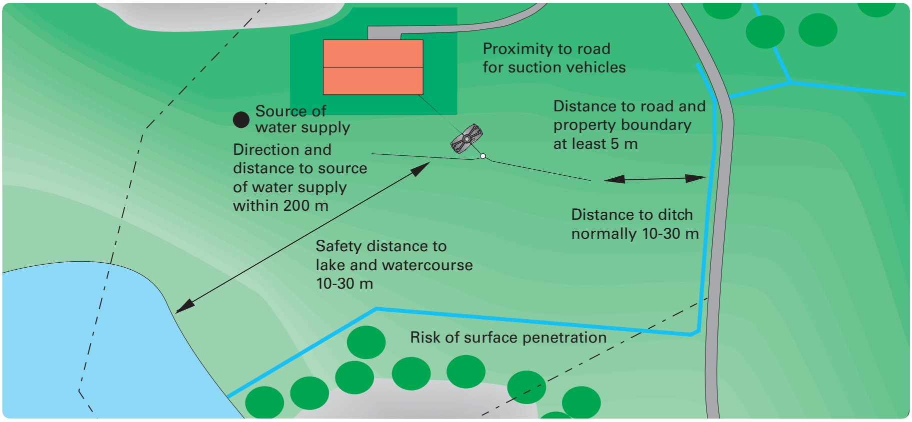


2. Infiltration trench



3. Sand filter trench

Site of waste water treatment system



Draw up a site plan

When planning a drainage system, a site plan must be drawn up first. This is used both for the application to the local environmental health department and for planning the work. There should also be a drawing of a cross-section in which the grade of crushed stone and sand are made clear as well as providing a drawing which shows how the system will be built (see next two-page spread).

Position on the plot

The septic tank must be located so that it can be accessed easily by the local authority's sludge-emptying trucks. The area required is only approx. 6 m^2. Uponor's septic tanks have a modern design which sees them installed horizontally, reducing the pit depth and volume.

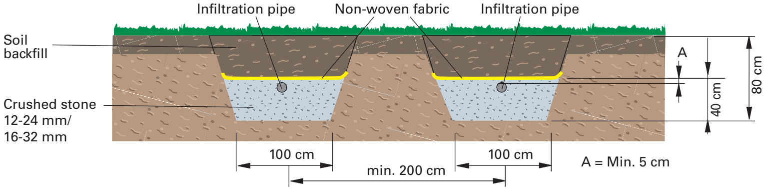
Uponor's distribution chamber requires little space and only a shallow depth and is easy to connect to distributor pipes in various directions according to requirements. In order to reduce clogging, exploit the topography so that the ground pipes from the house have an even incline; avoid unnecessary bends.

Uponor recommends that a gully trap be fitted to the drain pipe immediately outside the foundations. This facilitates the flushing of the pipe in the event of a blockage. The infiltration or sand filter trench for a typical 5-person household only takes up an area of approx. 30 m^2. The septic tank or trench should not be put somewhere that means vehicles pass by it as this results in greater ground pressure.

The illustration above provides examples of safety distances for, amongst other things, roads, boundaries, lakes and watercourses.

Infiltration trench

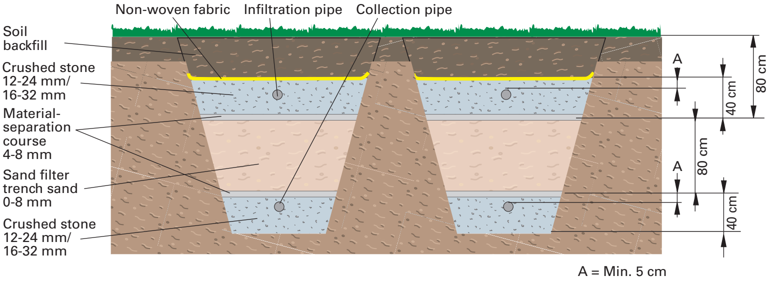
Separate passes



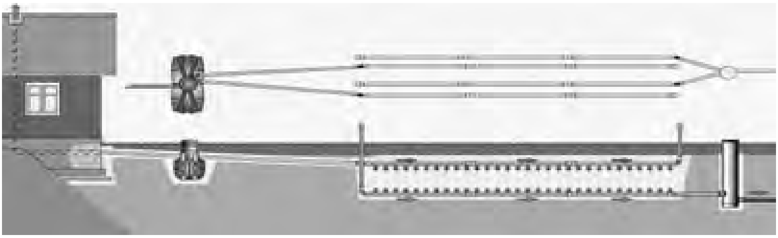
Sand filter trench

Separate passes

An infiltration or sand filter trench system can be laid as a standard field where the distance between the pipes is 1.5 m. Alternatively, they can be laid as separate ditches where the distance between the pipes is approx. 2 m.



How to install an Uponor septic tank 2 m^3



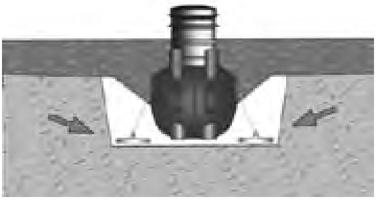
System for all waste water, Uponor septic tank.

Installing the septic tank

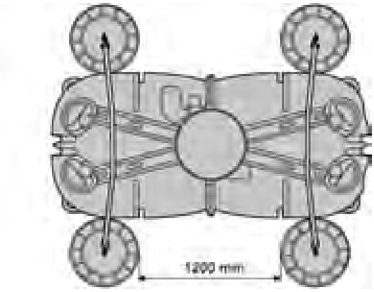
The pit for the septic tank is dimensioned so that anchor plates can be located next to the tank. The pit should be approx. 15 cm deeper than the bottom of the tank. Level out a layer of gravel or sand on the bottom of the pit and compact the bottom. Lower the septic tank into the pit using lifting ropes. Check that the level of the tank is correct in respect of incoming drain pipes and that the tank is balanced.

Anchoring

If the ground is marshy, the septic tank must be anchored using the Uponor Anchoring System. Place straps over the tank. Position the anchor plates level with the bottom of the tank and completely outside of the tank's bottom area. Pre-tension the straps. Place a layer of sand approx. 20 cm thick on the anchor plates. Tighten the straps so that they are taut.



Anchoring
the septic tank



Backfilling the pit

Backfill around the septic tank with stone-free sand and compact with a vibratory soil compactor in layers approx. 30 cm thick. Connect the 110 mm drain pipe from the dwelling (incline 1-2 cm/m) to the inlet spigot of the septic tank. The house's drains are always ventilated via the roof. Fit the outlet of the ventilation pipe a fair distance above the roof ridge and as far as possible away from the intake air inlet. Finally, fill the septic tank with water.

The distribution of water to the trench

Septic tanks are available in different types and sizes. The water distribution can take place either via a separate distribution chamber or using a control unit built into the septic tank. A trench which is fitted with a distribution chamber can hold 2-6 infiltration pipes while a trench for a septic tank with a built-in control unit can have two infiltration pipes. A distribution chamber allows you to position the septic tank and the trench wherever you want in relation to each other.

Built-in control unit

The septic tank is fitted with two 90 mm outlet spigots. Rubber sealing rings are placed on the spigots and then flexible bends. The flexible bends allow you to position the pipes in the correct direction. Connect the distributor pipes to the flexible bends.

Setting the built-in control units

The septic tank must be filled with water when the control units are set. There is a grey liner pipe inside the control units. Position each liner pipe's marked steps so that they are at the same level as the water. This means the water flows to the infiltration pipes are the same size. An even load across the entire trench extends the system's service life and improves the purification effect.

Insulation

Insulate the tank and other parts near the surface with insulating sheet if the frost tends to be deep.

Fill the septic tank with clean water

- immediately after installation
- after each emptying.

How to install an Uponor septic tank 4 m^3

Assembly

The length of connecting pipes and ventilation pipes is suitable for a gap of 600 mm between the tanks. If the tanks are located closer together, the pipes must be cut down accordingly.

All pipes must have a minimum projection of 100 mm inside the tank wall. The pre-drilled holes for the ventilation pipes are positioned so that it is possible to mount these pipes after the tanks have been assembled and the backfill has been done up to the level just underneath the pre-drilled holes for the ventilation pipes.

Step 1:

Position the inlet tank.
Connect the supply pipe to the inlet pipe on the tank. Grease the sealing ring and the end of the connecting pipe. Insert the connecting pipe into the inlet tank at least 200 mm.

Step 2:

Position the outlet tank, 600 mm from the inlet tank (or closer if preferred, see note above).
Grease the sealing ring and the end of the connecting pipe from the inlet tank. Route the connecting pipe back from the inlet tank so it enters the sealing ring on the middle tank. The pipe must have a projection of approx. 100 mm inside the tank walls.

Step 3:

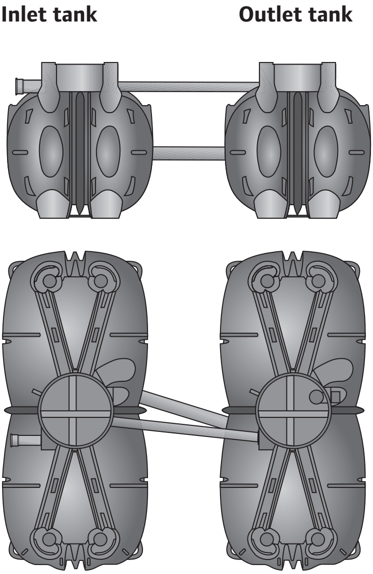
Backfilling and compaction can now take place to the level just underneath the holes for the ventilation pipes. Once the rubber rings and pipe ends have been greased, the ventilation pipes can be fitted in the same way as the connecting pipes.

Step 4:

Fit the rubber rings for the risers to the tanks and then position the risers.

Step 5:

Backfilling and compaction.



How to install an Uponor septic tank 6 m^3

Assembly

The length of connecting pipes and ventilation pipes is suitable for a gap of 600 mm between the tanks. If the tanks are located closer together, the pipes must be cut down accordingly.

All pipes must have a minimum projection of 100 mm inside the tank wall. The predrilled holes for the ventilation pipes are positioned so that it is possible to mount these pipes AFTER the tanks have been assembled and the backfill has been done up to the level just underneath the predrilled holes for the ventilation pipes.

Step 1:

Position the inlet tank.
Connect the supply pipe to the inlet pipe on the tank.
Grease the sealing ring and the end of the connecting pipe.
Insert the connecting pipe into the inlet tank at least 200 mm.

Step 2:

Position the middle tank, 600 mm from the inlet tank (or closer if preferred, see note above).
Grease the sealing ring and the end of the connecting pipe from the inlet tank.
Route the connecting pipe back from the inlet tank so it enters the sealing ring on the middle tank. The pipe must have a projection of approx. 100 mm inside the tank walls.

Step 3:

Position the outlet tank, 600 mm from the inlet tank (or closer if preferred, see note above).
Connect the connecting pipe as in step 2.

Step 4:

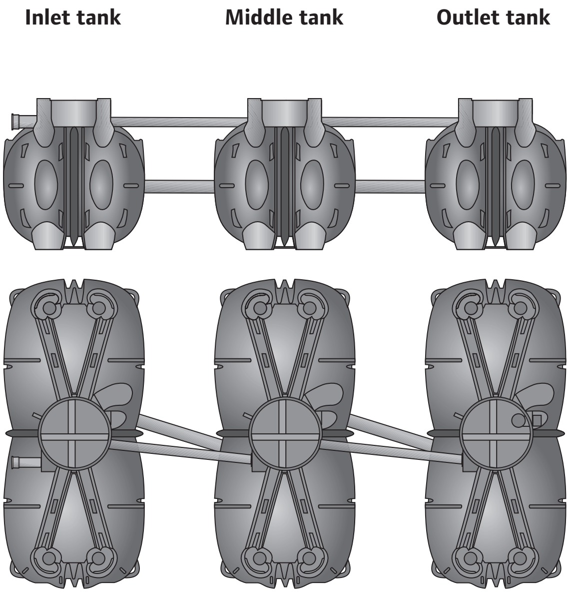
Backfilling and compaction can now take place to the level just underneath the holes for the ventilation pipes. Once the rubber rings and pipe ends have been greased, the ventilation pipes can be fitted in the same way as the connecting pipes.

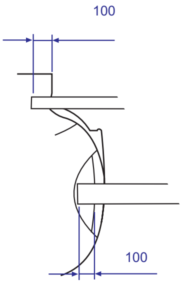
Step 4:

Fit the rubber rings for the risers to the tanks and then position the risers.

Step 5:

Backfilling and compaction.


Inlet tank
Middle tank
Outlet tank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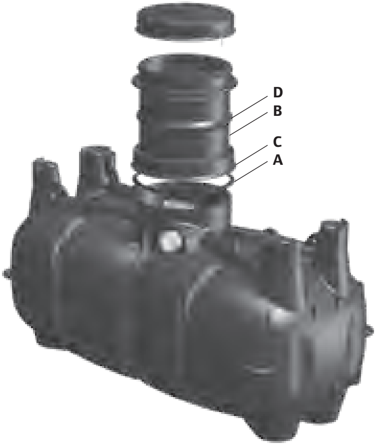
100

Risers – installation instructions



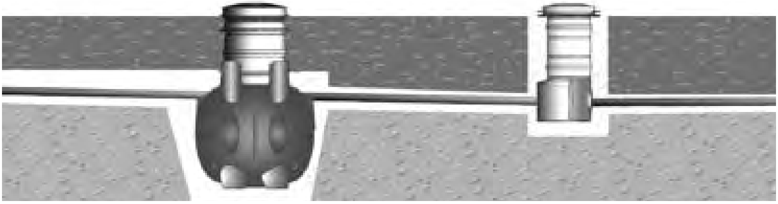
1. Fitting risers

Position the sealing ring (A) on the neck (B) of the tank. Grease the socket end (C) of the riser with Uponor lubricant. Place the riser (C) so that the text ”IN” on the riser pipe is facing the tank's inlet. Press down the riser so that the neck of the tank fits right into the riser's socket.

2. Extending risers

To extend a riser, cut it down to the ”Cut-off line” (D) in the middle of the riser. Use Uponor's 560 mm extension pipe and cut it down to a suitable length. Place a seal ring in the second groove in each end of the extension pipe (E). Fit the bottom section of the cut riser as per step 1. Fit the extension pipe and then the top section. Max. installation depth is 1 metre from invert inlet to ground level.

How to install an Uponor distribution chamber



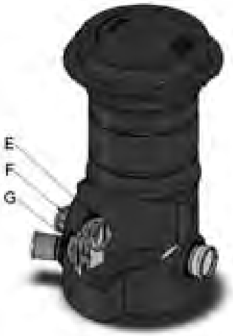
Distribution chamber

Place the distribution chamber in the pit on an even and well-compacted bottom. Check that the height of the drain is correct with regard to the septic tank and infiltration field. Fit the 110 mm drain pipe to the distribution chamber's socketed inlet spigot. Check that the inlet spigot elbow inside the distribution chamber is pointing straight down.

Flow adjuster

Fit a lip seal (E) to the hole of each outlet spigot. Mount the flow adjuster in the distribution chamber by pushing the connecting part (F) from outside into the connection. Position the adjusting plate (G) from inside the distribution chamber. It is important to set the flow adjusters so that an equal amount of water is brought into each distributor pipe. Check the setting once backfilling around the drain is complete by pouring water into the bottom of the distribution chamber and placing the adjusting plate so that the opening is at the same level as the water surface.

- close all regulating dampers
- fill with water above the regulating dampers
- open a regulating damper halfway
- allow the water to sink to a new level
- open the remaining regulating dampers to the water surface level



Extending or shortening the drain

In order to extend the distribution chamber, you saw off the top part of the neck of the drain (marked “Cut-off line”, A). Use a 400 mm extension pipe. Affix a rubber ring to both pipe ends (B) and push a pipe end on to the bottom part of the distribution chamber. Push the top part of the drain into the other pipe end. The extension pipe must be pushed in until it hits the “shoulders” at the bottom and top of the drain.

When shortening the drain, cut both above and below the necks (A and C) on the drain (marked “Cut-off line”). Use a 400 mm pipe when shortening. Position it as described above. The minimum length of the shortening pipe is 200 mm.

Fitting outlet spigots

The distribution chamber has two pre-drilled holes for outlet spigots. Additional outlet spigots can be fitted by drilling Ø 121 mm holes where there are drill marks (D). A maximum of six outlet spigots can be connected to the distribution chamber.

Distributor pipes

The distributor pipes connect the distribution chamber to the infiltration pipes. The length of these pipes is at least 1 metre and they are connected to the outlet spigots of the distribution chamber. A suitable incline is 0.5-1 cm/m. Position the pipes on a compacted sand bed and cover with sand or fine gravel. By fitting flexible bends to the end of the distributor pipes, it is possible to turn the infiltration pipes to face the correct direction.

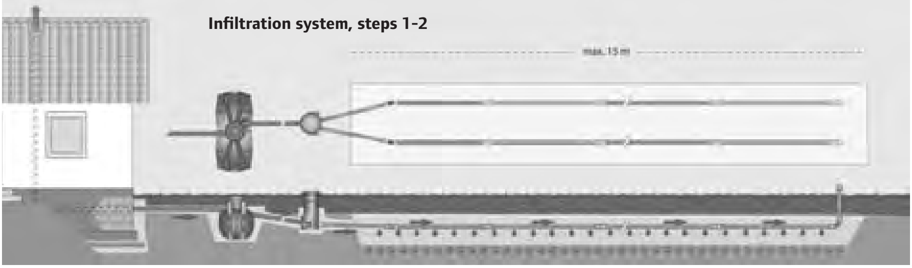
How to install an Uponor infiltration/sand filter trench system

1. Distribution layer

The distribution layer is a 30-40 cm thick layer of washed crushed stone with a particle size of 12-24 or 16-32 mm. The soil on the bottom of the pit must be horizontal and even, but not compacted – do not trample on it or use vehicles to flatten it. The pit can be common to several infiltration pipes or a separate ditch can be dug for each pipe. The separate ditches can be facing different directions from the distribution chamber.

2. Infiltration pipes

Level out the bottom of the pit in order to form a base for the layer of crushed stone. Position the infiltration pipes in the layer of crushed stone (green stripe facing upwards) so that the incline of the pipes is 0.5-1 cm/m and so that there is at least 30 cm of crushed stone under the pipes. At least 5 cm of crushed stone (8-16 or 12-24 mm) must cover the pipes. The total thickness of the layer of crushed stone is 30-40 cm. Fit flexible bends to the outlet ends of the pipes and then connect ventilation pipes (picture 9) to these which will stick out above the snow during the winter. The distance between the infiltration pipes in the same direction in separate ditches must be at least 2 metres. The distance between the pipes in a shared pit must be at least 1.5 metres. The max. length of every single Infiltration pipes is 15 metres. The pipes can be extended using connecting sockets. Finally, place the non-woven fibre on the crushed stone and backfill the pit.


Infiltration system, steps 1-2

Where necessary, the infiltration system can also be supplied with a separate built-in distribution chamber.
In this case the control units will be in the septic tank. See the instructions on the previous two-page spread.

3. Filtering layer

Water purification takes place in the layer between the crushed stone and the sand. Phosphorus binds to the sand and the organic substances are broken down in the bio layer. The filtering layer consists of sand with a particle size of 0-8 mm. The layer is approx. 85 cm thick. On top of the filtering layer is a distribution layer, non-woven fabric and backfill earth.

4. Collection layer

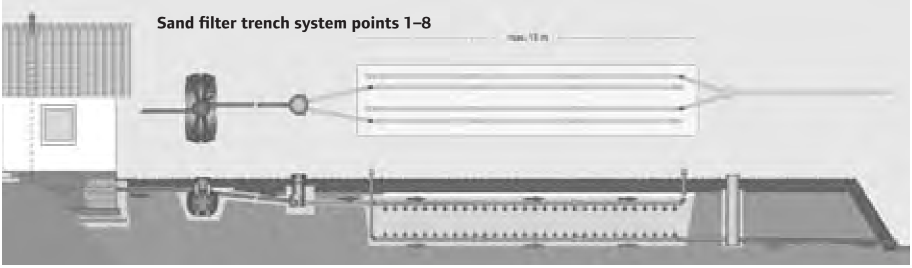
The collection layer is the bottom layer of the sand filter trench and its task is to collect the treated waste water which is then led to the outlet drain via collection pipes. Collection gravel with a particle size of 8-16 or 12-24 mm is used in the collection layer. The collection layer is approx. 30 cm thick.

5. Collection pipes

The collection pipes are drainage pipes through which the treated water is led away. Place the collection pipes in a collection layer with an incline of 0.5-1.0 cm/m. The pipe system continues on from the collection pipes after flexible bends in ventilation pipes for quite a distance above ground level. Fit ventilation cowls to the ventilation pipes as in picture 9.

6. Outlet well

The collection pipes are routed to an outlet well that also functions as a sampling well. The well is fitted with a socketed inlet spigot which the drain pipe can be connected to directly. Level out a base for the outlet well at a suitable height. Position the outlet well vertically and fill sand around the well. Large sand filter trenches can have several outlet wells.



Sand filter trench system points 1–8

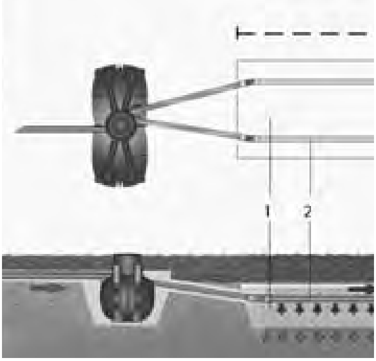
7. Outlet pipe

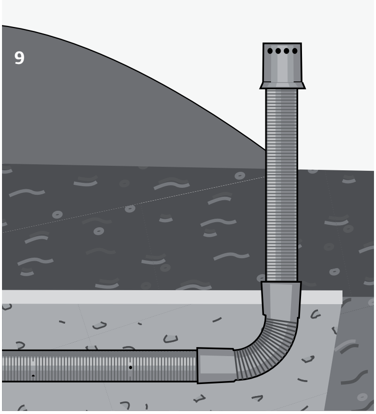
The treated water is transported from the collection drain through an outlet pipe (110 mm) to a suitable location in the terrain, e.g. an open ditch. If the differences in levels on the plot are not suitable for a sand filter trench system, the treated water must be pumped to the outlet location. The outlet pipe's opening should be fitted with a grille or a cover to stop small animals entering the system.

8. Leakproof sand filter trench

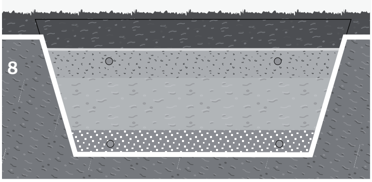
A leakproof sand filter trench has a rubber sheet laid on the bottom of the pit for the sand filter trench. The rubber sheet prevents waste water from penetrating the groundwater. See the installation instructions on the next page.

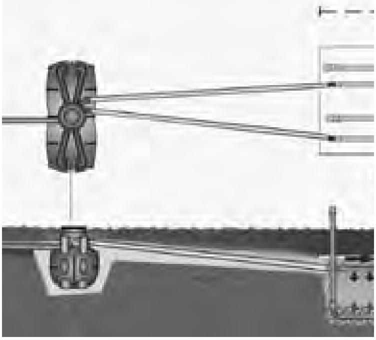
The rubber sheet is also placed over the ends of the pit. Ensure that the rubber sheet is not damaged when it is laid out. The edge must not be folded over the side of the sand filter trench as this will block the air supply to the microorganisms that are present in the soil.



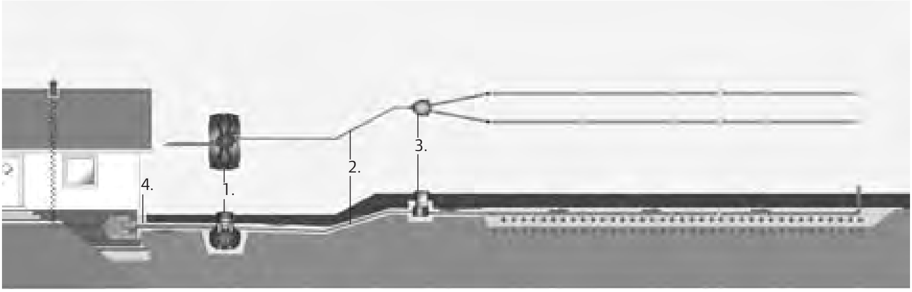


Ventilation pipes are fitted to the outlets of the infiltration pipes. Ventilation cowls are installed at the ends of the pipes.





How to install an integrated pump system from Uponor



Septic tank with pump chamber

Uponor's pump system includes a 2 m^3 septic tank, a pump chamber, a submersible pump and infiltration pipes designed for a 30 m^{2}infiltration trench. The septic tank's inlet spigot is 110 mm and the outlet spigot fits a 40 mm pressure pipe. Install the septic tank with pump chamber as described.

Installing the pump and pressure pipe

The pump is assembled at the factory. Fit the pump to the side of the pump chamber using a bracket which is attached to the outgoing pressure pipe. The pump must always be fitted in the bracket already attached. The pump system is supplied with a separate fixed-length pressure pipe which connects to the outlet spigot using a flexible pressure hose. Fit the separate pressure pipe to the pressure pipe from the pump with a quick-release coupling. The pipe must not be twisted. If the pressure pipe from the septic tank is cut to size, the guide tube from the pump must also be cut to size. Connect from the pump to a 40 mm outgoing pressure pipe fitted with a quick-release coupling.

Connecting to the distribution chamber

A reducer adapter with seals is provided for connecting up the pressure pipe. If possible, lay the pressure pipe with a infiltration pipe 1–2 metres in front of the distribution chamber. This slows down the incoming water flow.

Power cable

The pump's power cable is an MCMK 3 x 2.5 mm^2. Feed the power cable in from the wall of the riser pipe through a feed-through seal. Electrical installation may only be carried out by a qualified electrician. Any excess cable must be coiled up and not left loose in the well as this can obstruct the floating switch's movement.

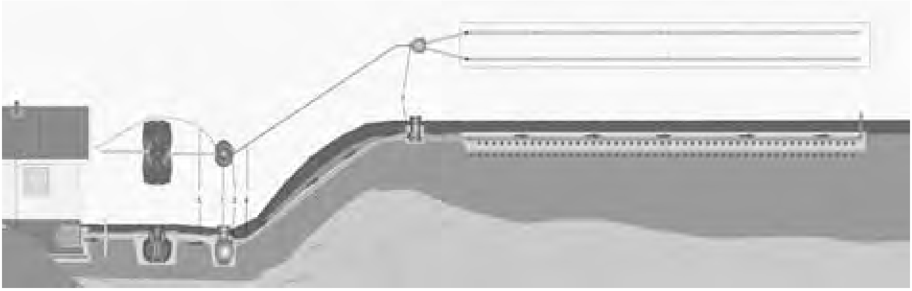
Replacing or maintaining the pump

Always install the pump in the original bracket after it has been taken away for repair or service or when replacing the pump. This ensures that the pump is always in the correct position in the pump chamber and also makes sure that the floating switch operates smoothly. Disassemble the quick-release coupling when the pump needs to be repaired or maintained and lift the pump out by holding on to the pressure pipe. The length of the floating switch must be 28 cm so that it can move freely in the pump chamber. The pump is equipped with a non-return valve. For ventilation to work, a separate ventilation pipe must be routed between the septic tank and the distribution chamber at a level above the surface of the liquid. Further information on the pump's functionality/maintenance is available in the pump supplier's installation instructions.

The power of the submersible pump included in the package is sufficient for a lifting height of 8 m with a flow rate of 2 l/s. The table shows the max. distance between the pump chamber and the distribution chamber at a lifting height of 2 metres when the accompanying pump is used.

Diameter of the pressure pipe	Distance between pump chamber and distribution chamber
40 mm	< 70 m
50 mm	< 200 m
63 mm	< 500 m

How to install a pump chamber from Uponor



The septic tank and infiltration or sand filter trench are installed as described in previous pages.

1. Pump chamber

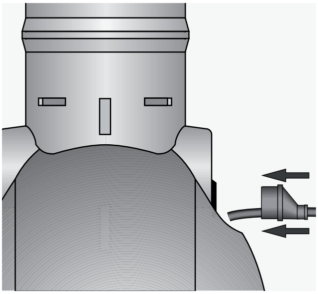
Install the pump chamber horizontally on a flat bed of sand. Anchor the drain with the Uponor Anchoring System if the ground is marshy or the groundwater is near the surface. The pump chambers are available in two sizes: 0.5 and 1.0 m^3. Select a submersible pump with a floating switch that has sufficient power for a flow rate of 1.0 l/s for the lifting height between the pump chamber and distribution chamber. The majority of pumps on the market are suitable for use with the well.

2. Reducer adapter 110/40

Fit a reducer adapter to both the pump chamber's outlet and the distribution chamber's inlet. Push the end of the Ø 30 mm pressure pipe through the adapter in both wells.

3. Pump

Suspend the pump (Picture 1) on the pump chamber's brackets slightly below the centre of the well. NB! The pump's outlet side must be equipped with a non-return valve which stops the water flowing backwards into the pressure pipe.



4. Polyethylene pipe (PE)

Install a PE pressure pipe between the pump chamber and the distribution chamber. Connect the pipe according to the pump manufacturer's instructions. For connecting the PE pressure pipe to both wells, two reducer adapters with seals are included in the delivery of the pump chamber. If possible, lay infiltration pipes (1–2 cm/m) at least 1–2 metres in front of the distribution chamber. This slows down the incoming water flow into the well.

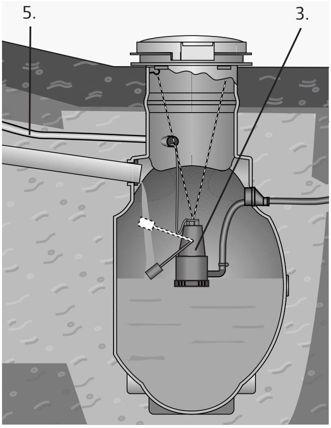
NB! Use a flexible pressure hose inside the well!

A PE pressure pipe is quite rigid and the connection to the pump can cause the pipe to become twisted at an angle. This is why it is best to use a flexible pressure hose for the part located inside the well, i.e. between the pump and the feed-through on the outlet side in the pump chamber. If the pump has a non-return valve, the ventilation must be routed with a separate ventilation pipe between the septic tank and the distribution chamber drain at a level above the surface of the liquid.

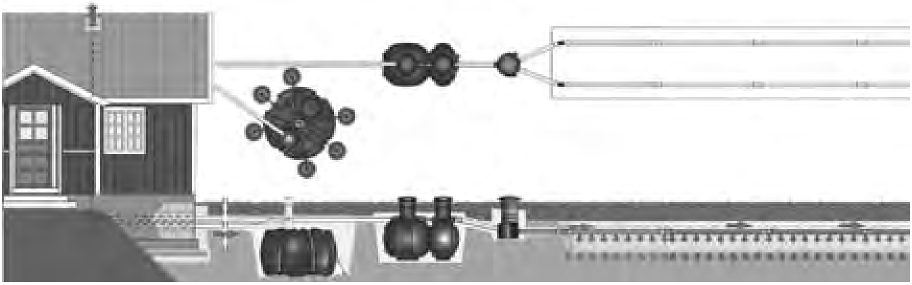
5. Power cable

Connect a power cable suitable for surface installations at the neck of the well. NB! Mark the location of the cable on your drawings. It is always safest to allow an electrician to carry out the electric connection.

(Picture 1) The submersible pump installed in the pump chamber.



How to install a holding tank



Installing a closed septic tank

The depth of the pit for the septic tank is dimensioned so that anchor plates have space at the bottom of the pit and the drain pipe which is routed to the tank can be covered with soil and be protected with insulation if required. The greatest permitted laying depth measured on top of the tank is 0.75 m. The max. groundwater table is 0.5 m from the bottom of the tank. Level out and compact the bottom of the pit until it is horizontal. Drain a pit in clay soil or bedrock so that any running surface water does not load the tank.

Anchoring

The Uponor Anchoring System can be used for anchoring. Three anchoring kits are required to anchor Uponor's holding tank. Each kit contains two anchor plates and a strap with tensioning device. Installation instructions are included with the anchoring system. Place the tank horizontally at the bottom of the pit. The minimum overflow is 450 mm when anchor plates are used.

Connecting the drain

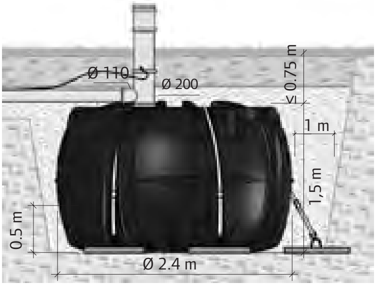
Remove the screen plug from the tank and fit the emptying pipe. Position the emptying pipe manifold towards the household drain and connect the drain pipe with a double socket. When backfilling the trench, ensure that the emptying pipe is vertical. Shorten the emptying pipe if required so that the pipe's screw cap protrudes slightly above the ground.

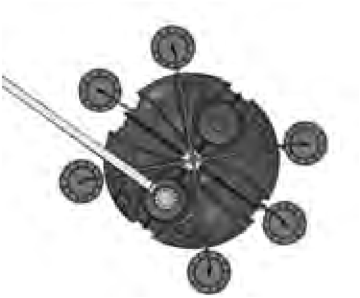
Backfilling the pit

The sand used to fill the shaft should not contain stones. Spread the filling sand evenly and compact with a vibratory soil compactor in layers approx. 20 cm thick. Compact the filling sand in the tank's central hole with water or an internal vibrator. If required, protect the tank and drain pipe against frost/ground frost with sheets of insulation.

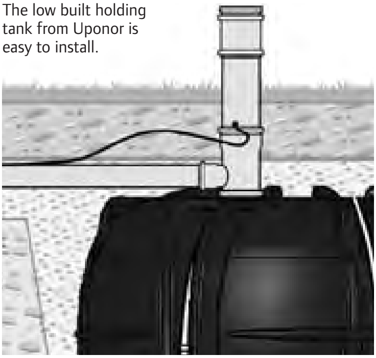
Alarm sensor

The conductive sensor comes with a cable 2 metres long and a feed-through for attaching it to the emptying pipe. In order for it to work, the sensor must be attached to the alarm device. Place the alarm indoors in a visible place in a dry area of the house. Drill a hole which the sleeve for the feed-through goes through (Ø 32 mm) directly underneath the screw cap in the emptying pipe's upper end for the sensor's feed-through. Thread the sensor cable through the sleeve and stretch it out so that the cable's marking tape is level with the upper edge of the drain connection. At this alarm level the tank holds extra water, approx. 200 litres. Change the alarm level by adjusting the sensor's level. A level change of 10 cm corresponds to a volume of approx. 300 litres. Cover the electric cable that is routed underground from the sensor to the house with a protective pipe. Connect the electric cable (e.g. MSK 2x0.75 mm^2) and the sensor cable using the supplied connector.





The low built holding tank from Uponor is easy to install.



Important to keep in mind

PLANNING

Location of the drainage system

- Locate the septic tank so that the sludge-emptying trucks can reach it easily.

- Consult with the local environmental health department about a particle size analysis. It will show the soil's capacity to absorb waste water. Examine the groundwater table and the flow direction above all with regard to the source of water supply.
- Place the system somewhere that no vehicles can drive over the top of it. The picture on page 4 shows examples of suitable safety distances to property boundaries, watercourses and sources of water supply.
- On a slope, lay the infiltration pipes in directions according to the contours, not down a hill.
- Ensure that surface water drains off from a sand filter trench system or an infiltration system.
- Use non-woven fabric to prevent fine material from clogging the layer of crushed stone.

Dimensioning

- The size of an infiltration/sand filter trench that a typical 5-person household needs is only approx. 30 m^2. Check that the area is large enough.
- A pump chamber which is 0.5 m^3 is sufficient for a single family. A well of 1 m^3 is designed to serve 2–3 families.

- Only waste water from toilets is generally transported to a closed septic tank.

Ventilation

- The ventilation of the house's drains is routed to the roof. Install the ventilation pipe's outlet a fair distance above the ridge of the roof and as far away as possible from the supply air's intake. It is not permitted to use a vacuum valve.
- The ends of the infiltration pipes are routed to ground level and equipped with ventilation cowls. They let the air in to the purification process as well as making it possible to inspect and maintain the pipe system.
- The ventilation of the drain pipe which leads to the closed septic tank is also routed to the house's ventilation.

Drainage system

- Lay the drain pipe underground from the dwelling with as even an incline as as possible without unnecessary bends. If the waste pipe is long, it should be fitted with a flushing pipe or gully trap.
- Check the incline of the pipes by measuring using a levelling instrument, a spirit level or a water hose for example. The incline of the infiltration pipes in particular must follow the instructions carefully.

Insulation

- Consider the climate and likelihood of the soil freezing when determining the depth of the installation. Avoid freezing and frost damage by using insulation if necessary.

- The protective blanket of snow during winter must not be removed from tanks or pipes.

Anchoring

- Anchor both the septic tank and pump chamber with the Uponor Anchoring System if the ground is marshy.

- A septic tank must always be anchored.

- Drain the pit to avoid the pressure which the water in the pit may cause.

Electricity

- Mark the power cable's routing on the drawings.
- Cover the electric cable from the sensor to the house with a protective pipe.

CONSTRUCTION WORK

- Use material according to the instructions for the crushed stone and filter layers.
- Place sand or fine gravel around drain pipes in the ground, the septic tank and mainfold drain. Compact well with a vibrator.
- Level out the bottom of the infiltration pit horizontally so that the water is infiltrated straight down.

Pump system

- The submersible pump must be equipped with a non-return valve which prevents water flowing backwards when the pump is not in use.
- Monitor the functionality of the pump regularly. If the pump does not work the drain will soon cease to function.
- If the pump is only in use during the summer, take it out of the well for the winter and let the water drain from the pressure pipe.
- Select a large enough pump chamber so that there is sufficient volume during a power cut or pump disturbances.
- The pump must be equipped with a floating switch which starts and stops the pump automatically.

Maintenance

- The septic tank is usually emptied at least once a year. If only greywater runs into the septic tank, emptying once a year is sufficient.
- After emptying, the septic tank is immediately filled with clean water.
- An alarm system facilitates monitoring of how often a closed septic tank needs to be emptied.
- The alarm sensor should be lifted out of the tank when emptying and rinsing are in progress.

Contact information

Make sure you take the time to add the names of contacts for the drainage system to your list of contacts. This will make things easier if you have questions etc. in future.

Inspection and maintenance instructions

Septic tank

Septic tanks for greywater + toilet water must normally be emptied at least once a year. Septic tanks for greywater must also be emptied once a year but exceptions are more common here as it depends on the design sludge storage volume in the greywater septic tank.

IMPORTANT!

When emptying the sludge, the chambers must be emptied in order: the first and then the second chamber. This is to avoid any possible movement of sludge between the chambers. After emptying, the septic tank must be filled with water in reverse order: second and finally the first chamber.

At least once a year, ideally in conjunction with sludge emptying, is it useful to visually inspect the septic tank. Check the cover and lock but also, where possible, inside the septic tank for any fouling. Rinse out as required.

Distribution chamber

The distribution chamber should be inspected once a year. Check the cover and lock. Fouling can occur in the distribution chamber. A small amount of fouling may be rinsed away. However with large quantities, you should try to collect most of it up and then rinse the drain out due to the risk of blockage. This is an indication that the distribution chamber needs to be inspected at shorter intervals.

Pump and pump chamber

The pump must be inspected and maintained according to the pump manufacturer's instructions. Check the non-return valve is working properly to avoid “backflow” into the system. It is important to check the cover and lock of the pump chamber and the connections between the pump and PEM pipes. If there is any doubt about the functionality/condition of the electrical connection, contact an electrician.

Infiltration pipes/collection pipes

These pipes can be inspected though the ventilation pipes. Insert a stick/rod into the pipes to check whether or not water is collecting there. If water is present in the pipes, then the trench is not functioning as it should.

A high water level may be due to a temporary or constant change in groundwater conditions. These must be monitored until the water subsides. If there is still water in the pipe when the water level should normally be low, the system must be drained. Check that the ventilation pipes and the ventilation cowls are not overgrown.

Outlet well

Check that the cover and lock are intact. Is the water in this well cloudy or discoloured and smelly? If it is, the sand filter trench is not functioning as it should and action is required.

Uponor infiltration module system

There are a number of different standard system solutions for Uponor's infiltration module system with gravity:

- Integrated pump systems in septic tanks for infiltration and sand filter trenches
- Separate pump systems for infiltration and sand filter trenches
- Infiltration installation with infiltration modules
- Sand filter trench system with infiltration modules

In addition, Uponor can customise solutions based on plans or other requests.

Uponor infiltration modules provide a good biological environment.

General

The infiltration modules are used instead of the spraying layer in a conventional infiltration or sand filter trench. The performance of the infiltration modules makes it possible for the area of the trench to be reduced, which is an advantage for many reasons, including if the plot space is limited.

The infiltration modules are used as a second step when treating sewage from an individual property. As a first step, the sewage is treated in Uponor's septic tank, where it is separated from solid particles when, during a slow and laminar flow, it passes through the three chambers.

After the septic tank, the flow is divided up in the distribution chamber between the infiltration pipes, which in turn distribute the sewage across the infiltration modules.

Due to the mesh pipes in the infiltration module being constructed from a number of spirally wound threads, a large surface is created for the bioskin to grow on.

The thin mesh also allows the air to pass freely through the module, leading to increased oxygenation. The total skin from the mesh pipes amounts to 16 m^2 per linear metre of the sand filter trench, which provides a good margin for the bioskin to break down the remaining pollutants in the waste water.

The thin mesh on the mesh pipes also reduces the risk of clogging if sludge movement should occur. The infiltration modules are separated from surrounding backfill deposits by a geotextile which is laid over infiltration pipes and filter modules.

The depth of the groundwater table often requires the infiltration trench to be laid fairly shallowly. This means that any loads of earth are not distributed over the ground but load the filter modules fairly directly. This means that the area above the filter modules must be shielded from all forms of traffic as well as point loads.

Planning

Planning and approval before installation of the infiltration module takes place in the same way as for conventional infiltration. An application must be made to the local environmental health department.

A site plan of the area around the system should be available as planning documentation.

The parameters that play a decisive role in the performance of the installation are:

- the quality of materials in the ground that will discharge the treated water
- the groundwater table where the system is to be installed
- safety distance from lakes, watercourses and streams
- the incline of the site
- distance to source of water supply
- distance to road and property boundary
- local regulations

How to install an infiltration module system

A. Sewer pipes

Route the sewer pipes from the house to the septic tank and lay them firmly on a compacted bed of sand. Inclination at least 1–2 cm/m. Gully traps must be placed on long pipework >25 m.

B. Septic tank

The septic tank must be balanced on the sand filter trench. If it is placed on marshy soil it must be anchored. Adjust the neck of the inspection cover to the relevant laying depth.

Max. laying depth is 1.5 m from the centre of the tank to ground level

In a septic tank with integrated distribution, the control units are located on the outlet. You can adjust these so that an even distribution of water is obtained in the infiltration pipes.

C. Distribution chamber

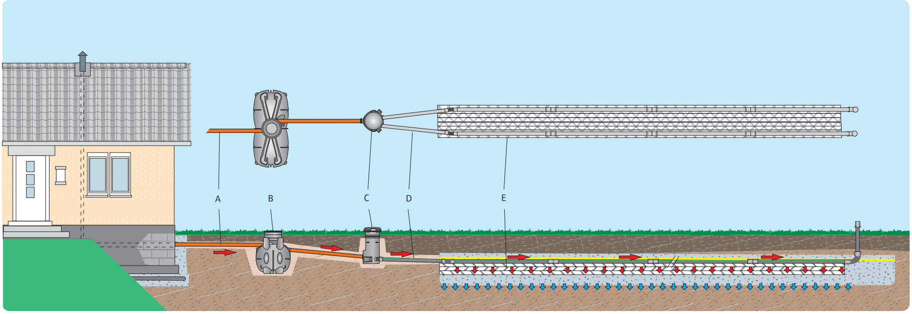
Balance the drain on the sand bed. There are control units in the distribution chamber which can be adjusted so that an exact distribution of water is obtained. An even distribution over the entire bed extends the service life and the degree of treatment. Damping in the bottom prevents uneven distribution in the event of a surge.

D. Distribution pipes

Lay the distributor pipes with an incline of 0.5–1 cm/m between the distribution chamber and the infiltration module trench.

E. Infiltration module

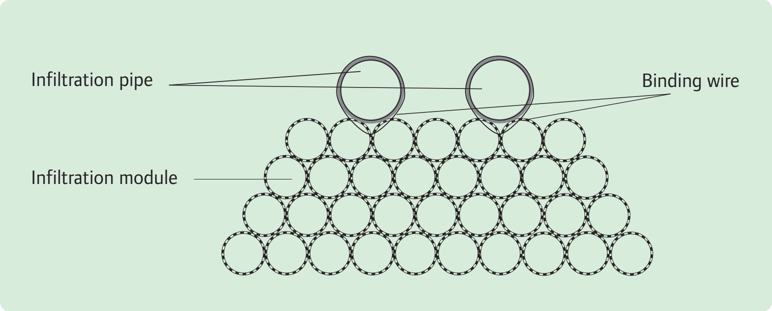
Place the infiltration modules in a row after each other in the pit. The incline must be 0.5–1 cm/m lengthwise. They must be



balanced laterally. Connect the two spray pipe passes to the distributor pipes and place them in the "valley" between two mesh pipes as shown in the picture.

Notice that the green stripe on the pipes must be turned upwards (and the outlet holes thus straight down) and the incline of the pipes must be 0.5–1 cm/m. Fix the infiltration pipes by tying them securely to the mesh pipes as shown in the picture.

Arrange the ventilation pipes above ground at the end of the infiltration pipes using flexible bends and part of the distributor pipes. Finish by fitting ventilation cowls which protect the pipes above ground.



Dimensioning

The dimensioning of a waste water system for an individual drainage system is based on the standard flow where a household (5 people) releases 600 litres of greywater a day (greywater = bathwater, washing-up water, laundry water), provided that WC water (toilet water) is NOT connected to the system. If this is the case, an additional 250 litres of water a day is added.

Size of the household	**Number of infiltration modules**
600 litres of greywater/day Bathwater, washing-up water and laundry water	6 modules
850 litres of toilet water and greywater/day Bathwater, washing-up water, laundry water and toilet	8 modules

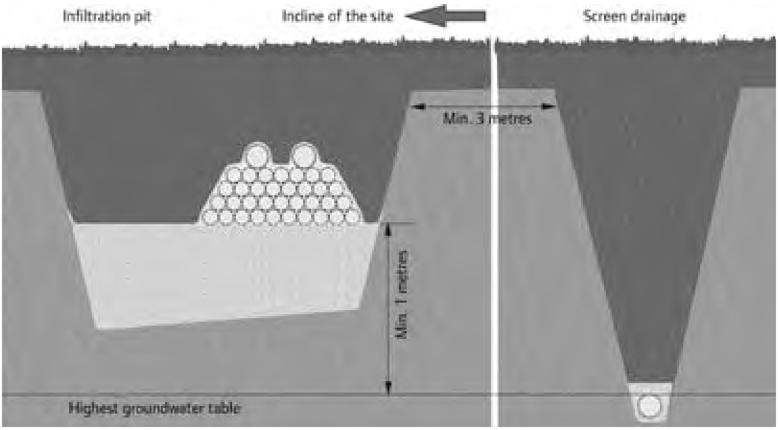
Positioning with regard to the groundwater table

In order to ensure the effectiveness of the purification, the vertical distance between the infiltration surface and the highest groundwater table must exceed 1 metre.

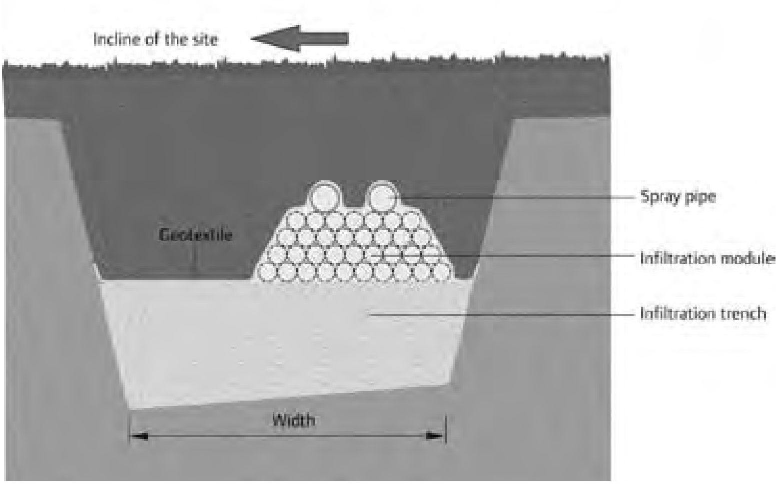
It may be necessary to install screen drainage piping upstream from the infiltration system in order to lower the water table when there are high groundwater flows.

The piping must be laid at a depth that corresponds to the highest acceptable groundwater table.

Waste Water Treatment



Infiltration trench – size and design



Length of the pit

- for a greywater system – 8 metres
- for a toilet water and greywater system
- 10 metres

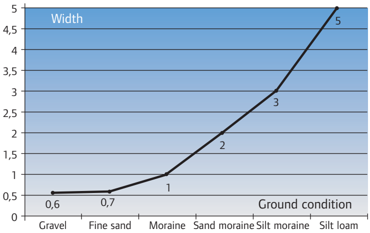
Width of the pit

- min. 0.6 metres, depending on the soil's permeability

In order to divert the treated water to the surrounding soil, the surface area and permeability of the material beneath the modules need to be sufficient. Underneath the modules, place a 30–40 cm bed of sand filter trench sand (particle size 0–8 mm) at the bottom of the pit. The width of this bed is determined by the type of soil already on the site.

The approving authority will often require a particle size or "grading" analysis of the surrounding soil in order to determine the soil particles' size distribution and with that, the ground's capacity to allow the treated water to pass through it.

Width of the pit (metres)



Sand filter trench – size and design

Number of sand filter trench modules:

- for a greywater system – 6 modules, giving a total module length of 7.2 m.
- for a greywater and toilet water system – 8 modules, giving a total module length of 9.6 m.

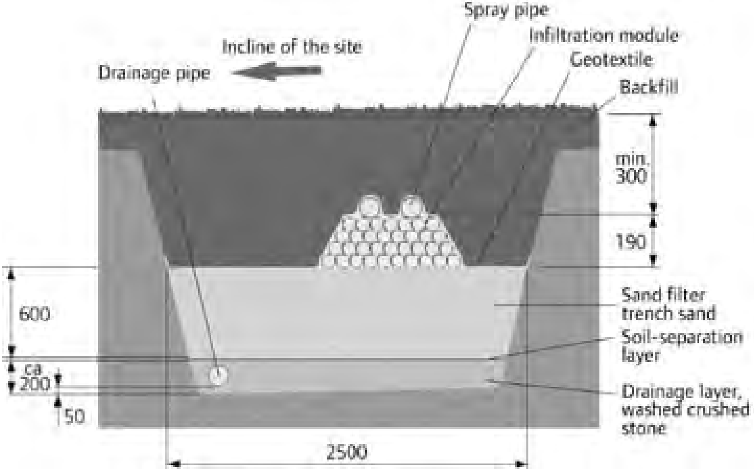
Put a layer (approx. 200 mm) of washed crushed stone, size 12–24/16–32, at the bottom of the pit to collect the treated water. On top of this layer, a material-separation course is laid to separate it from the sand filter trench sand above.

Use drain pipes to form a collection pipe, which should be laid approx. 50 mm from the bottom of the pit and with an incline of approx. 5–10 mm/m.

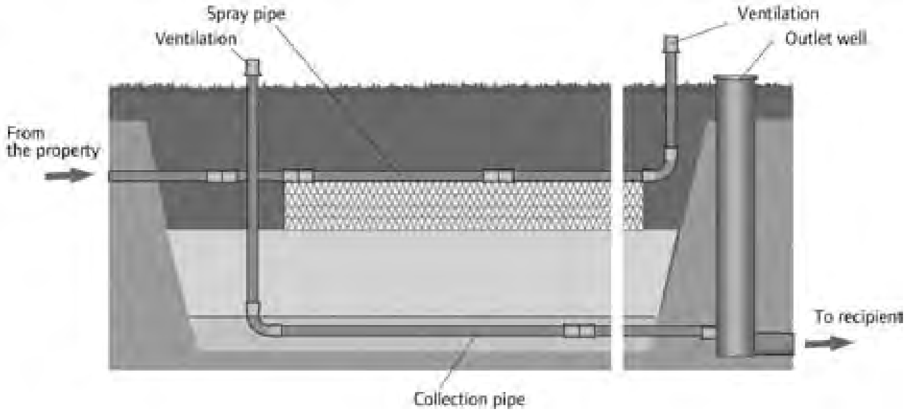
Treatment of the waste water takes place in the modules and in the sand filter trench sand. The depth and width of this trench should be 1,3 and 2.5 metres respectively

Place non-woven fibre over the modules and sand filter trench sand in order to separate these.

CROSS SECTION



LONGITUDINAL SECTION



Parallel sand filter trench – size and design

Number of modules for parallel sand filter trench:

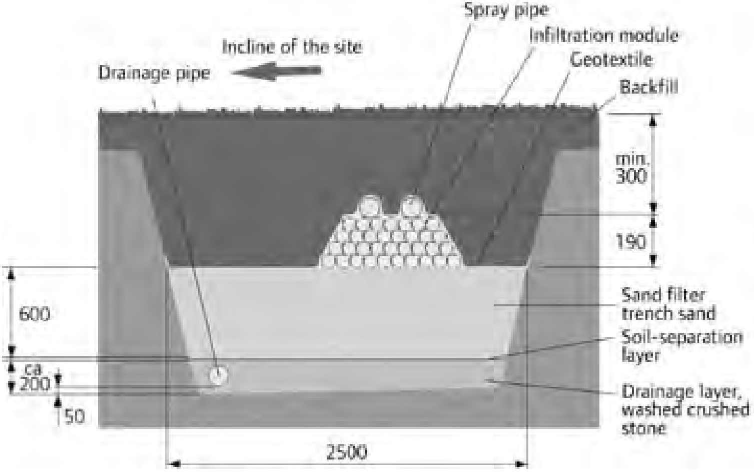
- for a greywater system – 6 modules, giving a total module length of 7.2 m.
- for a greywater and toilet water system – 8 modules, giving a total module length of 9.6 m.

Put a layer of washed crushed stone, grain size 12–24/16–32, at the bottom of the pit to collect the treated water. Place non-woven fibre over this layer in order to separate it from the sand filter trench sand above.

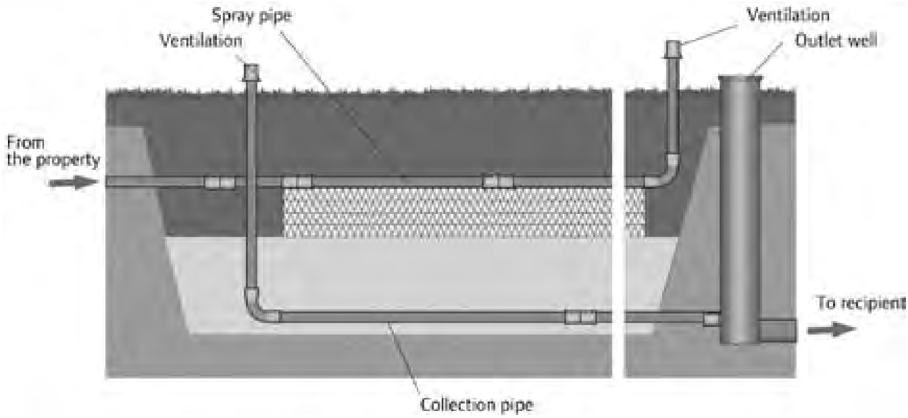
Use drain pipes to form a collection pipe, which should be laid approx. 50 mm from the bottom of the pit and with an incline of approx. 5–10 mm/m. The drainage piping should be surrounded by a minimum of 50 mm crushed stone. Treatment of the waste water takes place in the modules and in the sand filter trench sand. The depth and width of this trench should be 0.9 and 5 metres respectively

Place non-woven fibre over the modules and sand filter trench sand in order to separate these from the backfill material.

CROSS SECTION



LONGITUDINAL SECTION



Self-monitoring – inspection and maintenance

Septic tank

Septic tanks for greywater and toilet water (bathwater, washing-up water, laundry water and toilet) must normally be emptied at least once a year. Septic tanks for greywater must also be emptied once a year but exceptions are more common here as it depends on the design sludge storage volume in the greywater septic tank.

During sludge emptying, the chambers must be emptied in order: the first and then the second chamber. This is to avoid any possible movement of sludge between the chambers.

After emptying, the septic tank must be filled with water in reverse order: second and finally the first chamber. At least once a year, ideally in conjunction with sludge emptying, is it useful to visually inspect the septic tank. Check the cover and lock but also, where possible, inside the septic tank for any fouling.

Distribution chamber

The distribution chamber should be inspected once a year. Check the cover and lock. Fouling can occur in the distribution chamber drain. A small amount of fouling may be rinsed away. However with larger quantities, you should try to collect most of it up and then rinse the drain out due to the risk of blockage. This is an indication that the distribution chamber needs to be inspected at shorter intervals.

Pump and pump chamber

The pump must be inspected and maintained according to the pump manufacturer's instructions. Check the non-return valve is working properly to avoid “backflow” into the system. It is important to check the cover and lock of the pump chamber and the connections between the pump and PEM pipes. If there is any doubt about the functionality/condition of the electrical connection, contact an electrician.

Infiltration pipes/collection pipes

These pipes can be inspected though the ventilation pipes. Insert a stick/rod into the pipes to check whether or not water is collecting there. If water is present in the pipes, then the trench is not functioning as it should. The high water may be due to temporarily high groundwater conditions or temporary overloading. If there is still water in the pipe when the water level should normally be low, the system must be drained. Check that the ventilation pipes and the ventilation cowls are not overgrown.

Outlet well

Check that the cover and lock are intact. Is the water in this well cloudy or discoloured and smelly? If it is, your sand filter trench is not functioning as it should and action is required.

Important to keep in mind

- If the system is installed in areas that have plenty of snow, the ventilation pipes must reach a height above ground that means the ventilation also functions during the winter.

- Roll out the geotextile over the infiltration module layer as well as laterally over the trench of sand filter trench sand.

- Backfilling uses existing masses of earth. Stones that are the size of a fist and larger must be removed in order to avoid damaging piping and modules but also due to the stones' poor frost insulating ability. Backfill carefully so that no infiltration pipes or modules are displaced.

- With a gravitational infiltration system, the infiltration pipes are normally located 60–80 cm below ground, but in some cases the laying depth can naturally be shallower. However, the backfill layer should not be less than 40 cm to ensure sufficient protection against freezing. If the system is installed in areas with colder climates and/or is used sporadically during the period from October to March, then the minimum laying depth must be increased or frost protection measures taken, e.g. soil resistant grade insulation sheets.

- As mentioned in the introduction, the filter modules have a limited rigidity against loads of earth. If required, the area above the filter modules must be shielded from all forms of traffic as well as from point loads.

- The infiltration pipes/collection pipes can be inspected through the ventilation pipes. Insert a stick/rod into the pipes to check whether or not water is collecting in there. If water is present in the pipes, then the trench is not functioning as it should.

- Note that the house's drains must be ventilated on the building's roof, above the ridge. A vacuum valve must not be used.

Uponor anchoring system installation

Uponor's anchoring system has been produced on the strength of calculations and practical field testing of the tanks described in these instructions. Uponor is not liable for the product and its performance if the product is used in a different way or with other products than those described in these instructions.

Contents

The anchoring system contains:
- 2 x anchor plates Ø 560 mm
- 1 x anchoring strap with loops
- 1 x anchoring strap with latch type fastener

NB! The number of anchoring systems required for the different tanks are indicated in the drawings and tables on pages 303–304.

Anchor plate installation

- Thread the strap's lower loop through the holes in the anchor plate. Ensure that the strap is not twisted (Fig. 1).
- Thread the lower loop through the loop in the middle of the strap (Fig. 2).
- Pull the strap reel through the loop (Fig. 3).
- Tighten the strap so that a knot occurs (Fig. 4 + Fig. 5).

NB! Uponor's "U" symbol on the anchor plate must be facing upwards during installation, i.e. on the same side as the anchoring strap's knot.

Anchoring the tank

- Pull the anchoring strap over the tank. Pictures 7–10 show the position of the strap on different tanks.
- The anchor plates are installed at the same level as the bottom of the tank. This means the size of the dug pit must take this into account. Drawings 7–10 for the different tanks provide information on the space requirements.
- After the tank has been fixed in place in the lift pit, position the anchor plates according to the drawing for each tank (Fig. 7-10). The plates must be installed at the same level as the bottom of the tank. Adjust the plate so that the strap does not become twisted.

NB! It is important that the plates are positioned far enough from the tank walls that they are beyond the plumb line from the tank wall (Fig. 6).

- Stretch the strap with the latch type fastener; only stretch until there is no more slack in the strap.
- Backfill and compact to a level of approx. 20 cm above the anchor plates.
- Stretch the anchor straps but not so much that they are lifted up from the ground.
- Backfill and compact in accordance with the tank installation instructions.

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6

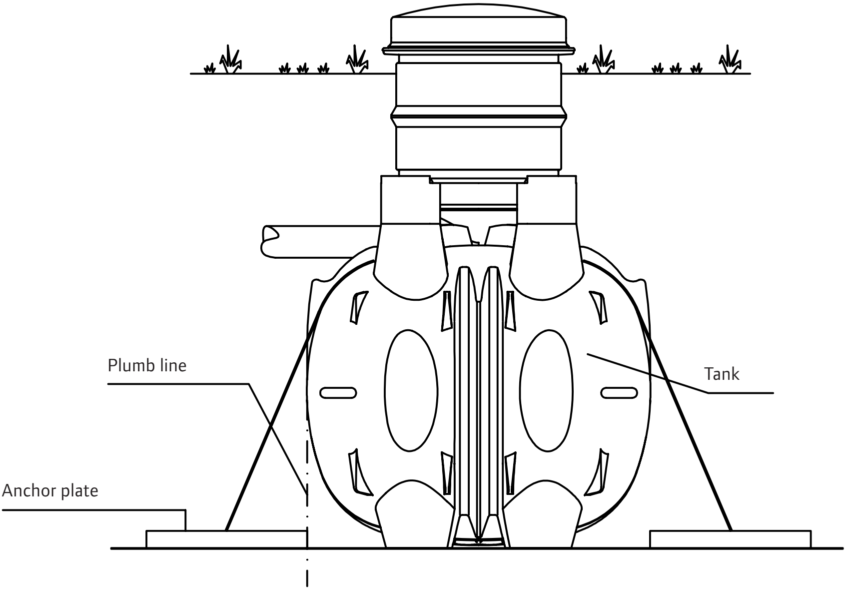


Fig. 7

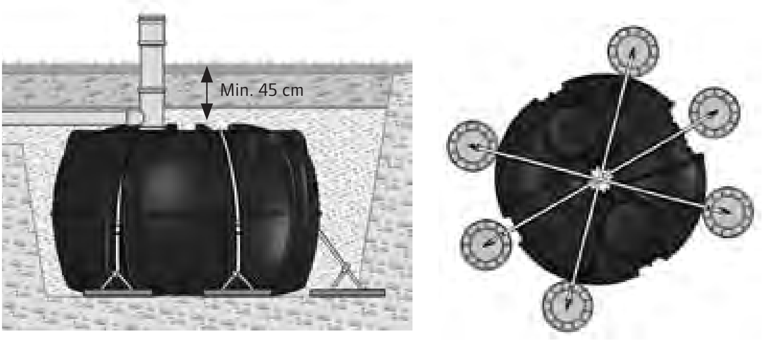
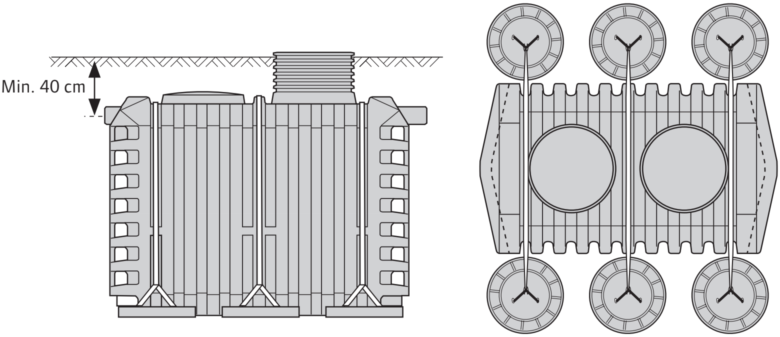


Fig. 8



A (m^3)	B (m)	C
1,5	1,28	2
2,0	1,60	2
3,0	2,08	3
3,5	2,40	4
5,0	3,20	5

A = The tank's volume

B = The tank's length

C = Number of anchoring systems

Fig. 9

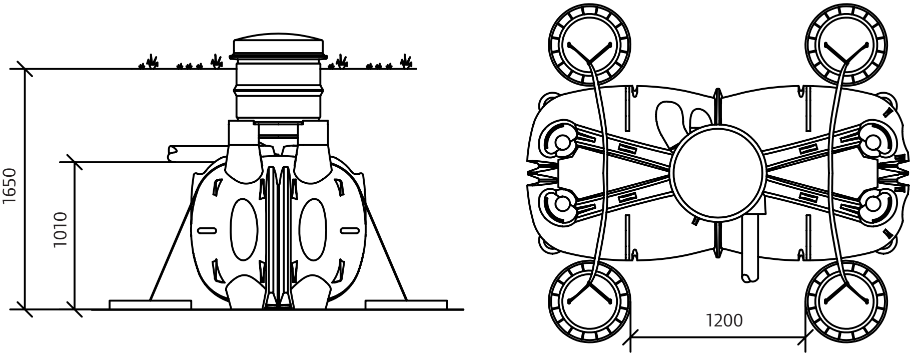
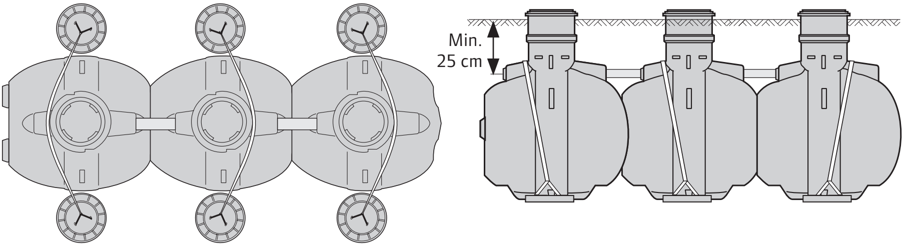


Fig. 10



A (m^3)	B (m)	C
0,5	0,80	1
1,0	1,35	1
1,5	2,10	2
2,0	2,75	2
3,0	3,90	3
4,0	5,20	4

A = The tank's volume

B = The tank's length

C = Number of anchoring systems

Uponor Holding Tank 5.3 m^3

An Uponor Holding Tank is used when it is not possible to discharge the sewage to a general sewage system or to set up an infiltration system.

Due to its limited capacity, the tank can only collect sewage. The amount of sewage collected should be as little as possible. This can be accomplished by using low flush toilets and fittings. Make sure that the pipes are routed right up to the tank if low flush toilets are used. Rainwater must be dealt with separately.

The tank is emptied by a sludge-emptying truck which transports sewage to the treatment plant. The Uponor Holding Tank is rotational moulded and manufactured from polyethylene (PE), which allows the tank to withstand the substances that are normally present in an average household. The service life of the tank is more than 50 years with normal use.

Product data:

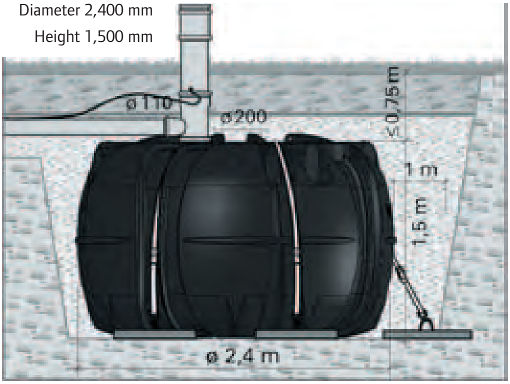
- Storage capacity 5.3 m^3
- Diameter 2,400 mm
- Height 1,500 mm
- Weight 230 kg.

The Holding Tank is supplied with a Ø 200 mm riser with Ø 110 mm inlet. A mains-powered water supply and sewage alarm is provided.

Approvals

The tank is manufactured according to Uponor's specifications for rotational-moulded polyethylene tanks. The tank is Sitac approved.

Weight 230 kg
Diameter 2,400 mm
Height 1,500 mm



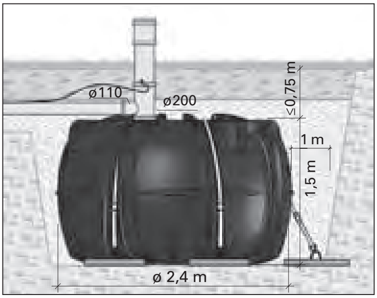
The holding tank has a Ø 200 mm riser with a Ø 110 mm connection pipe (max. groundwater table is 0.5 m under the bottom of the tank). The tank must not be exposed to traffic.*

Pit

The pit for the holding tank should be so deep that, if required, there is space to install Uponor's anchor plates or a concrete base underneath the tank. Furthermore, there must be space for the house's drain pipes and if there is the risk of deep ground frost, there must also be space to insulate the drains. The maximum laying depth is 0.75 m above the top of the tank and the soil at the bottom of the pit must be level and compacted. The holding tank can be lifted into the pit using a rope on top of the tank or with slings and rings inside the tank. If the tank is installed on clay or bedrock, the pit must be drained in order to prevent water collecting which could expose the tank to pressure. Maximum groundwater table is 0.5 m from the bottom of the tank.

Anchoring

The holding tank is anchored with Uponor's anchoring system. Three Uponor anchoring system kits are required to anchor the tank. Each kit contains two anchor plates and one strap. The strap's position has been marked with anchor symbols ( ) on the tank. Installation instructions are supplied with the anchoring system. Place the tank horizontally at the bottom of the pit.



Minimum overfill: 0.45 m if anchor plates are used. Maximum groundwater table: 0.5 m from the bottom of the tank.

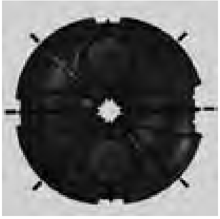
Anchoring in a concrete base

The tank may also be anchored in a concrete base. In this case, a 10 cm thick concrete base must be cast under the tank at the bottom of the pit. Cast six stainless steel anchor rings into the concrete around the tank, in the same locations as the anchor symbols on the tank. When installing in bedrock, wedge anchors are used in the same way. When the concrete has set, place a 10 cm thick layer of sand above it and position the tank horizontally on the sand. Place the straps over the tank, attach them to the rings and tighten using a latch type fastener.

Connecting the riser

Remove the protective cover from the tank, apply a little grease and insert the riser pipe into the seal. Push down the pipe and ensure that the inlet connection is correct. The connection between the riser pipe and the tank must be horizontal in order to achieve maximum leakproofness. Turn the riser pipe so that the connection can be coupled to the house's drain on its side and connect the pipes. Ensure that the riser pipe is balanced during backfill. Cut the riser pipe to the correct length so that the cover is at a suitable height in relation to the ground level.

Anchoring with anchor plates.



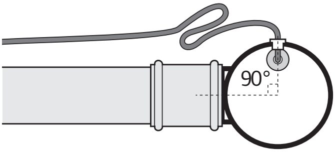
Concrete base 2.8x2.8 m or Ø 3 m

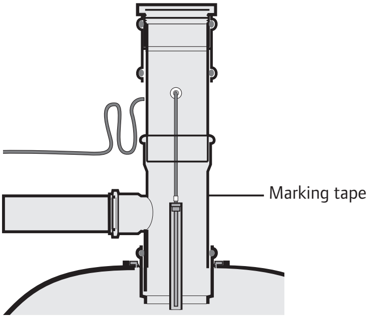
Backfilling the pit

Use stoneless sand for backfilling. Spread out the sand evenly and compact it carefully in layers approx. 20 centimetres thick. Use water or a stick to compact the sand in the central hole of the tank during backfilling. If required, use insulation plates to protect the tank and waste water from frost.

Child safety

Ensure that the cover for the emptying pipe is always securely in place to avoid accidents involving young children and animals. Tighten the cover so hard that a lever is needed to loosen it. Even greater safety can be achieved by e.g. laying a heavy plate over the cover, using a lockable covering or drilling a hole through the side of the cover and the pipe thread and inserting a self-tapping screw there.





Installation instructions for holding tank 10 m^3

Increase the volume through combination

If all waste water from a property is routed to a sealed container or if toilet use is extensive, a holding tank with a larger volume is generally required.

By combining two Uponor holding tanks measuring 5.3 m^3 each, a tank is formed with a total volume of over 10 m^3. Place the tanks next to each other and join them with a 160 mm connecting pipe according to the installation instructions below. The waste water from the house runs into the first tank. When that one is full, the waste water runs into the second tank. When the second tank has also been filled, both tanks are emptied.

Pit

Dig a shared pit (minimum base area 7x3.5 m). Level out the bottom of the pit horizontally. Dimension a pit depth so that the anchor plates have space at the bottom of the pit and the drain pipe that leads to the first tank can be covered with soil and insulated if required. Level out and compact the bottom of the pit. The tanks can be lowered into the pit using the rope on top of the tank or with lifting ropes attached to the lifting loops on the tank.

NB!

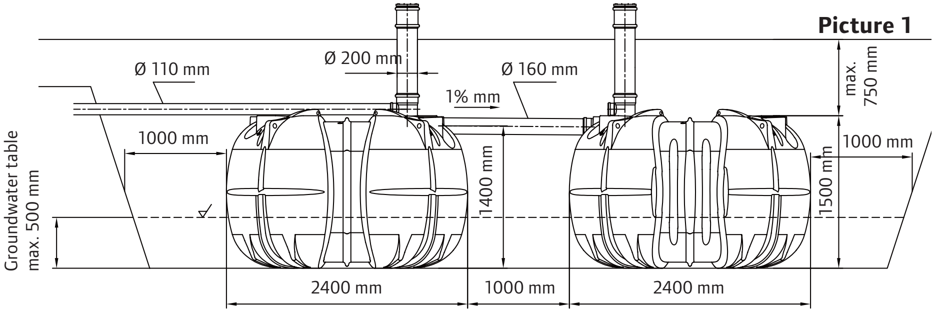
The maximum laying depth is 0.75 m measured from the top of the tank.

If the tank is installed on clay or bedrock, the pit must be drained in order to prevent any water that collects from loading the tank.

The groundwater table may reach a maximum of 0.5 m above the bottom of the tank.

Holding tanks must always be anchored.

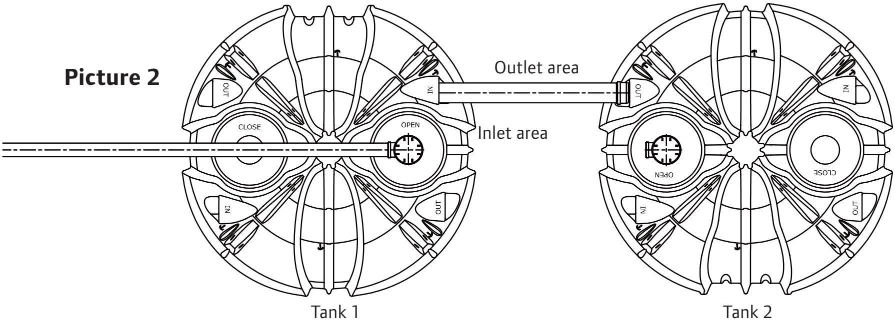
Picture 1



Installing the tanks

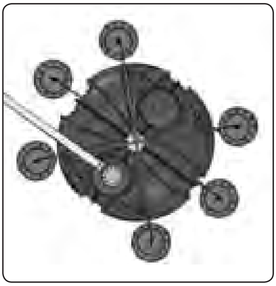
The tanks must be located somewhere where there is no vehicular traffic. However it is important to ensure that the sludge-emptying truck can empty the tanks. When holding tanks are used, the house's drains must be ventilated on the building's roof, above the ridge. Follow the local authority's regulations when the holding tanks are placed on the plot. The regulations concern, for example, the safety distances to watercourses, wells, ditches or neighbouring plots. Place the tanks at the bottom of the pit as shown in Picture 2. The distance between the tanks must be at least 1 m so that the backfilling can be compacted. Position the tanks so that the inlet “in” to tank 1 and the outlet “out” from tank 2 align with each other (Picture 2).

Picture 2



Anchoring

Anchor the holding tank with the Uponor anchoring system. Three anchoring kits are required to anchor the tank. Each kit contains two anchor plates and one strap. The positions of the straps have been marked with anchor symbols (↓) on the tank. Installation instructions are supplied with the anchoring kits.



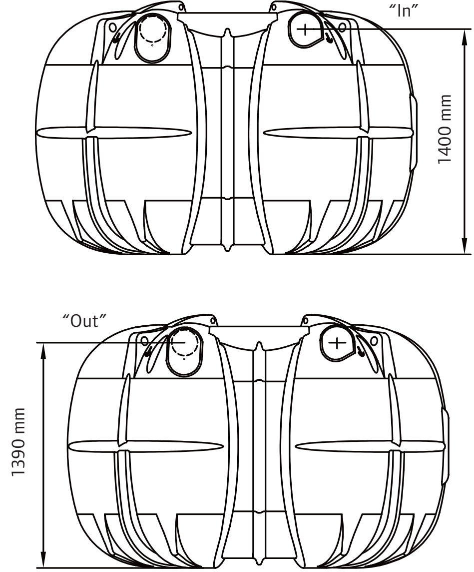
Installing the pipe connecting the tanks

Drill a hole in the inlet area “in” in the first tank with a 165 mm drill bit. Use the aiming point (Pictures 3 and 4). Drill a hole in the outlet area “out” in tank 2 so that the intermediate pipe's incline is 1%. The outlet aiming point is located exactly 100 mm lower than the inlet aiming point. If the distance between the tanks is 1 m, drill a hole in tank 2 at a level 10 mm lower than the hole in tank 1. In this case, mark this aiming point 90 mm (100 mm minus 10 mm) above both aiming points on the tank (Picture 4) and drill the hole. Install a feed-through seal in the holes (Picture 5).

Cut a 300 mm long piece of the intermediate pipe (Ø 160 mm, 2 m) at the socket end. Sand the end of the cut pipe and bevel with a rough file for example. Slide the socket end in through the feed-through seal in tank 2 so that the socket is in contact with the feed-through seal (Picture 6). Remember to use a lubricant.

Measure the distance between the socket and the hole in tank 1. Cut the intermediate pipe so that the length is the distance + 300 mm. Sand down the end of the pipe. Slide the pipe in through the feed-through in tank 1. Pull the pipe backwards and slide it into the socket in tank 2.

Picture 3



Picture 4

Picture 5

Picture 6

Connecting the riser pipe and drain pipe

Remove the protective plug for the riser pipe from the first tank. Lubricate the seal (image 7). Install the riser pipe's socket in the seal. Push the pipe down (Picture 8). The connection between the riser pipe and the tank is narrow in order to achieve an absolutely leakproof connection. Align the riser pipe's branch towards the house's drain and connect the drain pipe (Picture 9).

Install the second tank's riser pipe in the same way. Plug the second tank's 110 mm inlet connection with a 110 mm plug.

Ensure that the riser pipes are vertical during backfilling. If required, cut the riser pipes so that the screw cap protrudes slightly above ground level.

Picture 7

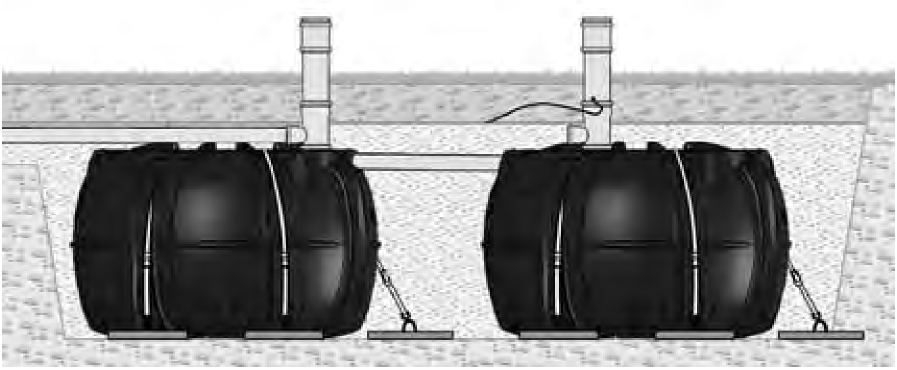
Picture 9

Picture 8

Backfilling the pit

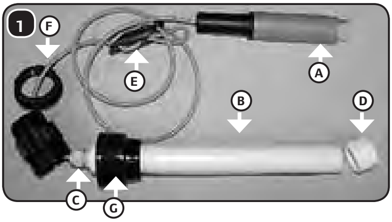
The sand used to fill the pit may not contain large stones. Spread the filling sand evenly and compact with a vibrator in layers approx. 20 cm thick. Compact the filling sand in the tank's central hole with water or an internal vibrator.

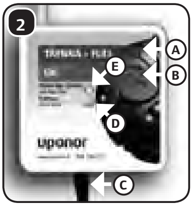
If required, protect the tank and drain pipe against frost/ ground frost with sheets of insulation.

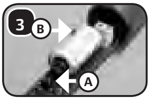


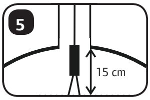
Assembly instructions

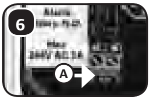
Mount the outdoor unit (1B) on the cover of the septic tank's emptying pipe. The indoor unit or the display (2) may be installed anywhere in the house, although it is recommended that you install it as close as possible to the septic tank. Each outdoor unit (transmitter) and display (receiver) are coded in pairs, ensuring that neighbouring alarms cannot interfere with each other and give rise to incorrect level alarms. Wherever the alarm is serviced, both units must be returned. NB! When testing the functionality of the alarm, the sensor's electrodes (1A) must be submerged in liquid for at least 90 seconds before the alarm is activated.











Testing the radio link's range and the sensor's functionality

This test is recommended if the distance between the outdoor unit **(1)** and the alarm **(2)** exceeds 70 m, or if the radio link is otherwise obscured by buildings or similar structures. To facilitate the testing of the alarm's functionality, the alarm's normal 90 second delay is disengaged during the test programme.

Activating the test programme

Loosen the nut of the cable feed-through **(1C)** and loosen the pipe's plastic cap **(1D)**. Remove the circuit board from the pipe **(1B)** (carefully pull the antenna). Activate the test programme by pressing and holding the button on the circuit board **(3A)** down for at least 5 seconds. Locate the outdoor unit **(1)** close to the installation site. Locate the display **(2)** in the desired installation site in the house. Connect the mains adapter to the display **(2C)** and to the mains socket. The radio link is OK if the green LED light **(2B)** flashes approx. once a second. If the link does not work, the light flashes **(2A)** erratically or "jams".

If you wish to monitor the sensor's functionality, submerge the sensor's electrodes **(1A)** in liquid or short-circuit them with a metallic object such as a coin, whereby the FULL alarm on the display is immediately activated **(2A)**. The test programme is terminated automatically after approx.10 minutes or by pressing the outdoor unit's push button **(3A)**.

Installing the outdoor unit

Drill a hole measuring approx. 45 mm in the cover of the emptying pipe **(4)**, secure the plastic socket to the hole **(4)** using the nut **(1F)**. Ensure that the nut for the sensor cable's feed-through **(1C)** is tightened. Thread the sensor and the cable **(1A)** with the adjuster sleeve **(1E)** through the setting collar, push approx. 60 mm of the protective pipe **(1B)** firmly into the sleeve and tighten the jam nut **(1G)**.

Adjusting the sensor's position in the tank

The sensor **(1A)** hangs freely from the fastening cable. When the sensor's electrodes come into contact with the liquid, the level alarm is activated.

The height of the sensor is altered by adjusting the length of the cable loop in the adjuster sleeve **(1E)**.

You should try to allow for an "emptying time" of one week after a FULL alarm. A guideline value is the installation in Fig. **(5)**.

Installing the display (2)

Install the display **(2)** in the desired location in the house. Install as close to the outdoor unit as possible. Avoid installation in close proximity to metallic surfaces as these can affect the radio link's functionality.

Open the display's cover **(2)** and attach the underside of the casing to the wall with the screws supplied. Connect any control cable for external alarms to the alarm relay's terminal blocks on the circuit board **(6A)**. Close the display's cover and connect the mains adapter to the DC plug **(2C)** and also to a 240 V mains connection.

Changing the battery in the outdoor unit

When the voltage in the outdoor unit's **(1B)** battery **(3B)** is low, the LED light "LowSign/Bat" will flash **(2E)** and a warning tone from the display's buzzer will be heard. This means that it is time to change the battery. (Battery model 123A, 3V lithium camera battery).

Loosen the plastic socket's jam nut **(1G)** and loosen the pipe **(1B)** from the socket. Loosen the nut for the cable feed-through **(1C)**, loosen the pipe's plastic cap **(1D)** and carefully remove the circuit board from the the pipe **(3)**. Remove the old battery from the battery holder **(3B)**. Use a tool such as a small screwdriver to help you. Put the new battery in the holder.
NB! Remember to check the polarity!

Operating instructions

The numbers in brackets refer to the picture.

The Uponor wireless water and waste water alarm consists of two parts:

A transmitter unit that is installed on the cover of the tank's emptying pipe. A sensor is connected to this which monitors the liquid level in the tank. The receiver unit with visual and audible alarms (see picture) which can be installed anywhere in the house. The receiver is sent updated tank level information every few minutes.

In normal mode, only the green LED light **(2)** on the receiver unit is lit continuously.

When the liquid level in the tank rises to the point where the sensor's electrodes are submerged in liquid, the FULL alarm is activated. The red LED light flashes during a FULL alarm **(1)**. The internal buzzer and the alarm relay are activated. This means that it is time to empty the tank. The alarm relay can be connected to an external alarm such as a GSM modem for the automatic ordering of emptying service (see installation instructions). To avoid false alarms, the level sensor has an activation delay of approx. 90 seconds.

If you press the ALARM RESET button **(4)** the buzzer is switched off and the alarm relay deactivated. The red LED light **(1)** stops flashing and stays continuously lit. When the tank has been emptied, the receiver reverts automatically to normal mode.

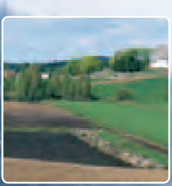
The level sensor automatically monitors the radio link's functionality. If the receiver has not been updated by the transmitter within approx. 30 minutes, the red Low Sign/Bat LED light will flash **(3)** and the warning buzzer will be activated.

If this fault occurs, ensure that the outdoor unit is not mechanically damaged and that its radio output signal is not otherwise impaired (e.g. by snow, vehicles, etc.). The fault may also signify that the battery in the outdoor unit needs to be changed. The battery normally has a service life of up to 10 years. To change the battery see the installation instructions.

Pressing the ALARM RESET button **(4)** silences the buzzer. The warning light **(3)** remains lit until the fault has been corrected.

The level sensor also automatically detects the sensor's functionality. If the communication between the sensor and the outdoor unit is broken, the green LED light on the receiver **(2)** flashes instead of staying continuously lit.

There is a special test programme for testing the radio link's range and the sensor's functionality (see the installation instructions for further details).



UPONOR INFRASTRUCTURE

UPONOR SMALL SEWAGE TREATMENT PLANTS AND PHOSPHOROUS REMOVAL SOLUTION

Efficient waste water treatment by small sewage treatment plants or phosphorous removal systems

8.2 Uponor Small Sewage Treatment Plants

High operational reliability

By combining a standard sludge separator with a process tank that has no moving parts or electrical components, we have achieved a high level of functional reliability. This simple and reliable system is the result of many years of development work. Thanks to its simplified technology, it has been possible to design the small sewage treatment plants as a reliable and cost-effective purification system.

High grade purification

The Uponor Small Sewage Treatment Plants are based on SBR technology, combining biological purification with chemical precipitation. Batch purification ensures that each batch can be cleaned under identical conditions, avoiding variations in incoming flows. Most of the phosphorous is precipitated through the addition of a flocculation agent. The amount of flocculent dosed can be adjusted using a simple handle. The pre-programmed process parameters are tried and tested, only requiring adjustment in exceptional circumstances.

Eco-friendly

Plant nutrient substances precipitated during the process are held in the sludge and thereby available for further refinement.

Simple installation

Installing an Uponor Mini Treatment Works is simple and can be done with minimal effort.

1. Installing the plant
2. Connecting incoming and outgoing waste pipes
3. Connecting electrical cable (230V, 1 phase)
4. Replenishment of flocculation agent
5. Starting the process (main power switch thrown)

Good total economy

Initial outlay and ongoing operation costs are kept low thanks to the simple and uncomplicated technology employed.

- Low electricity and chemicals consumption
- Very simple installation
- Minimal maintenance

Technical data

Uponor Clean I Small Sewage Treatment Plant (SSTP)

Measurements

Width, mm	1920
Length, mm	2400
Inlet height, mm	1180
Outlet height, mm	1130
Height with riser pipes, mm	2030
Transport height, mm	1500
Weight, kg	240
Junction size, mm	110
Sludge volume, m^3	2,5
Process volume, m^3	1
Total volume, m^3	3,5

Electricity

Electricity	230V 1 phase 10A
Flow capacity	
Nominal flow, l/day	850
Max flow, l/day	1050
Size of batch, l	170
Out pumping time, min	13
Household number	1-7

Operating costs

Consumption of flocculation chemical, l/year	40-60
Consumption of flocculation chemical, dl/batch	0,5
Consumption of electricity, kWh/day	0,9
Consumption of electricity, kWh/year	App. 330
Sludge removal	At leat once a year

Installation

Depth from inlet sewer to ground level, max	1,2 m
Depth from top of the tank to ground level, max	1,0 m
Diameter of riser pipe	560 mm

General presentation

1.1. General

The biological/chemical action Uponor Small Sewage Treatment Plants are designed to purify wastewater produced by households in permanent occupation or other residences occupied throughout the year. The batch action treatment works processes all forms of domestic wastewater (bath, dishwashing, laundry and toilet water). The system does not contaminate groundwater as its plastic reservoirs are fully sealed and treated water is only discharged into open drains or, for example, an infiltration layer after treatment. In protected groundwater areas, discharge water can be channelled outside the protected area.

Inappropriate items, such as waste traditionally the province of landfill dumps or waste classified as hazardous and potentially a risk to the plants' biological function, may not be disposed of in the system.

1.2. Functionality

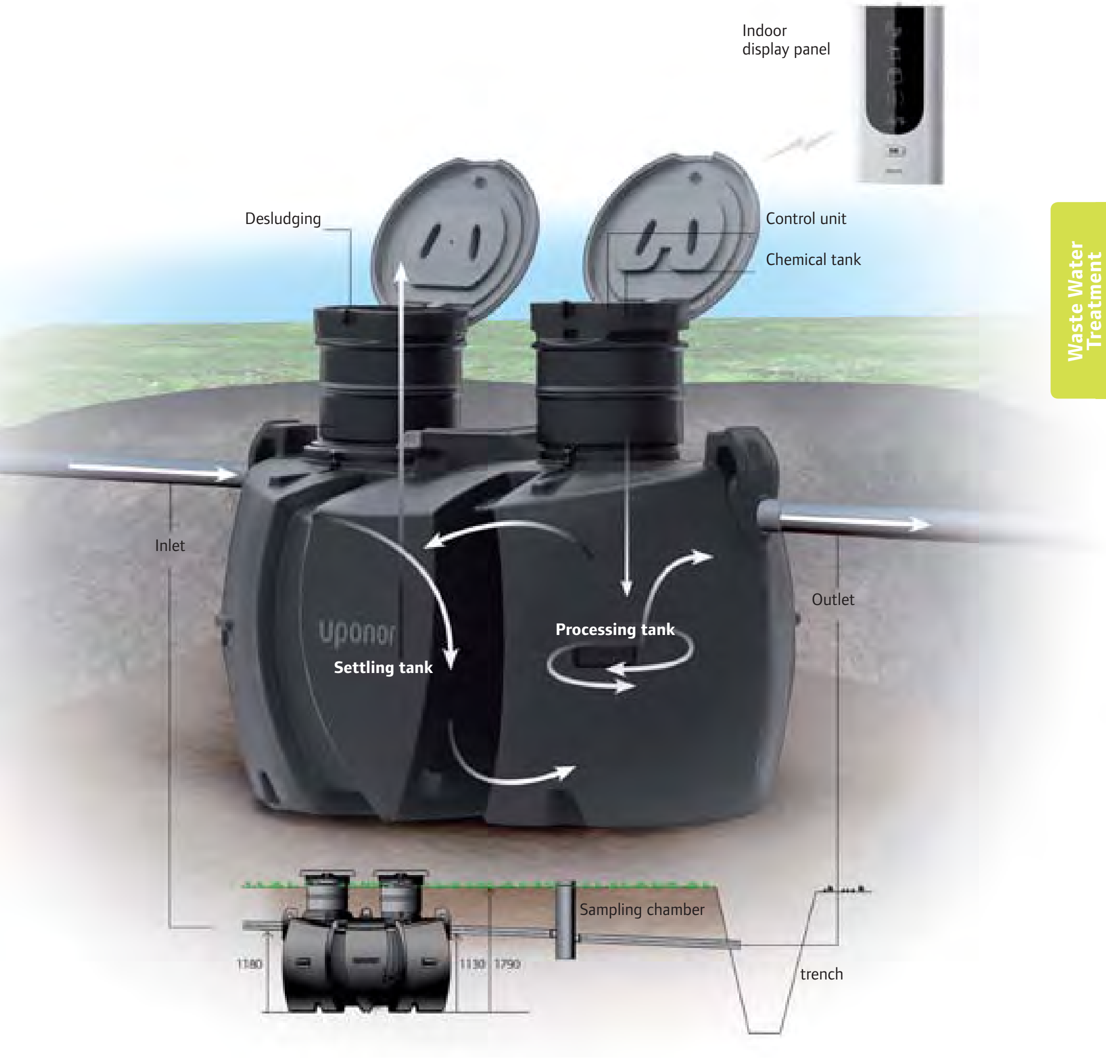
The functionality of the Uponor Uponor Small Sewage Treatment Plant is based on the principle of batch purification. Wastewater is treated in batches of a predetermined quantity, each batch being purified for identical periods of time. This eliminates the effects of flow variation. In addition, the amount of active sludge in the process tank is kept at a constant level and precipitant dosing takes place in relation to the volume of the flow. This ensures that all wastewater receives the same controlled treatment. The purification process is a combined biological and chemical process. Purification process phases:

- wastewater is sedimented in the sludge separation tank(s)
- process tank filling
- ventilation/oxygenation
- precipitant dosing and mixing
- initial precipitation/sedimentation
- surplus sludge returned to sludge separator
- second precipitation/sedimentation
- treated water is removed

Uponor Clean I small sewage treatment plant is designed to treat domestic wastewater from a family of one to seven persons. Uponor Small Sewage Treatment Plant 10 treats domestic wastewater from two families, max 10 people. Uponor Small Sewage Treatment Plant 15 treats domestic wastewater from three families, max 15 people. In situations where no water is being channelled into the works, the process switches to standby or maintenance mode. During this time, wastewater in the process tank is ventilated on a regular basis. This ventilation maintains activity levels amongst the microorganisms in the sludge. Wastewater and sludge is channelled out without the assistance of mechanical pumping. Below the surface of the wastewater there are no moving parts that require servicing. The air use for the various functions comes from an air pump located in the switch cabinet above ground.

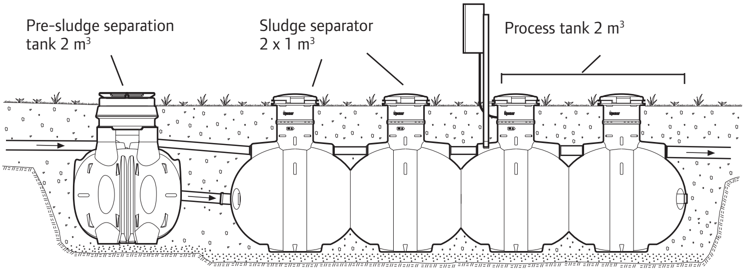
Uponor Clean I Small Sewage Treatment Plant

For a single family's wastewater.



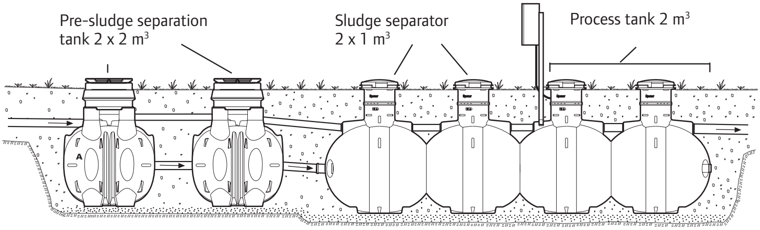
Uponor Small Sewage Treatment Plant 10

For two families' wastewater.



Uponor Small Sewage Treatment Plant 15

For three families' wastewater



Planning

Ask the environment and health protection department of the local authority for advice when planning a waste system for a property.

Take the following considerations into account when siting the plant on the property:
- local regulations and instructions set down by the environmental office
- selection of discharge site and discharge method
- distance from the discharge site to watercourses, wells or drinking water extraction sites
- distance to bedrock
- water table level and direction of flow
- elevation and ground surface appearance
- protective distance to road, neighbouring property boundary, etc.
- proximity to road, allowing sludge emptying to be carried out
- the works must be sited so that no vehicle traffic runs over it.

Take the following factors into consideration when installing the works:
- Plan the discharge so that there can be no backflow into the works.
- Position the switch cabinet so that the indicator light is easily visible.

Check that an appropriate wastewater flow rate has been achieved. Maximum flow rates are
- Uponor Clean I small sewage treatment plant: 1.0 m^3/24 hours
- Uponor small sewage treatment plant 10: 2.0 m^3/24 hours
- Uponor small sewage treatment plant 15: 2.3 m^3/24 hours

Install the waste pipe underground from the property, laying it as evenly as possible and without unnecessary bends. Ventilation of the property's waste must be routed to the roof of the property. Fit the ventilation pipe outlet a good way above the roof ridge and as far as possible from the supply air intake. Use of vacuum valves in the ventilation pipe is not permitted.

In instances where there is a risk of extensive ground frost, insulate the tank and other exposed parts with a ground sheet (or equivalent).

Rain water, surface water and drain water may not be channelled into a batch processing treatment works.

In the case of new builds and properties where repairs or renovation works are being carried that are subject to the granting of building permits, a permit application must be made to the local planning authority or a planning application must be submitted. The application must be accompanied by a plan of the wastewater treatment system. This plan shall be compliant with the ordinance applicable to wastewater treatment in the locality in question.

The plan should contain the following:
- site plan showing the location of the plant and wastewater discharge
- cross-section drawing showing plant works, waste pipe and discharge levels
- description of plant showing the treatment plant's installation instructions, function principles and service functions. On the basis of this plan, the local authority is able to assess suitability of the system and associated equipment for the proposed site.

Installation and Commissioning of Clean I

Digging a pit

Dimension the width and length of the pit so that there is at least half a metre of working area around the tank(s). For standard installations, the pit depth required for the small sewage treatment plant is about 2.0 m. For deeper installations, see the section entitled 'Extension of riser pipes'. If the tanks need to be anchored so that they are not lifted by high water table levels, the anchoring plates will require a gap of approximately 60 cm on both sides measured from the outermost point of the tank wall.

Installing the tanks

Level and compact the bottom of the pit with gravel or sand. Check that the bottom of the pit below the tanks is level. Attach the lift lines to the sides of the tank (the lifting points are marked with labels), and lower the tank(s) down onto the levelled layer.

Anchoring the tanks

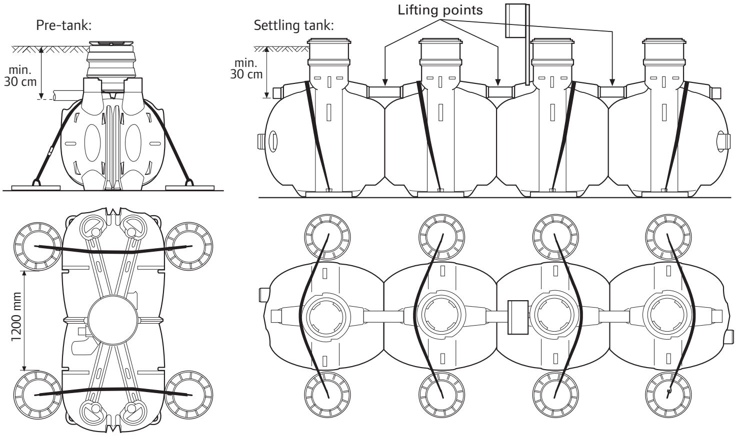
If the ground is made up of a clay soil, or if the water table level is high, it is important that the tanks are anchored. This can be done using the Uponor Anchoring System. In pits sunk into bedrock, securing straps must be attached to anchor slippers. Drain pits in clay soil or bedrock so that any collecting surface water does not lift the tank. The Uponor Anchoring System makes process of anchoring tanks in demanding locations quick and simple.

The anchoring plates must be positioned level with the bottom of the tank and fully outside the plumb line from the tank wall. Pull the securing straps over the tank and secure them in the anchoring plate eyelets. Compact a 20 cm thick layer of sand over the anchoring plates. The securing straps can then be tightened. Finally, fill in the pit, compacting as you go.

Connecting the tanks (Uponor Small Sewage Treatment Plant 10 and 15)

Fit the Ø 110 mm connection pipe and the Ø 75 mm ventilation pipe that come with the system between the purification tank and the pre-tank as shown in the installation drawing on pages 6-7. Use Uponor lubricant (or equivalent) to make it easier to insert the pipe through the seal.

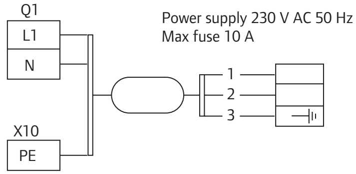
Anchorage using the Uponor Anchoring System



Waste connection

Connect the waste feed from the property to the treatment works inlet using the Ø 110 ground waste pipe and connect the Ø 110 ground waste pipe to the treatment works outlet. Purified water is normally channelled to the nearest open ditch or is sent to an after treatment stage. The outlet must be sited so that there can be no backflow into the treatment works following heavy rain, spring flooding, etc. For information about suitable discharge sites, consult your local authority's environment and health protection department.

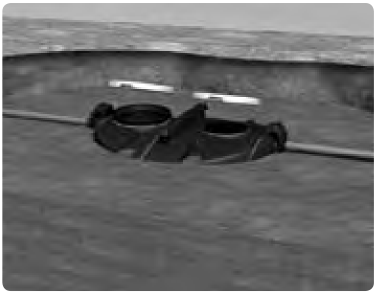
Power cable connection



Backfilling the pit

Backfill the pit around the treatment works with sand or gravel that contains stones no larger than 20 mm. Compact the backfill in layers of 15-20 cm. Mechanical compaction must not be used in areas above the tanks or interconnecting pipes.

Installation of riser pipes, Clean I


1. Lift the lids off. The riser pipes, control unit, precipitant reservoir and other parts are stored inside the first part of tank.


2. First remove the carton with installation supplies, and after that the precipitant reservoir.


3. Then remove the control unit.


4. Separate the riser pipes from each other.


5. Place the sealing rings in the riser pipe´s both ends. NB! No lubricant can be used.


6. Screw the riser pipes into the tank. Tighten the screws simultaneously from both sides of the pipe.

Riser pipe extension, Clean I

Normal installation depth is about 0,6 m. If the plant must be installed deeper than normally required, the plant's riser pipes must be extended.

1. Cut the riser pipes at the marked „Cut off line".

2. Use an Uponor 560 mm extension pipe and cut it to the appropriate length (max lenght 1,0 m). Fit the sealing rings on the first groove on each end of the pipe.

3. Lubricate the lower sealing before installing the extension pipe (about 20 cm) until it reaches the stop mark.

4. Lubricate the upper sealing before installing the cut off riser pipe. The extension pipe is pressed approx. 20 cm inside the riser pipe. NB! Maximum and installation depth, measure from the inlet pipes bottom to the ground surface, is max 1,2 m.

5. Install the lids to the riser pipes and screw them tight with bolts and nuts.

Installing the switch cabinet, Clean I

1. Install the air hose by pushing them to equivalent coupling. Secure that the hose are pressed to the bottom. NB! Follow the color codes at the bottom of the switch cabinet. In the couplings, there are similar color ring than the color of the hose. Red hose goes to red coupling etc.

2. Secure that the hose are not twisted or bended.

3. Lower the control cabin inside the riser pipe.

Installing the precipitant reservoir

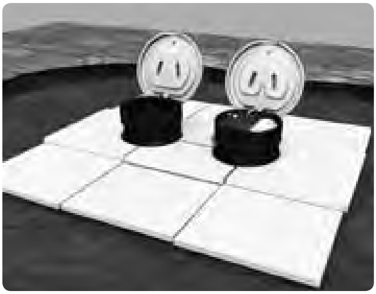
1. The yellow hose is attached to the reservoir, check that it is attached in the right place of the control cabin.

2. Lower the reservoir inside the riser pipe.

Eletrical Cable

1. Install the connection box beside to the riser pipe. Professional electrician is recommended for connecting the cables to the plant and inside the house to the main electrical centre. The cable must be fitted with an earth fault breaker. In areas that are subject to frequent lightning storms, we also recommend to install an over-voltage protection system.

2. Press the air hose to the coupling in the lid. The hose supplies the air to the control cabin.



3. Where there is a risk of extensive frost, the tanks and other frost-sensitive objects must be protected using insulated ground sheets (e.g. 100 mm Styrox). Do not remove snow accumulation covering the tank during the winter, except for the purposes of servicing the system.

Backfill the pit. Leave at least 10 cm space between the ground surface and the lid to secure the functions of wireless alarm system and supply air intake.

Commissioning

1. Lift the reservoir from the tank and fill the reservoir with Uponor precipitant (15 litre). Use protective gloves and goggles when handling precipitant. Put the cork back to the reservoir. Check the information on precipitant from the canister.

2. Uponor Clean I small sewage treatment plant is ready for use.

Commissioning of wireless alarm system

Range test

In order to find the best location for the display panel, it is recommended to test the range of the radio signal.

1. Switch on the control cabin while the display panel is switched off. If the control cabin is already connected, unplug the cable and plug it again.

2. Switch on the display panel and start the coupling of the units by pressing the OK button over 5 seconds.

3. When coupling has done successfully, the control cabin is automatically switched on to range test mode. During the test there might flash three colors in the display panel:
   a. Green = good connection
   b. Yellow = moderate connection
   c. Red = no connection or poor connection

4. The range test ends automatically after 15 minutes. Test can be interrupted by pressing the OK button from the display panel or by pressing the test button on the control cabin.

Install the display panel in best place discover by the range test. Plug the cable and the display panel. Note that the control cabin (transmitter) and the display panel (receiver) should be situated no more than 70 m apart in a way that the display panel is as close as possible to the small sewage treatment plant. Do not place the display panel in a place where other buildings or equivalent can prevent the wireless connection.

NB! The following steps should perform without interruption.

Figure 7.2.1

Turn on the plant by connecting the electric coupling to connection box. The control cabin searches the display panel for 5 minutes to create the wireless connection ("P---"sign will flash in the display of the control cabin). Go to the display panel.

Activate the display panel by pressing the OK button at least 5 seconds.

Figure 7.2.2

After the 5 seconds the wireless connection sign starts to flash. The connection is now forming. Within 5-10 minutes, the wireless connection sign stops to flash and the green OK light go on.

If the connection is not formed the wireless connection light is red. In such a case, try again like described earlier. Location change of the display panel may help to form the connection. Check that the distance between the panel and the control unit is not too long and there are not any buildings to prevent the radio signal.

Lock the tank's lids. Waste water system is now ready to use.

Figure 7.2.3

The usage

Daily operations of the small sewage treatment plant are followed by the display panel inside the house. More accurate observations can be made by checking the switch cabinet inside the plant.

The display panel

There are four functions in the display panel:

- Four alarm symbols
- One reminding symbol
- Green OK sign
- OK/reset button

Wireless connection

The amount of chemical precipitant is low

Water level is high

Device failure in the switch cabinet

Reminder of sludge emptying Normal function without interruptions (green light) OK/check button to clear the alarm

Display panel – Alarm functions

There are four alarm functions in the display panel which activates when there is a fault situation. During the alarm situations the display panel shows the following:

1. Green OK sign goes out.
2. The red sign starts to flash in equivalent sign where the fault is occurring. An alert signal starts. (The alert signal is on 30 seconds per hour)
3. The alarm is cleared by pressing the OK button. The alarm sign stops the flashing but stays on. The alert signal stops.
4. When the fault is fixed the red light goes out and green OK light lit.

Display panel – The reminding function

The display panel tells when it is time to empty the sludge tank. The emptying should be within a month from the reminding sign.

1. Yellow sludge truck symbol starts to flash and the alert signal starts. (The alert signal is on 30 seconds per hour) Green OK light is on.
2. The reminder sign is clear by pressing the OK button. The sign stops the flashing but stays on. The alert signal stops.
3. When the sludge emptying is performed, the reminder is reset by pressing the test button in the switch cabinet. Press the test button over 10 seconds while the text E000 is shown in the display of the switch cabinet. The sludge truck sign goes out.

Figure 7.2.4 Display panel – Settings

There are three switches at the backside of the display panel:

1. Alert signal on/off
   The highest switch is for choosing the alert signal on or off.
2. Alert signal on/off during the night time
   The switch in the middle is for choosing the alert signal on or off during the night time.
3. Reminder of the sludge emptying
   The lowest switch is for activating the reminder for sludge emptying. Whether the small sewage treatment plant is located in the area where is municipal sludge emptying, the reminder can be switched off.

Switch cabinet

Switch cabinet is situated under the lid of process tank. There is a display in the switch cabinet from which can be read the batch counter value, check the situation of the plant and observe the possible fault situation's code. Outside the cabinet is a test button which is used to activate the display, to run the test program and clear the reminder of sludge emptying.

Figure 7.2.5 Switch cabinet – Display

When the plant is working properly, there is only a batch counter value in the display.

Functions during the fault situation

The batch counter value and the fault code (letter E and the number code) are shown in the display. Ref. troubleshooting chart for Clean I. If there are multiple fault situations, all of the fault codes are shown in a row in the display.

Condition of the plant

The stage of the cleaning process can be seen from the display. By pressing the test button shortly (less than 5 seconds) the stage of the process is shown in the display. There is S and series of numbers. The result is shown 30 seconds before it normalizes back to the batch counter value.

Test phase

During the test phase certain functions of the small sewage treatment plant is tested. Before running the test, lift up the reservoir from its place. Look carefully the locations of each unit inside the process tank. The test run is started by pressing the test button over 5 seconds but less than 10 seconds. When the button is pressed down, the seconds are running in the display. Test button is released when the display shows S__5.

There will be S400 code in the display when the test phase is on. During the phase the plant is performing all the pumping functions in a row.

	Function	Time	Display
1.	Pump in	20 s	S401
2.	Sludge exhaustion	20 s	S402
3.	Pump out	5 s	S403
4.	Top reservoir	90 s	S404
5.	Dosing the precipitant	10 s	S405
6.	Ventilation	30 s	S406

After the test phase is over, the display normalizes back to showing the batch counter value. The cleaning process also normalizes.

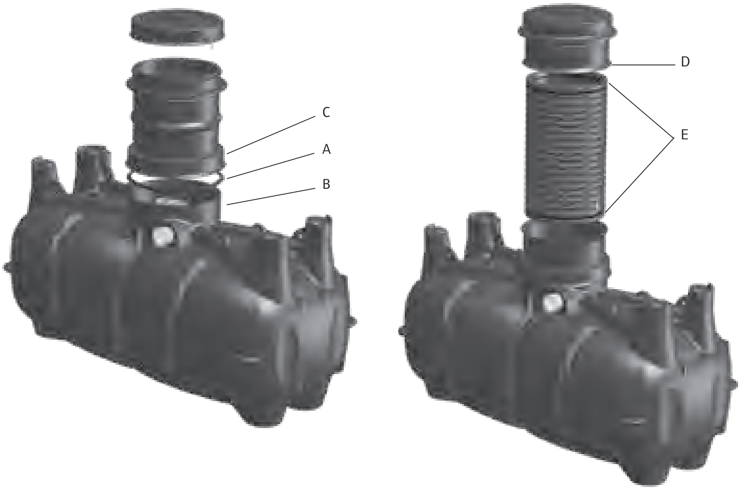
Clearing the reminder of sludge emptying

The reminder of the sludge emptying is cleared by pressing down the test button over 10 seconds. When the button is pressed down the seconds are running in the display. When the test button is released after 10 seconds, the code E000 will appear in the display.

Troubleshooting chart for Clean I

Alarm	Fault code	Cause	Effects	Action
Wireless connection	E011	Power outage in the display panel	The display panel is not working	Check the power adapter
		No connection	The display panel is not working	Activate the connection
		Repetitive connection problems	The display panel is not working	Change the location of the display panel
		Power outage in the switch cabinet	The small sewage treatment plant is not working	Check the power connection
The amount of chemical precipitant is low	E021	The amount of chemical precipitant is low in the reservoir	Phosphorous reduction impaired	Top up chemical reservoir
High water level	E031	Blockage in the pump in module	Water level is high, sludge increases	Clean the pump in module blockage
		Heavy water consumption	Temporarily overload	Observe the water usage
	E032	Blockage in the discharge location/discharge pipe	Plant can not remove the water	Clean the blockage
		Blockage in the pump out module	Cleaning efficiency impaired	Clean the pump out module blockage
Device failure in the switch cabinet	E040	Fault in the air fan	The small sewage treatment plant is not working	Contact Uponor for repair
	E041	Fault in the solenoid valve of the chemical dosing	Phosphorous reduction impaired	Contact Uponor for repair
	E042	Fault in the solenoid valve of the sludge return	Sludge return is not working	Contact Uponor for repair
	E043	Fault in the solenoid valve of the pump out	Pump out is not working, the alarm of E032 activates	Contact Uponor for repair
	E044	Fault in the solenoid valve of the pump in	Pump in is not working, the alarm of E031 activates	Contact Uponor for repair
	E045	Fault in the solenoid valve of the ventilation	Disruption in the treatment process	Contact Uponor for repair
	E046	Fault in the program	The small sewage treatment plant is not workin	Contact Uponor for repair
Reminder of sludge emptying	E051	Sludge separation tank is filling with sludge	Disruption in the treatment process	Empty the sludge separation tank by calling the service provider. Clear the alarm after emptying by pressing the test button in the switch cabinet over 10 seconds.

Installation of Small Sewage Treatment Plant 10 and 15



1. Installing risers

Place the seal ring (A) on the neck of the tank (B). Lubricate the socket end of the riser (C) using Uponor lubricant. The riser (C) must be positioned so that the text "IN" shown on the riser pipe is directed towards the tank inlet. Press the riser down so that the tank neck is fully secured in the riser socket.

Riser pipe extension, 10pe

When raising, cut the riser at the "Cut off line" mark (D) in the middle of the riser. Use an Uponor 560 mm riser pipe and cut it to the appropriate length. Place a sealing ring in the 2nd groove on each end of the riser pipe (E). Fit the lower section of the cut riser in accordance with point 1. Fit the riser pipe and then the upper section. Max installation depth is 1 m from the water flow inlet to ground level.

Installing the Switch Cabinet, Small Sewage Treatment Plant 10 and 15

When delivered, the switch cabinet comes attached between the riser pipes by a pin in "transport position". Undo the two screws located inside the cabinet, lift the cabinet to the pillar and re-tighten the screws. Secure the cabling between the process tank and switch cabinet to the pillar before backfilling. Switch cabinet electrical connections must be carried out by a qualified electrician.

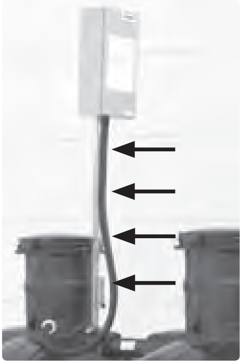
The switch cabinet can be turned in four different directions on the telescopic pillar. Choose the direction that makes the indicator light most visible from the property.

Raising height of the switch cabinet

When extending the riser pipes it may also be necessary to extend the control cabinet pillar. This is done by fitting the extension tube on the pillar and then fitting the switch cabinet on the extension tube. This longer tube can be purchased separately.

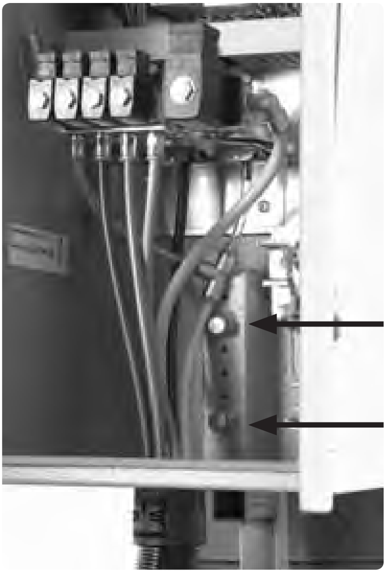
Switch cabinet in transport position.

Undo the two screws and lift the cabinet.



The protective hose must be secured to the pillar using cable ties located 30 cm apart. This prevents the protective hose connection inside the switch cabinet coming loose during installation.

Fit the switch cabinet to the pillar and secure the hose.



Re-tighten the screws.

Commissioning

1. Uponor Small Sewage Treatment Plant 10 and 15: Fill the sludge separation tank(s) and purification tank sludge separator with through the pre-tank riser pipe up to 2/3 of the total volume. Similarly, fill the process tank with water to approximately 2/3 of its volume.

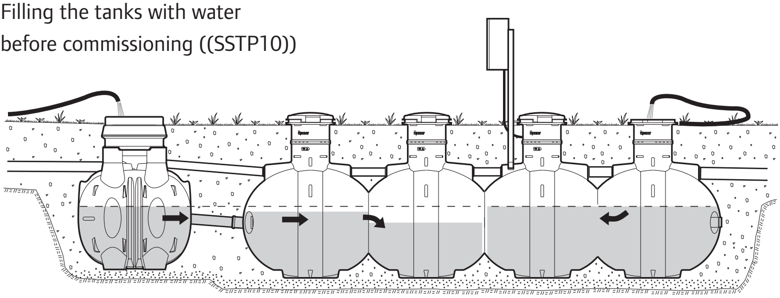
2. Fill the 15 litre chemical reservoir located below the switch cabinet in the process tank reservoir with Uponor precipitant. Use protective gloves and other protective clothing when handling precipitant.

3. The treatment plant is commissioned once wastewater starts flowing in. Start the treatment plant using the blue switch inside the switch cabinet. Turn the switch to the ON position.

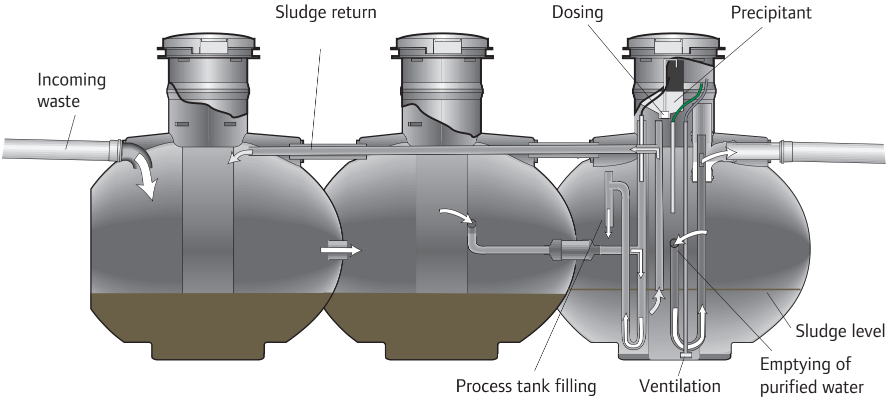
4. Make sure that the indicator light on the outside of the switch cabinet is on. In some instances, it may take a full treatment cycle before the indicator light comes on. The indicator light goes out when there is a fault. Check that the indicator light is visible from the property.

5. Finally, check that the switch cabinet and tank covers are locked.

Filling the tanks with water before commissioning ((SSTP10))



Operation



Sludge separation **Process tank**

Small Sewage Treatment Plants parts

Main components of the SSTP:

- pre-sludge separator (SSTP 10 and 15)
- purification tank, including:
  - sludge separator
  - process tank
  - chemical reservoir and dosing pump
  - switch cabinet

1. Sludge separation/emptying

As part of the pre-treatment process, solid matter is separated in the sludge separation tanks using precipitation. The sludge collected must be drained at least twice a year. The sludge must only be drained out from the sludge separator. The process tank must not be emptied.

2. Process tank

The process tank is located in the outlet end of the treatment works below the switch cabinet. In Small Sewage Treatment Plant 10 and 15 have a volume of 2 m^3 . The process tank houses all functional units for various functions. All units are connected to the switch cabinet by way of colour coded air hoses.

3. Switch cabinet

The main components of the switch cabinet are:

- main power switch
- control computer
- batch counter
- valve package
- air pump
- start limit relay switch
- electrical outlet
- indicator light

Main power switch

The treatment plant is started using the main power switch during commissioning.

Control unit

The control unit controls the entire process using pre-programmed software. The process begins with ventilation. The process re-starts with ventilation even after a power outage. The control computer features a series of red LEDs, each of which indicates a stage in the treatment process. These LEDs are located at the bottom of the control unit.

Top line X0 = start level
X1 = pressurised dosing
Bottom line Y0 = air pump
Y1 = chemical dosing
Y2 = sludge return
Y3 = pumping out
Y4 = pumping in
Y5 = ventilation/agitation

Air pump

An air pump (55 W on the W 5pe, 80 W on the 10pe and 15pe) supplies the necessary amount of compressed air for the various functions. The operation time of the air pump is approximately 16 hours per day when the treatment works is operating at full capacity.

Start level

Once the water level in the process tank has reached start level, the treatment process begins.

Alarm level

The indicator light on the switch cabinet goes out if the water level in the sludge separation tank rises above the alarm limit.

Electrical outlet

There is an electrical outlet in the switch cabinet that is intended for use when the system is being serviced.

Indicator light

There is an indicator light on the switch cabinet. This light remains on when the system operates normally and goes out if there is a fault. Further information about faults can be found later on by troubleshooting chart.

4. Precipitant reservoir and dosing pump

The process tank riser pipe houses the chemical reservoir. This reservoir must be topped up on a regular basis.

The number of times this needs to be done is dependent on the volume of incoming wastewater. Small Sewage Treatment Plant 10 and 15 provide a dose of approximately 1 dl/treatment batch. The dosing pump is set to these values upon delivery.

The dosing pump is located in a niche in the bottom of the chemical reservoir. The air hose connecting the dosing pump to the system is yellow. Only precipitants recommended by Uponor must be used, in this case a solution of aluminium hydroxide.

Before use, read the chemical's safety information sheet. Aluminium hydroxide is an irritant, and you should wear protective gloves (such as washing up gloves) when handling it. If you get splashes on your skin, rinse using clean water.

Functional units

1. Inlet module

The process tank fills with pre-treated waste water from the sludge separator using air channelled into the inlet module. The inlet module air hose is blue.

2. Ventilation and agitation module

The task of the ventilation unit is to oxygenate the wastewater. The bacterial culture necessary for the biological degradation process is an organic substance that requires oxygen. The same unit is also used to circulate the chemical. Adding precipitant to the system guarantees a good treatment result and separates phosphorous from the wastewater. The ventilation and agitation module air hose is grey.

3. Precipitant dosing pump

The precipitant dosing pump is located in the chemical reservoir in the riser pipe. The chemical is dosed into the treatment works using the air pump. The chemical dosing pump has a yellow air hose.

4. Sludge return

After the initial settling stage, the active surplus sludge is returned to the sludge separator. The sludge return air hose is brown.

5. Discharge module

After the second settling stage,
the treated water is pumped out of the system. The outlet module air hose is red.

6. Start level

The start level is the water level in the process tank at which the treatment process begins.
The start level module air hose is green.

7. High level module

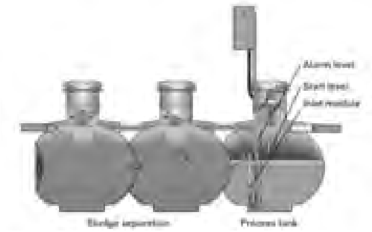
The high level module produces an alarm if the water level in the sludge separator goes above maximum. The high level module air hose is black.

Treatment cycle

Pre-treatment of wastewater takes place in the sludge separation tank(s). Solid substances that are lighter and heavier than water are separated from the wastewater. These substances are stored in the sludge separation tank.

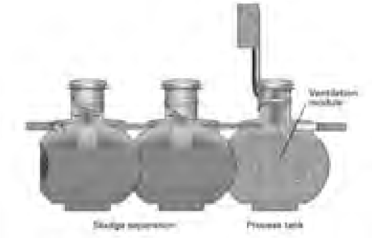
1. Filling the process tank

The process tank is filled with pre-treated water from the other sludge separation tank until the start level is reached in the process tank and the process commences.



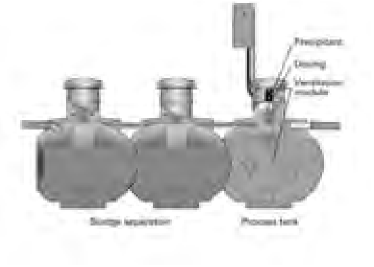
2. Ventilation

Ventilation keeps the active sludge moving whilst, at the same time, giving the microorganisms the oxygen they require in order to break down the organic substances present and remain alive.



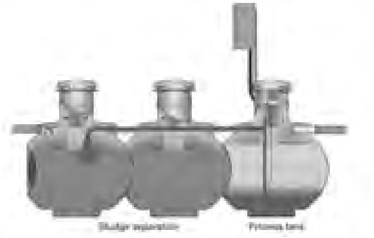
3. Dosing and mixing the chemical

The precipitant removes phosphorous from the wastewater. It is injected into the wastewater by a short blast of air.



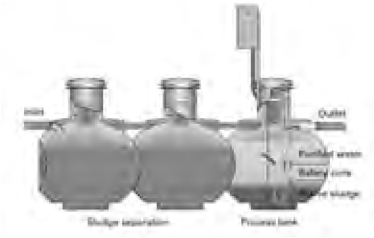
4. Settling, return of surplus sludge and secondary settling

Solid particles are allowed to settle for a period of about 60 minutes. During settling, the water flow in the process tank is stopped and the sludge sinks to the bottom. A certain amount of "active sludge" must, for the purposes of the process, be retained in the process tank. Surplus sludge is returned to the sludge separator after each treatment cycle.



5. Emptying of treated water

Once a treatment cycle is complete, the treated water produced is discharged.



6. Standby and maintenance phase

If the start level in the process tank is not reached after pumping in, the system switches over to standby mode. In this mode, the biological process is maintained through oxygenation/ventilation. If the start level is subsequently achieved, a treatment cycle is initiated. If the start level is not achieved, the system remains in standby mode for 72 hours after which it enters the maintenance phase. The maintenance phase starts when the process tank start level has not been reached for a period of 72 hours, e.g. during holidays. The task of the maintenance phase is to maintain the biological function of the system in situations where there is no wastewater load in the treatment works. The maintenance phase consists of a standby mode and a ventilation, sludge return and filling phase. If the start level is not achieved after filling, a new standby phase begins, after which the process is cycled back to the beginning of the maintenance phase.

Service

Servicing procedures to be carried out by the property owner

In order to ensure disruption-free operation, there are a few servicing and inspection measures that must be implemented on a treatment works at regular intervals.

Use protective gloves and follow the instructions when servicing the system. Lock the sludge separation tank and switch cabinet covers after carrying out servicing procedures and wash the hands thoroughly.

The most important servicing procedures to be carried out by the property owner are:

- filling the chemical reservoir at intervals of 1-6 months
- ensuring that the installation is booked in for sludge emptying at least twice a year or when the alarm sign goes on.

The chemical reservoir is located in the process tank riser pipe. The reservoir has a capacity of approximately 15 litres. Use protective gloves and other protective clothing when handling Uponor precipitant. Only use Uponor precipitant in the treatment works.

Visually check the chemical level in the reservoir every three months. If the chemical runs out, the reservoir will issue an alarm to the switch cabinet, causing the switch cabinet indicator light to go out.

Sludge must only be emptied from the sludge separation tanks. The process tank must not be emptied.

Once emptied, fill the sludge separation tanks with clean water to 2/3 their total capacity.

All servicing procedures, e.g. inspections, replenishment of the chemical reservoir, emptying, repairs, changes, etc., must be noted in the service logbook along with the date the procedure was carried out.

Service agreement

Upon delivery of an Uponor Mini Treatment Works, a service agreement is taken out. The agreement includes a technical inspection of the installation, carried out once a year after the delivery date.

Important information

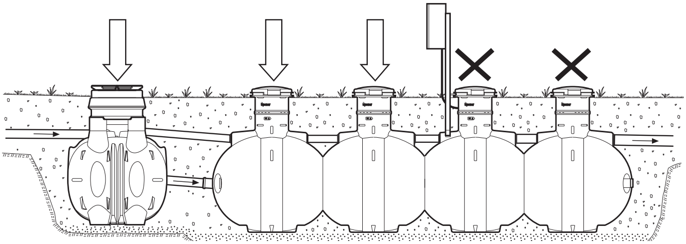
NB! The biological treatment process is extremely sensitive to the effects of various toxic substances, e.g. oils, strong acids, alkalis, etc. Do not load wastewater with any of the following:

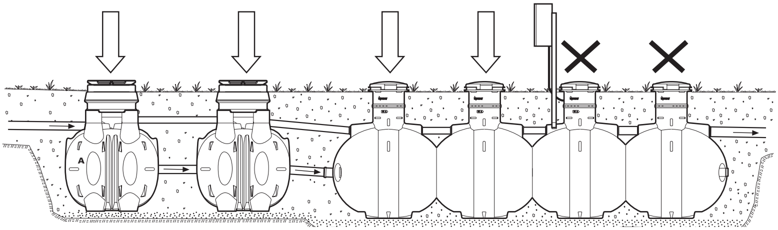
- wrapping paper, newspaper, paper towels
- textiles, e.g. stockings
- nappies, tampons, cotton buds, sanitary towels or condoms
- sand, building waste
- fat, oil or other substances that form toxic fumes
- petrol, solvents, paint or other flammable or explosive substances.
- pharmaceutical waste

Sludge emptying instruction, Uponor Small Sewage Treatment Plant 10 and 15

The plant should normally be emptied of sludge twice a year. Only the pre-sludge storage tank(s) and the sludge storage tank(s) are to be emptied (see below). After emptying, the sludge separation tank(s) must be refilled with water to 2/3 of its/their total volume.

NB! Only empty sludge as described below, i.e. only empty those tanks marked with arrows.





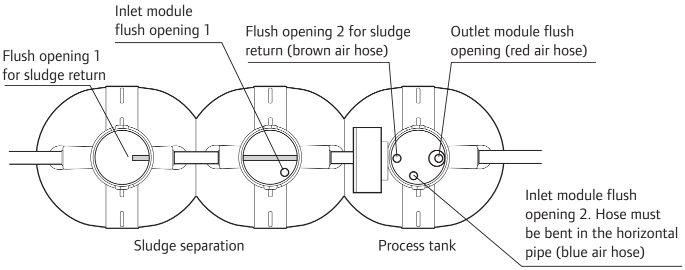
Troubleshooting chart

Fault	Cause	Effects	Action
Indicator light is out	A fuse has blown General power outage	Treatment works function impaired	Check fuses
Indicator light is out	Chemical reservoir empty	Phosphorus reduction impaired	Top up chemical reservoir
Indicator light is out	Light is broken	Fault messages message	Contact Uponor for repair
Indicator light is out	Leak in an air hose	Incorrect fault message	Contact Uponor for repair
High water level / indicator light is out	Overloading	Temporary increase of the water level in the process tank	Check whether the outlet pip, pump in or pump out pipes or sludge return pipe is blocked. Clean using water hose (see p. 18). If there is no blockage, the water level will fall back after a few treatment cycles
Batch counter value does not change despite water being consumed	The plant has not been filled with sufficient water after replenishment		Wait, status will return to normal once the tank has been filled
Batch counter value does not change despite water being consumed	Air pump damaged Logic circuit damaged	Disruption in treatment process	Contact Uponor for repair
Air pump does not work	Air pump damaged	Disruption in treatment process	Contact Uponor for repair
Strong odour in outgoing water	Air pump damaged A solenoid damaged Logic circuit damaged	Problem in treatment process	Contact Uponor for repair
Solid matter in outgoing water	Too much sludge	Process overloaded	Empty the sludge separation tanks

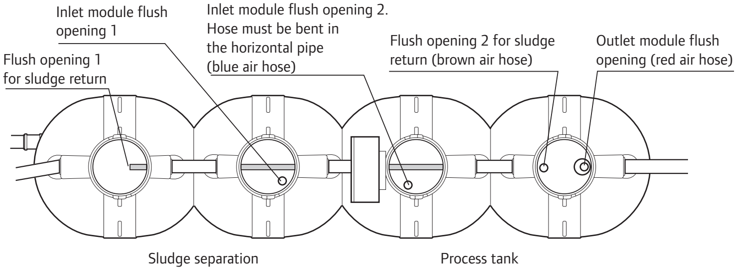
Opening blocked process pipes

If any of the treatment works' functional units (pumping in, sludge return or pumping out) are blocked, the blockage must be removed by flushing with water. Insert the flush hose through the appropriate flush opening. The openings are open grey Ø 32 mm pipe ends that can be seen by opening the tank covers. Where there are blockages, also check that there is nothing preventing outflow into the ground drain pipe after the treatment works. This should be checked at the discharge site/point for the treated water.

Mini Treatment Works 5pe: Process pipe flush openings



Mini Treatment Works 10pe and 15pe: Process pipe flush openings



Contact information

Water & Sewage Consultant/Planning

Name

Address

Telephone

Place of Purchase/Supplier

Name

Address

Telephone

Installer/Contractor

Name

Address

Telephone

Service

Name

Address

Telephone

Sludge Removal

Name

Address

Telephone

Local Authority Environment and Health Protection Department

Name

Address

Telephone

Uponor Clean Easy extends the service life of your infiltration/land filter trench and ensures that it achieves a high purification protection level

The environment - our own responsibility

The discharge of wastewater that has been inadequately neutralised of its phosphorous content is a major contributing factor to overfertilisation. It (overfertilisation) is the outcome of the excessive utilisation of plant nutrients, particularly phosphorous, but sometimes also nitrogen, and ultimately leads to a substantial increase in the numbers of plankton algae. When these algae die, they sink to the bottom of the watercourses in which they grow until they are broken down. When large volumes of plankton are broken down, they consume significant quantities of the water's oxygen content, resulting in an oxygen deficiency. This deficiency can in turn result in bottom-dwelling animals and, in certain instances, fish dying.

Extended service life

When initially installed, well-built infiltration and land filter systems are compliant with current water treatment requirements. However, they have a limited service life and within 5 years the purification effect they have will reduce, unable to achieve a phosphorous reduction level of at least 70 %.

Clean Easy function

Chemical treatment principles

Phosphorous precipitation takes place in the first tank chamber, where agitation is also carried out. Chemical sludge is stored in the tank. Water is channelled to subsequent treatment via the distribution chamber.

When treating phosphated water, it is important that the correct flocculent to water volume ratio is used. This flocculent must be mixed efficiently into the wastewater. In Uponor Clean Easy, the amount used is adapted to the flow, ensuring an optimal quantity. Flocculent is only added when water is used.

System maintenance

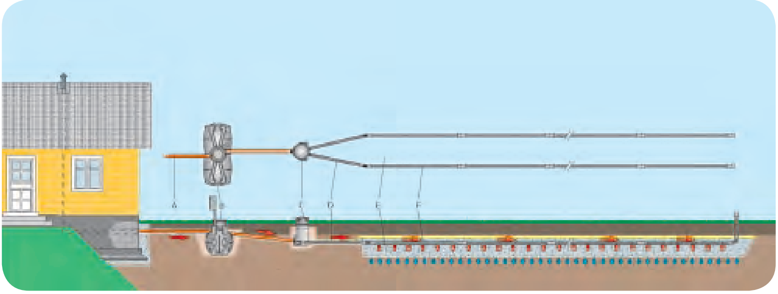
A well-installed Uponor waste water system is easy to use and maintain. The property should have be furnished with updated maintenance and use instructions.

The waste water system should be used and maintained in accordance with its instructions, ensuring that the system works correctly and is compliant with all statutory waste regulations.

Clean Easy channels water to the distribution chamber, from where it is distributed to the land filter trench/infiltration system.

The chemical is dosed in the first tank chamber.

Installing Uponor Clean Easy

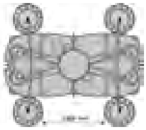


Before installation

Check the delivery and make sure that you have access to all installation equipment. The system is supplied with a 230 V 1 phase power cable.

Installing Clean Easy

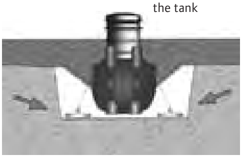
The pit for the tank is dimensioned so that anchoring plates can be positioned at the side of the well. The pit should be about 15 cm deeper than the bottom of the well. Spread a layer of gravel or sand along the bottom of the pit and compact the surface. Lower the tank into the pit. Check that the level of the tank is correct in relation to incoming waste pipes and that it is perfectly horizontal.



Anchoring

If the ground is unstable, the tank must be anchored using the Uponor Anchoring System. Pull the securing straps over the reservoir. Position the anchoring plates level with the bottom of the tank and fully outside the bottom area of the tank. Tension the securing straps. Cover the anchoring plates with a layer of sand about 20 cm thick. Tighten the securing straps so that they are stretched.

Anchoring the tank

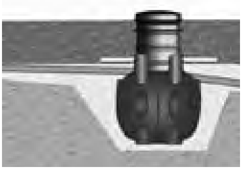


Backfilling the pit

Fill around the tank with stone-free sand and compact in layers approximately 30 cm thick. Connect the 110 mm waste pipe from the property (1-2 cm/m drop) to the tank inlet spigot. Ventilation of the property's waste must always be routed to the roof of the property. Fit the ventilation pipe outlet a good way above the roof ridge and as far as possible from the supply air intake. Finally, fill the tank with water.

Insulation

Insulate the tank and other parts with insulation material if there is a possibility of frost permeating deep into the ground.



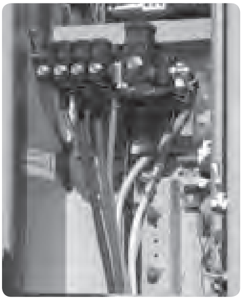
Fill Clean Easy with water

- immediately after installation
- after each emptying.

Installation of switch cabinet

Fit the switch cabinet in as high a position as possible so that it is kept free from snow.

Fit the switch cabinet on the pillar. Secure the switch cabinet in position using the bolts inside the cabinet.



Connect the power cable to the switch cabinet. NB! Use a qualified electrician for this job.

Installing/Increasing height of risers

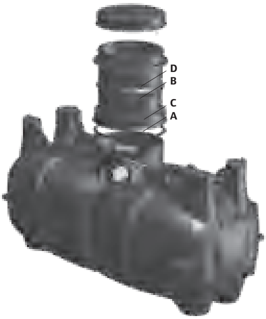
1. Installing risers

Place the sealing ring (A) on the neck of the tank (B). Lubricate the socket end of the riser (C) with Uponor lubricant. The riser (C) must be positioned so that the text "IN" shown on the riser pipe is directed towards the tank inlet. Press the riser down so that the tank neck is fully secured in the riser socket.

2. Increasing the height of risers

When raising, cut the riser at the "Cut off line" mark (D) in the middle of the riser. Use an Uponor 560 mm riser pipe and cut it to the appropriate length. Place a sealing ring in the 2nd groove on each end of the riser pipe (E). Fit the lower section of the cut riser in accordance with point 1. Fit the riser pipe and then the upper section.

Max installation depth is 1 m from the water flow inlet to ground level.



Functional check after installation

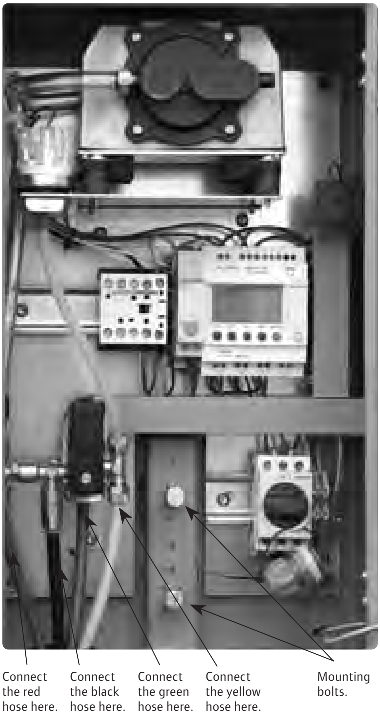
Fill the chemical reservoir with Uponor flocculent. Use protective goggles and gloves. Lift the chemical reservoir out of the tank riser pipe and place it on the ground beside the switch cabinet.

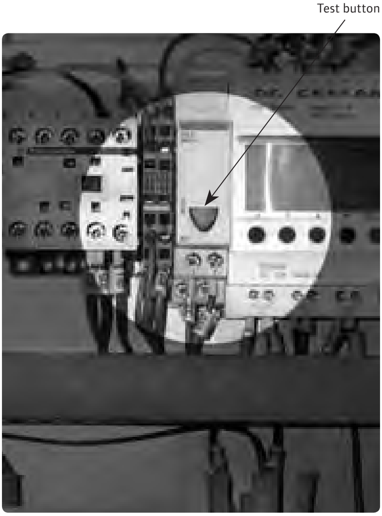
Place the graduated glass under the outlet pipe.

Turn on the power in the switch cabinet. Press the "test button" and wait 120 seconds. Approximately 40 ml flocculent will be dosed into the graduated glass. Dosing will cease after 12 seconds, at which point the water will be pumped from Clean Easy to the filter. Check that the water is distributed evenly in the distribution chamber. The air pump stops after 390 seconds.

Place the chemical reservoir back down into the riser pipe.

Press the "test button" again. Check that air bubbles form around the agitation pipe in the first chamber of the tank. This indicates that flocculent is being mixed with the wastewater. Close the well cover and the switch cabinet door. The air pump stops after 390 seconds.





Self-inspection/maintenance instruction Uponor Clean Easy

In order to ensure the function of Uponor Clean Easy, the system must be inspected twice a year. Regular inspection guarantees function and extends the service life of the waste water system.

Note actions performed such as topping up flocculent levels, sludge emptying or self-inspections in the service logbook.

Clean Easy is fully automatic, but the level in the flocculent reservoir should be checked at least every three months. The indicator light on the switch cabinet will go out if the level in the reservoir is excessively low.

Functional check, Clean Easy

This check must be performed at least twice a year and split into two sections - dosing/pumping out and agitation. Use protective goggles and gloves.

Dosing/Pumping out

1. Lift the flocculent reservoir out of the Clean Easy riser pipe and place it on the ground next to the switch cabinet (Figure 1).

2. Place the graduated glass under the outlet pipe.

3. Press the grey "test button" and wait 120 seconds (Figure 2).

4. Approximately 40 ml of flocculent will be dosed into the graduated glass. Dosing ceases after 12 seconds.

5. The water is channelled out from Clean Easy into the filter. Check that the water is distributed evenly in the distribution chamber.

6. The air pump stops after 390 seconds.

7. Place the chemical reservoir back down into the riser pipe.

Agitation

8. Press the "test button" again. Wait 120 seconds. Ensure that air bubbles form around the agitation pipe in the first chamber of the tank. This indicates that flocculent is being mixed with the wastewater. The air pump stops after 390 seconds.

9. Lock the well cover and switch cabinet door.

10. The display features a counter that records how many batches of treated water have been channelled from the phosphorous chamber into the filter. Each batch has a volume of 175 litres of water. Record the value shown on the counter each time the chemical levels are toped up.

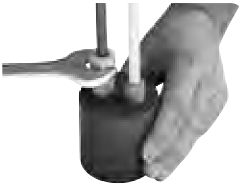
Dosing adjustment

If necessary, the amount of flocculent can be adjusted by opening the "grey" nut on the chemical pump (19 mm box spanner). The pump doses approximately 40 ml of flocculent. If you need to increase the dose, lift the pipe approximately 0.5 cm, tighten the screw and dose in the graduated glass. If this is not enough, simply repeat the procedure (Figure 3).

Figure 1

Figure 2

Figure 3



Clean Easy /sludge emptying

Clean Easy must be emptied twice a year as residual sludge can accumulate. Check the tan when topping up the flocculent level, i.e. 3-4 times a year, and request additional emptying if necessary.

Distribution chamber

The distribution chamber should be inspected once a year. Check the cover and lock. Fouling can build up inside the distribution chamber. If there is only a little fouling, it can be rinsed away. Because of the potential for blockage, larger quantities should be removed by collecting up most of the fouling material and then rinsing. This is a signal that the distribution chamber needs inspecting on a more frequent basis.

IMPORTANT!

When emptying sludge, empty the chambers in sequence - first, second and, finally, third chamber. This is to avoid any sludge moving between the chambers. Once emptied, the tank must be filled with water in the reverse order - third, second and, finally, the first chamber. At least once a year, ideally when emptying the sludge from the system, perform a visual inspection of the tank. Check the cover and the lock and also, if possible,inside the separator for any build-up of fouling. Rinse if necessary.

Infiltration pipe/collection pipe

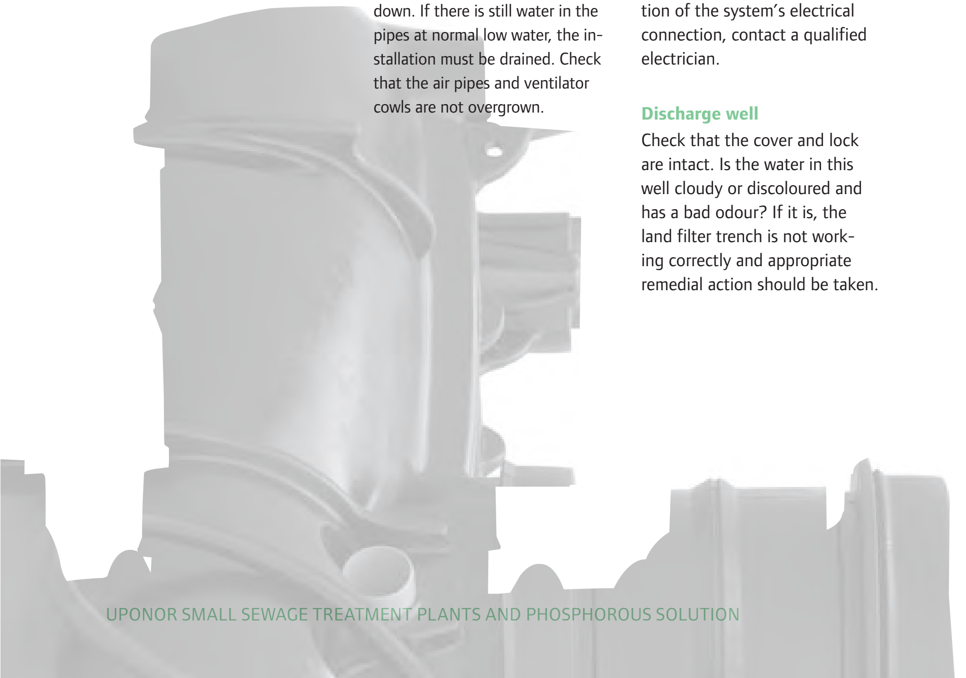
These pipes can be inspected through the ventilation pipes. Insert a stick/rod down into the pipes to check that there is no water present. If there is water present, the bed is not working as it should. The high water level may be the result of a temporary or permanent change in groundwater conditions. This must be followed up until the water level falls back down. If there is still water in the pipes at normal low water, the installation must be drained. Check that the air pipes and ventilator cowls are not overgrown.

Pump and pump chamber

The pump must be inspected and maintained in accordance with the pump manufacturer's instructions. Check non-return valve function in order to avoid the occurrence of a "backward flow" in the installation. On the pump chamber, it is important to check the cover, lock and connections between the pump and PEM pipe. If there is any doubt as to the function/condition of the system's electrical connection, contact a qualified electrician.

Discharge well

Check that the cover and lock are intact. Is the water in this well cloudy or discoloured and has a bad odour? If it is, the land filter trench is not working correctly and appropriate remedial action should be taken.



Uponor Phosphorous Removal Chamber - easy to install, maintain and use

The phosphorous chamber, which is easy to maintain, requires no troublesome filter replacement, filter materials or sand. On the whole, flocculent only needs to be topped up 2-3 times a year. The indicator light signals when the flocculent in the reservoir is running low. Continued operation of the system is ensured by performing inspections twice a year in accordance with the accompanying self-inspection software.

Quick and simple installation

The phosphorous chamber only requires a shallow pit measuring approximately 2 m x 2 m immediately after the sludge separator, along with a pipe connection for dosing and mixing that connects the first chamber of the sludge separator and the phosphorous chamber. The phosphorous chamber requires an electricity supply. Always employ a qualified electrician to carry out electrical work!

The signal light indicates when it is time to top up

Flocculent is added to the system via the chemical reservoir. A signal light indicates when it is time to top up the reservoir - generally 2-3 times a year.

Uponor's Phosphorous Chamber is very easy to use. The well has no moving parts or electronic components.

Effective phosphorous removal
- Extends the service life of the installation
- Ensures that the installation complies with requirements

Good economy
- Quick and simple installation
- Low operation costs

Easy to site
- Takes up little space
- Low build height

Very easy maintenance
- Flocculent topped up 2-3 times a year
- Only requires normal sludge emptying

High capacity
- Treats up to 4 m^3 wastewater per 24 hours

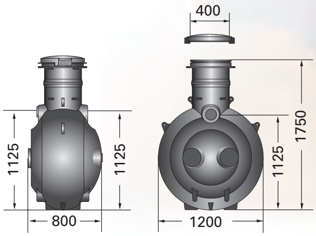
Cost-effective phosphorous removal

Wide area of application

Because dosing is done after water consumption, the phosphorous chamber can be used by up to 5 households. The solution is also ideal for use on camp-sites, in schools or in similar institutions. The maximum flow is 4 m³ per 24 hours.

Low operation costs

The cost of electricity and flocculent is kept to a minimum thanks to the use of batch dosing.

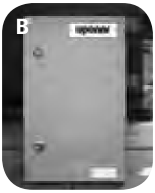


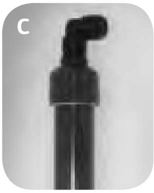
Packing list - Uponor Phosphorous Removal Chamber

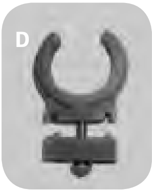
32 45 31 Uponor Clean Easy Plus

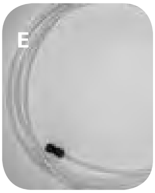
1 x well 0.5 m^3 with pillar, A
1 x switch cabinet, B
1 x dosing pipe, C
2 x dosing pipe brackets, D
1 x dosing hose 10 mm, 8 m, E
1 x protective pipe for dosing hose 50 mm, 5 m, F
2 x protective pipe seals 50 mm, G
2 x ground pipes 110 mm, L = 1000 mm, H
1 x graduated glass 100 ml, I

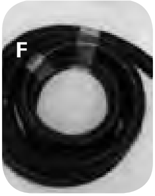
Uponor chemical percipitant 15 l must be purchased separately and is not included in this package!

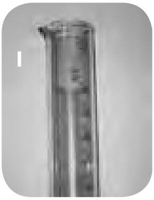












Phosphorous Removal Chamber Function

Chemical treatment principles

Using the separate, chemically active phosphorous chamber, which is fitted between the sludge separator and the infiltration/land filter trench, the phosphorous precipitant is dosed into the sludge separator's first chamber and mixed efficiently with the wastewater. The chemical sludge is stored in the sludge separator. Water is channelled to the land filter trench via the distribution chamber. Pumping increases the cleansing effect of the infiltration/land filter trench using the oxygenated water.

When treating phosphated water, it is important that the correct chemical to water volume ratio is used. This flocculent must be mixed efficiently into the wastewater. In Uponor's phosphorous trap, volumes are adapted to the flow rate, ensuring that the optimal volume is always used. Flocculent is only added when water is used.

Choosing the right flocculent is important

For phosphorous removal, a polyaluminium chloride-hydroxide solution is the best option. Aluminium compounds are particularly well suited for use in infiltration/land filter trenches as iron-based precipitants can produce fixed phosphorous in acid-free conditions.

System maintenance

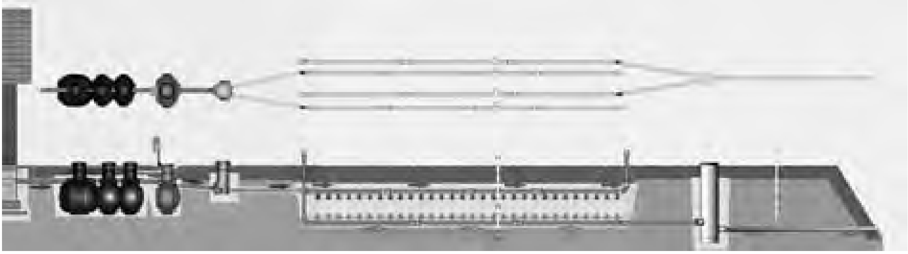
A well-installed Uponor waste system is easy to use and maintain. The property should have be furnished with updated maintenance and use instructions.
The waste water system should be used and maintained in accordance with its instructions, ensuring that the system works correctly and is compliant with all statutory waste regulations.


System functionality and dosing capability can be checked using the trap's test button.


From the phosphorous trap, water is channelled to the distribution chamber, from where it is distributed to the land filter trench/infiltration system.


The chemical is dosed in the first sludge separator chamber.

Installing Uponor Phosphorous Removal Chamber



Before installation

Check the delivery and make sure that you have access to all installation equipment. Drain the sludge separator (sludge emptying vehicle). It can make the working environment more pleasant by rinsing the separator with a high pressure washer in conjunction with the emptying process. If necessary, rinse the infiltration, collection and outlet pipes. The system is supplied with a 230 V 1 phase power cable.

Installing the phosphorous chamber

(Figure 1)

The phosphorous chamber is to be installed after the sludge separator. The levelled bottom of the pit should be 1,070 mm below the sludge separator outlet pipe. In order to enable sealing, there should be a gap of at least 500 mm between the phosphorous chamber and the sludge separator.

Connecting the sludge separator

The outlet pipe must be connected to the phosphorous chamber inlet pipe using a 110 mm wide waste pipe. If the sludge separator has an integrated distribution chamber, fit 90/110 reducers in the 90 mm outlet pipes (Figure 2). Fit a 45-degree bend to one reduce and a 45-degree branch pipe to the other reducer so that the 45-degree bend can be accommodated. Connect the branch pipe to the phosphorous chamber inlet pipe.

Figure 1

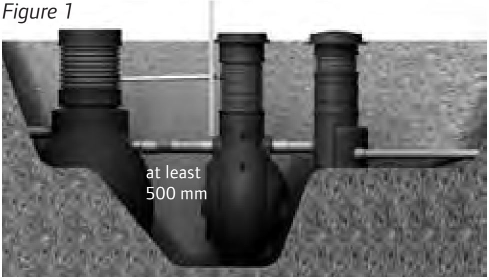
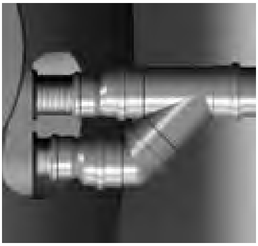


Figure 2



Initial backfilling of the pit

Fill the pit with sand up to the inlet pipe. Fill around the entire well. Compact every 30 cm.

Installation/connection of distribution chamber

Old distribution chamber

Connect the phosphorous chamber outlet pipe to the distribution chamber inlet using a 110 mm wide waste pipe.

Installation of a new distribution chamber

Install the distribution chamber so that the outlets are at the same level as the distribution pipes. See the distribution chamber installation instructions. Connect the phosphorous trap outlet pipe to the distribution chamber inlet using a 110 mm wide waste pipe.

Extending riser pipes

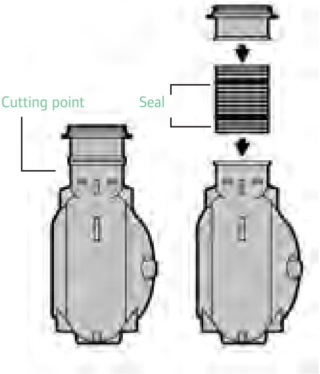
If the phosphorous chamber must be installed deeper than is normal, e.g. due to the position of the property's drain, the riser pipe must be extended. Using a saw, cut the riser along the "Cut off line" marking. Fit a 1.4 m, Ø 400 mm raiser pipe between the upper and lower sections. Each end must be fitted with a 400 mm sealing ring (in the second groove).

Note: Maximum tank installation depth, measured from the upper section of the tank body to the ground surface, is 1 metre.

Check to ensure that the chemical reservoir is not inside the riser pipe when you cut it.

Fitting protective pipes for the dosing hose (Figure 3)

The flocculent is dosed in the first chamber of the sludge separator. This ensures that the chemical sludge is retained in the sludge separator. The dosing hose protective pipe is to be fitted with a minimum 2 % fall to the sludge separator.



Drill a 50 mm hole in the phosphorous chamber pipe to accommodate the protective pipe.

The hole must be drilled at least 400 mm below the top edge of the riser pipe. Drill a 50 mm hole in the sludge separator riser pipe so that there is an inclination of at least 2 %. In sludge separators with multiple riser pipes, the protective pipe must be fitted in the riser pipe for the first chamber.

Place the pipe seals in the holes from outside the pipe. Cut the protective pipe so that the pipe reaches about 25 mm into the riser pipe. Fit the protective pipe in position.

Figure 3

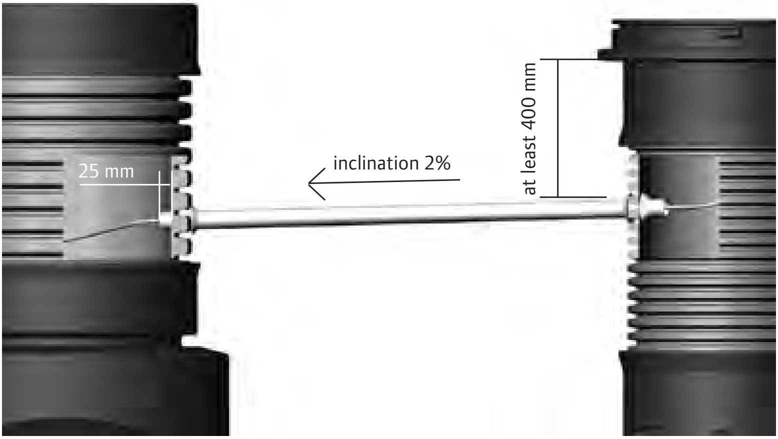
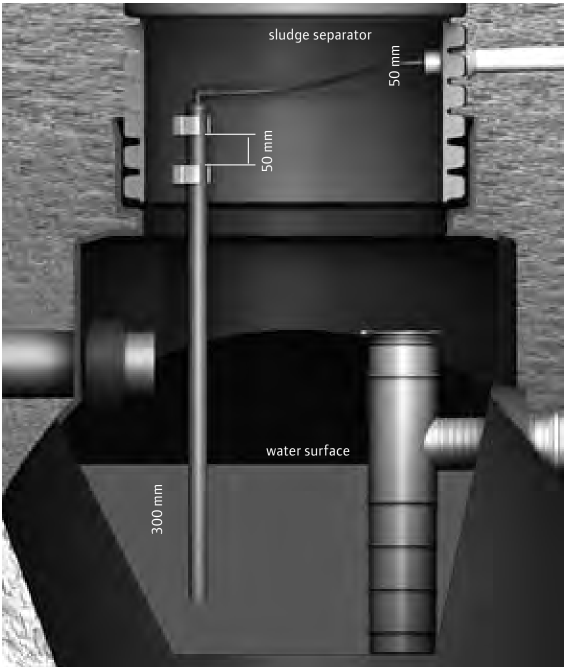


Figure 4

The chemical dosing pipe is to be fitted in the first sludge separator chamber.



Fitting the dosing pipe in the sludge separator (Figure 4)

Fit the dosing pipe brackets in the first sludge separator chamber near to the end of the inlet pipe. The installation height for the brackets is approximately 75 mm below the hole for the protective pipe.

The gap between the brackets should be about 50 mm. Measure the distance from the upper bracket to the lower edge of the inlet pipe. The length of the dosing pipe should be this measurement + 300 mm. Cut the dosing pipe to the correct length and secure the pipe in the brackets. Make sure that the lower end of the pipe is 300 mm below the lower edge of the inlet pipe.

Fitting the dosing hose (Figure 5)

Insert the dosing hose into the protective pipe. Secure the hose in the hose coupling at the upper end of the dosing pipe.

Make sure that the hose is securely connected to the hose coupling.
(See Figure 2 page page 364)

Once the hose is "tight", there should be about 1 metre of excess hose above the phosphorous chamber cover. Cut the hose to the correct length and connect it to the hose coupling on the chemical pump outlet pipe. Make sure that the hose is securely connected to the hose coupling.

Figure 5

Filling the pit

Backfill the pit to ground level. Form the ground so that surface water can run off.

Installing the switch cabinet

(Figure 6)

Fit the switch cabinet pillar in as high a position as possible so that the cabinet can be kept free from snow.

Fit the switch cabinet on the pillar. Secure the switch cabinet in position using the bolts inside the cabinet. Fit the hose protection pipe in the bottom of the switch cabinet via the lead-in. This protective pipe contains hoses of three different colours.

- **yellow**, chemical dosing
- **green**, start level
- **red**, out pumping

Connect the hoses as shown in Figure 6 to the quick release couplings (x 2) and the pointed end pressure monitor (x 1) in the cabinet.

Make sure that the hoses reach the bottoms of the quick release couplings. Connect the power cable to the switch cabinet. NB! Use a qualified electrician for this job.

Figure 6

Functional check (Figure 7)

Fill the chemical reservoir with Uponor flocculent. Use protective goggles and gloves. Lift the chemical reservoir out of the phosphorous chamber riser pipe and place it on the ground beside the switch cabinet. Disconnect the dosing hose from the chemical pump outlet pipe by pressing the quick release coupling. The hose disconnects.

Pull out the hose. Place the graduated glass under the outlet pipe.

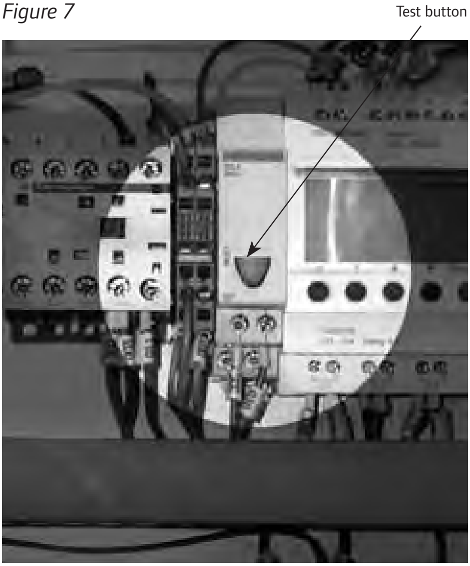
Turn on the power in the switch cabinet. Press the "test button" and wait 90 seconds. The chemical pump administers a dose of approximately 70-90 ml of chemical into the graduated glass. Dosing will cease after 45 seconds, at which point the water will be pumped from phosphorous chamber into the land filter trench.

Check that the water distributes itself evenly between the infiltration pipes. The air pump stops after 4 minutes. Secure the hose and lower the chemical reservoir into the riser pipe.

Press the "test button" again. Check that air bubbles form around the dosing pipe in the first chamber of the sludge separator. The chemical mixes with the wastewater inside the pipe. Close the well cover and the switch cabinet door.

The meter on the display clicks forward for every 100 litres of water pumped from the phosphorous trap to the filter trench. Follow the meter and record the value each time.

Figure 7



Self-inspection/maintenance instruction Phosphorous Removal Chamber

In order to ensure correct function of Uponor Phosphorous Removal Chamber, the system must be inspected twice a year. Regular inspection guarantees function and extends the service life of your waste installation.

Note any action taken, e.g. topping up flocculent levels, sludge emptying or any self-inspections performed in the service logbook.

The phosphorous chamber is fully automatic, but the level in the flocculent reservoir should be checked at least every three months. The indicator light on the switch cabinet will go out if the level in the reservoir is excessively low.

Functional check

This check must be performed at least twice a year and split into two sections - dosing/pumping out and agitation. Use protective goggles and gloves.

Dosing/Pumping out

1. Lift the flocculent reservoir out of the phosphorous trap riser pipe and place it on the ground beside the switch cabinet (Figure 1).

2. Disconnect the dosing hose from the chemical pump outlet pipe by pressing on the quick release coupling (Figure 2).

3. Place the graduated glass under the outlet pipe (Figure 3).

4. Turn on the power in the switch cabinet (Figure 4).

5. Press the grey "test button" and wait 90 seconds (Figure 5).

6. The chemical pump doses approximately 70-90 ml of flocculent into the graduated glass. Dosing ceases after 45 seconds (Figure 3).

7. Water is channelled out from the phosphorous chamber into the land filter trench. Check that the water distributes itself evenly in the distribution chamber.

8. The air pump stops after 4 minutes. Secure the hose and lower the chemical reservoir into the riser pipe.

Agitation

Press the "test button" again. Wait 90 seconds. Check that air bubbles form around the dosing pipe in the first chamber of the sludge separator. This indicates that flocculent is being mixed with the wastewater. Lock the well covers and the switch cabinet door. The display features a counter that records the number of batches of treated water that have been channelled from the phosphorous chamber to the filter. Each batch represents a volume of 100 litres of water. Record the value shown on the counter each time you top up the system with chemical.

Dosing adjustment

If necessary, the amount of flocculent can be adjusted by opening the "grey" nut on the chemical pump (19 mm box spanner). The pump provides a dose of approximately 70-90 ml flocculent when the "pipe" is pressed down in the bottom of the pump. If there is a need to reduce the dose, lift the pipe approximately 0.5 cm, tighten the screw and dose in the graduated glass. If this is not enough, simply repeat the procedure (Figure 6).

Figure 1

Figure 2

Figure 3

Figure 4

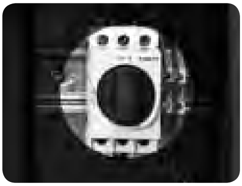


Figure 5

Figure 6

Self-check/maintenance instruction - Other

Sludge separator/sludge emptying

The sludge separator for greywater + toilet water should normally be emptied at least once a year, although additional emptying may be required if you are using a flocculent as the sludge will be more voluminous. Check the sludge separator when topping up the flocculent level in the phosphorous trap, i.e. 3-4 times a year, and request additional emptying if necessary.

Distribution chamber

The distribution chamber should be inspected once a year. Check the cover and lock. Fouling can build up inside the distribution chamber. If there is only a little fouling, it can be rinsed away. Because of the potential for blockage, larger quantities should be removed by collecting up most of the fouling material and then rinsing. This is a signal that the distribution chamber needs inspecting on a more frequent basis.

IMPORTANT!

When emptying sludge, empty the chambers in sequence - first, second and, finally, third chamber. This is to avoid any sludge moving between the chambers. Once emptied, the sludge separator must be filled with water in the reverse order - third, second and, finally, the first chamber. At least once a year, ideally when the sludge is emptying from the system, perform a visual inspection of the sludge separator. Check the cover and the lock and also, if possible,inside the separator for any build-up of fouling. Rinse if necessary.

Infiltration pipe/collection pipe

These pipes can be inspected through the ventilation pipes. Insert a stick/rod down into the pipes to check that there is no water present. If there is water present, the bed is not working as it should. The high water level may be the result of a temporary or permanent change in groundwater conditions. This must be followed up until the water level falls back down. If there is still water in the pipes at normal low water, the installation must be drained. Check that the air pipes and ventilator cowls are not overgrown.

Pump and pump chamber

The pump must be inspected and maintained in accordance with the pump manufacturer's instructions. Check non-return valve function in order to avoid the occurrence of a "backward flow" in the installation. On the pump chamber, it is important to check the cover, lock and connections between the pump and PEM pipe. If there is a doubt as to the function/condition of the electrical connection, contact a qualified eletrician.

Discharge well

Check that the cover and lock are intact. Is the water in this well cloudy or discoloured and has a bad odour? If it is, the land filter trench is not working correctly and appropriate remedial action should be taken.

Contact information

Water & Sewage Consultant/Planning

Name

Address

Telephone

Place of Purchase/Supplier

Name

Address

Telephone

Installer/Contractor

Name

Address

Telephone

Service

Name

Address

Telephone

Sludge Removal

Name

Address

Telephone

Local Authority Environment and Health Protection Department

Name

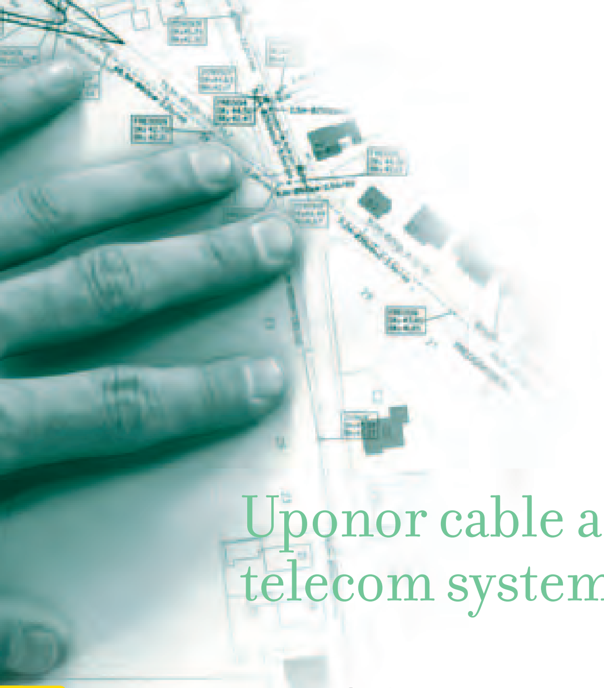
Address

Telephone

UPONOR INFRASTRUCTURE

CABLE AND TELECOM

Cable and Telecom



Uponor cable and telecom systems

8.1 Introduction

Uponor's cable duct system PVC and PE are used in buildings, above ground and in the ground as protection for low power and high power cables, as well as all types of data transfer cables, e.g. for cable TV, telephone and fibre optic networks.

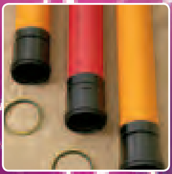
Uponor supplies a complete range of smooth, corrugated, double-walled and Uponor Tripla ducts as well as two-part smooth and flexible cable conduits for repair – all of an extremely high quality and with a documented lifespan of at least 100 years.

Continuous development and our many years of experience have resulted in a comprehensive, high-quality range with complete system solutions allowing for the smallest of details, making the system simpler to use in the protection of cables. The good material characteristics of the cable conduits allow them to tolerate cold and impact. Added to this, the cable conduit withstands most chemicals and other aggressive fluids. The PE duct is light and therefore easy to handle during storage, transport and installation.

Most of Uponor's cable protection duct systems are impervious to ground water so that you can lay the cable conduit as "empty conduit" and subsequently pull your cables or fibre-optic through without problems of penetrating soil, sand, ground water or anything else that may inconvenience or impede installation.

The system also includes:
- Conduit fittings range
- Cable jointing box range
- Cable covers
- Marker tape and marker netting

All cable and telecom products have been produced according to their original country's standards. Please contact Uponor technical support for more information.



uponor

UPONOR INFRASTRUCTURE

CABLE DUCTING SYSTEM

PE cable ducting system for protection of electrical and communication systems

8.2 Uponor cable ducting system

PE cable ducting system for protecting electrical, communications and data transfer cabling

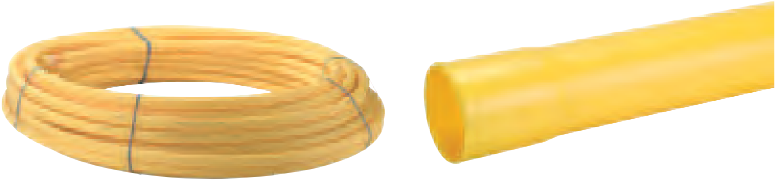
Uponor system solutions for protecting power, telecommunications and fibre optic cables cover a large range of cable conduits, warning materials, jointing boxes and various accessories. Cable conduits are manufactured from PE.

Uponor has developed a quality range of complete system solutions, where many practical details make the different solutions easy to use.

The good material characteristics of the cable conduits allow them to tolerate cold and impact. In addition, the cable conduit withstands most chemicals and other aggressive fluids. The PE conduits are lightweight and therefore easy to manage during storage, transport and installation.

Smooth, polythene cable conduits

Class SRN, SRS and SRE



Smooth PE cable conduits are supplied in dimensions 32-160 mm

Outer dim. mm	Inner dim. mm	Length m	Colour	Text on conduit	
110	102	6	Yellow	Kraftkabel SRN	
50	43	6	Yellow	Kraftkabel SRS	
75	66	6	Yellow	Kraftkabel SRS	
110	99	6	Yellow	Kraftkabel SRS	
160	144	6	Yellow	Kraftkabel SRS	
32	26	6	Black	Kraftkabel SRE-P	
50	40,8	6	Black	Kraftkabel SRE-P	
75	61,4	6	Black	Kraftkabel SRE-P	
110	90	6	Black	Kraftkabel SRE-P	**Pull wire**
32	28	50	Yellow	Kraftkabel SRN	Yes
32	28	100	Green	Svagströmskabel	Yes
32	28	100	Orange	Svagströmskabel	Yes
50	41	100	Yellow	Kraftkabel SRS	Yes
32	26	100	Black	Kraftkabel SRE-P	Yes
50	40	100	Black	Kraftkabel SRE-P	Yes

Table 8.2.1

Smooth PE conduit is available in straight lengths and on rings for protecting power, telecommunications and signal cables.

The conduit is smooth inside and outside and is manufactured in polythene. Supplied in lengths of 6 m or coils of 50 or 100 m in yellow, black, green, or orange colour.

Approvals

Manufactured according to
SS-EN 4241437.

Corrugated, polythene cable ducts

Corrugated PE cable ducts are supplied in dimensions 50-110 mm

Dimensions External diameter mm	Dimensions Internal diameter mm	Length m	Colour	Pull wire
50	42	50	Yellow	Yes
60	50	50	Yellow	Yes
93	80	50	Yellow	Yes
110	98	50	Yellow	Yes

Table 8.2.2

Uponor's corrugated cable ducts are used as temporary protection for cables and other types of line, etc. The conduit provides the cables with a degree of protection against the mechanical effects of the surrounding fill material.

The cable conduit is manufactured in PE and supplied in coils that are easy to transport, unwind and install.

Double-walled PE cable ducts

Double-walled PE cable ducts are supplied in dimensions 50-160 mm

Outer dim. mm	Inner dim. mm	Length m	Colour	Pull wire	Impervious/ pervious
50	42	3	Yellow		Impervious
50	42	6	Yellow		Impervious
50	42	6	Green		Impervious
50	42	6	Orange		Impervious
50	42	6	Yellow		Pervious
110	95	6	Green		Pervious
110	95	6	Yellow		Pervious
160	138	6	Yellow		Pervious
50	42	50	Yellow	Yes	
50	42	50	Green	Yes	
50	42	50	Orange	Yes	
110	95	50	Yellow	Yes	
110	95	50	Green	Yes	

Table 8.2.3

Uponor's double walled cable ducts for installing cables in the ground are smooth inside and corrugated outside. The smooth inner surface makes it easy to pull cables, even on changes in direction. The conduit is manufactured in PE which has high impact resistance, even at low temperatures. Due to the double wall, the structure of the cable conduit is both strong and easy to work with. The low weight of the conduit also allows for quick and less labour intensive installation.

Double-walled cable ducts are easy to install, even under difficult conditions. The conduit will also withstand loads during transport and handling. During installation, the flexible conduit follows the motion and composition of the ground. The need to employ conduit fittings is also kept to a minimum by the flexibility of the conduit.

Approvals

Uponor double-walled cable ducts are manufactured in accordance with SS-EN 4241437.

Uponor Cable Ducting System Tripla – Characteristics

The Tripla cable ducting system is named after the system's triple layer pipe. The pipe is made from polyethylene (PE). The system comes with all of the parts and fittings needed for connection to other systems such as concrete chambers and 100 mm pipes. The excellent load carrying capacity, impact resistance and lightness of Uponor Tripla make it ideal for a vast range of applications.

Figure 8.2.4

Tightness

The pipe socket is equipped with an integral seal which is held firmly in its groove by a support ring. This prevents the seal from being pushed along by the spigot pipe end. Use of an approved lubricant is recommended for ease of connection. Soap must not be used, as is it can "glue" the cables as it dries. The excellent airtightness of the Tripla system makes it ideal for blowing pull-cords. The socket joints can withstand blow pressures up to 3.0 bar and are watertight to an external pressure equivalent of a 3 metre water column – the same tightness performance as drainage systems. Correctly installed socket joints are therefore completely watertight, keeping the cables fully protected from moisture and freezing, and enabling cable to be pulled also in winter due to ice-free ducts. Tripla is specially designed for watertight cable ducting applications such as fibre installation.

Easy to install

The duct pipe has a longitudinal stiffness between that of double-wall pipe and PVC pipe. Tripla has sufficient stiffness to easily construct a vertically or horizontally straight cable duct up to hundreds of metres in length. At the same time, the pipe is not too stiff. It can bend around obstacles without compromising joint tightness. The duct pipe's integral socket measures100 mm in length, ensuring that the spigot end cannot slip out of joint. This property is particularly important in installations where the duct is lowered fully-built into the trench. The duct's long, integral sockets are flush with the pipe surface ensuring that the duct has no steps or other sharp edges that could damage cable sleeving. Unlike PVC pipe, the spigot end of Tripla does not bevelling after cutting, making installation simpler and quicker. Extra cut lengths can also be used by fitting double sockets, reducing pipe waste considerably.
The SN 8 class duct pipe weighs around 5 kg and the SN 16 pipe around 7 kg.

Figure 8.2.5

Design

Product tests and operating experience show that cable can be pulled through a continuous Tripla duct length of up to 300 m including three or four slight (R≥ 30 m) bends plus one or two sharper (R=15 m) bends below 60 degrees. Sharper pipe bends or bend fittings in the line shorten the pull-through length.

Direction changes

Direction changes in the line must be gradual to keep the cable pulling friction as low as possible. Gradual bends are achieved by bending the pipe. The maximum bend angles for Tripla pipe are given in the table below. Bends sharper than the angles given in the table will cause out-of-roundness. When bending, the pipe ends must be braced to prevent the socket joint from twisting. The maximum allowable angular deflection at socket joints is 2°.

Duct pipe	Pipe end displacement B (m)	Angular deflection
Tripla 110	1.20	38°
Tripla 160	1.00	32º

Table 8.2.6. Bending limits for a 6-metre pipe irrespective of strength class (figures from the Tripla design and installation manual).

Choice of strength class

Cable ducting pipes are classed based on ring stiffness and impact resistance as strength class A or B, in accordance with Finnish standard SFS 5608. The ring stiffness of class B pipe is SN ≥ 8 kN/m^2, and of class A pipe SN ≥ 16 kN/m^2.

Class A (heavy use) pipes are used:

- in subsoil piping and sand-filled channels in heavy traffic areas, and in subsurface road crossings
- The maximum installation depth for Class A (heavy use) pipe is 6.0 m.

Class B (medium use) pipes are used:

- in subsoil piping and sand-filled channels outside heavy traffic areas
- The maximum installation depth for Class B pipe is 6.0 m.

Minimum depth of cover

The duct pipes must have a minimum depth of cover of at least ≥ 0.4 m.

In trafficable areas the depth of cover must be higher: ≥ 0.8 m in light traffic areas and ≥ 1.0 m in heavy traffic areas.

Installation

Cutting and jointing

Tripla duct pipe can be cut by sawing between the pipe grooves. To make the joint, the cut end is then pushed fully home to the base of the adjoining pipe's socket. To facilitate the connection, a silicone based lubricant or rape oil is applied to the Tripla pipe seal.

Figure 8.2.7. Connecting Tripla duct pipe to a double socket.

Connecting Tripla to PVC pipe

Tripla duct pipe can be connected to PVC pipe using a purpose-designed reducer. The reducer fitting is first installed in the Tripla pipe socket, and the spigot end of the PVC pipe is then inserted into the reducer. When connecting the PVC pipe to the socket end, Tripla can be used in two ways:

- by cutting off the PVC pipe socket and connecting as described above
- by connecting a small piece of PVC pipe to the socket and making the Tripla joint as described above.

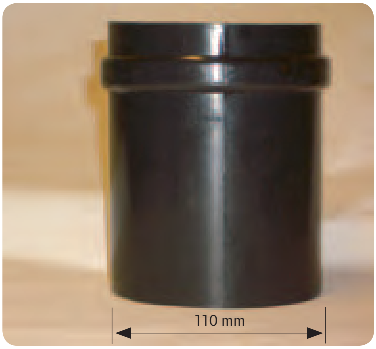


Figure 8.2.8. Heat-shrink fitting for Tripla cable duct pipes.

Rigid bends

The ducting system uses PVC bends at 22, 45 and 90°. The bends are fitted with an integral lip seal and the bend diameter,110 mm, is fully compatible with Tripla. The PVC bends have a wall thickness of 5.3 mm, which is equivalent to class A ring stiffness or SN 16.

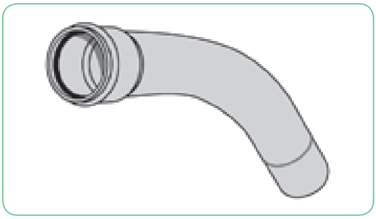


Figure 8.2.9. Cable ducting system rigid bend.

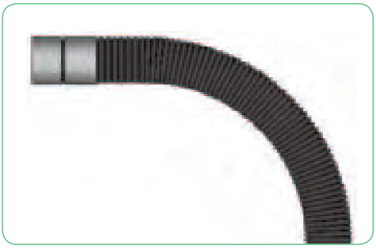


Figure 8.2.10. Flexible bend.

Figure 8.2.11. Branch fitting, 110/110 x 45°

Figure 8.2.12. Attachments for marking balls.

Figure 8.2.13. Splice box with Tripla duct pipes installed.

Flexible bends

The ducting system can also be installed with flexible bends. The flexible bends have a class B, SN 8 ring stiffness. Each bend has a socket and a ready installed seal on the spigot end. If flexible bend is installed at 90°, it must be anchored in position so that its bending radius cannot fall lower than 0.9 metres. Never use your knee to bend the flexible bend. Care must be taken not to buckle the bend fitting, as this can create a ledge in the cable duct.

Branches

The bell ends of the branch fittings fit directly onto the Tripla pipe sockets. The spigot end of the branch is coupled to the Tripla socket end with a PVC reducer. The PVC bends have a wall thickness of 5.3 mm, which is equivalent to class A ring stiffness or SN 16.

Underground splice boxes

Uponor splice boxes are made from rotational moulded PEM plastic. The boxes are designed for use as protective fibre optic splice enclosures, for example in roadside installations carried out by ploughing and in urban green areas. The box has ready positions for 50, 100, 110 and 160 mm lead-throughs. The base is ready perforated. The underside of the box cover is equipped with attachments for different marking balls. The box installation depth should allow for a thin gravel layer and a cellular plastic insulation board above the box cover, as well as at least a 20 cm backfill layer. The box location must be marked above ground with a marker post.

Lead-throughs and connection to concrete chambers

Tripla duct pipe is connected to a concrete chamber by first cutting a hole through the chamber wall with a diamond drill. An O-ring seal is then installed on the pipe end. The seal also allows approx. 15–20º angle deflection at the joint. The lead-through sizes for Tripla pipe are:

Ø 110 mm, drill hole 126 mm
Ø 160 mm, drill hole 176 mm

The pipe is pushed through the drilled hole and an O-ring seal (without lubricant) is installed on the pipe end. The pipe is then pulled backwards to drag the seal into the middle of the chamber wall.

Figure 8.2.14. Tripla lead-through into a concrete chamber.

Figure 8.2.15. O-ring seal position on the Tripla spigot end.

Sealing foundation wall lead-throughs

If a building has no pre-installed conduit, a Ø126 mm hole is drilled through the foundation wall to accommodate the Ø 110 Tripla duct pipe using a diamond drill. Before sealing with Sikaflex 11FC, the pipe surface must be cleaned with Sikacleaner 205 to improve adhesion of the 11FC to the pipe surface. An O-ring is fitted around the pipe as a lead-through seal. The Sikaflex sealant is then spread evenly around the inside of the lead-through hole with a spatula. The hole is then tidied up to receive the pipe, and the pipe is inserted centrally through the hole. Sikaflex 11FC is applied from both sides of the foundation wall so that the gap between the pipe and the hole is fully filled with Sikaflex sealant.

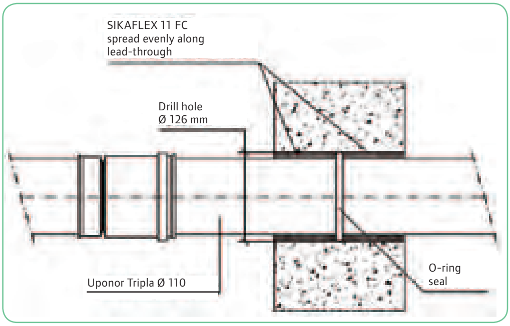
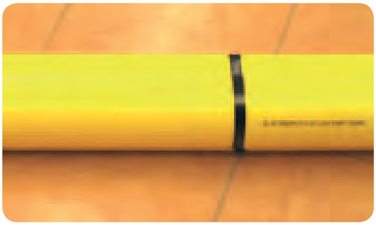
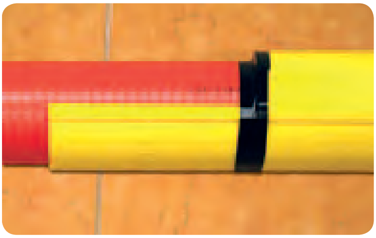
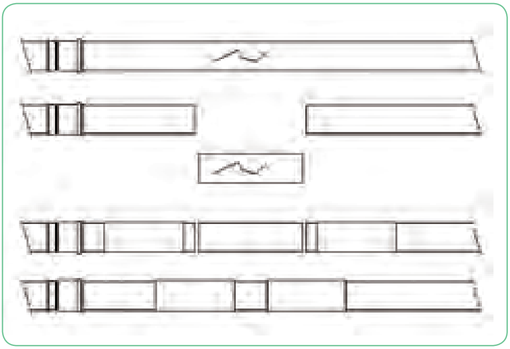


Figure 8.2.16. Cross section of lead-through.





Figures 8.2.17 and 18. Repairing a damaged Tripla pipe using the split pipe method.



Kuva 8.2.19 Example pipe repair methods.

Split pipes

Split duct pipes consist of two interlocking lengths of split pipe. The split pipe method provide a means of installing protective ducting in-situ around previously unprotected cables. Split pipe is also used to repair or replace damaged duct sections on existing lines.

Tripla split pipe comes in 120/110 x 3000 mm lengths which snap snugly into place when gently tamped by foot. The split pipe can be joined to another split pipe by sliding the top half along so that the bottom half is slightly longer than the top.

The pipe can then be fastened to the adjacent split pipe, e.g., with duct tape. This method provides a sand-tight joint.

Repairing damaged Tripla pipes using slip couplers

If point damage is identified on the duct wall before pulling the cable, the pipe is cut next to damaged spot and repaired by sliding a slip coupler in place over the top. The slip coupler joints must then be taped to make them sand tight. To achieve a watertight repair connection, a double socket coupler must be used. If the damage is more extensive, the entire damaged section is cut out and a new piece of duct pipe of matching length is fitted in its place with slip couplers. The Tripla ducting system uses 119 x 300 mm slip couplers.

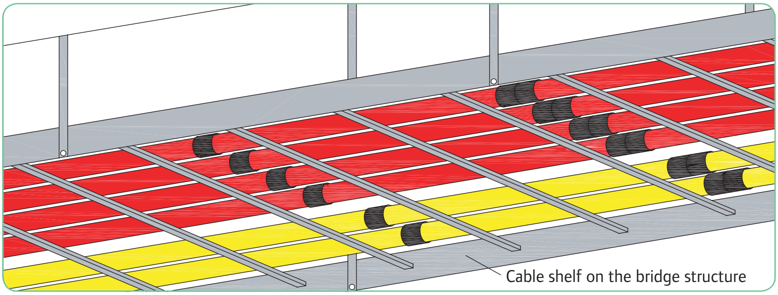


Figure 8.2.20. Cable ducting installed in a roof or bridge structure.

Duct supports

Duct pipe support is required, for example, in bridge and indoor installations and is carried out with grids or mounting brackets.

Cover sheets

A cover sheet is laid at a depth of 20–40 cm above the cable to indicate the cable's location in the event of subsequent excavations. The cables are normally covered with a 10–20 cm deep layer of sand and the cover sheet laid above.

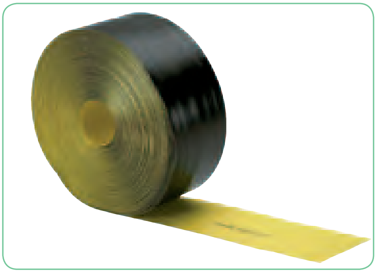


Figure 8.2.21. Cable cover sheet.

Plugging

End plugging of the duct pipe is carried out using purpose-made solid end plugs. The plugs fit both socket and spigot ends.

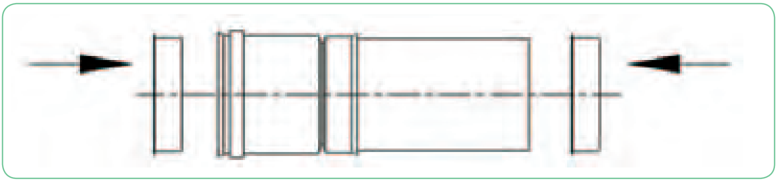


Figure 8.2.22. End plug installation.

Subsurface road and rail crossings

Installation beneath roads can be performed by moling. A cable is threaded through the Tripla pipe and the spigot end of the pipe is fastened to a soil displacement hammer (mole). The Tripla pipe is dragged by the mole through to the other side of the road or railway.

Figure 8.2.23. Fastening the Tripla pipe to the mole.

Figure 8.2.24. Slotting the Tripla pipe into the mole head.

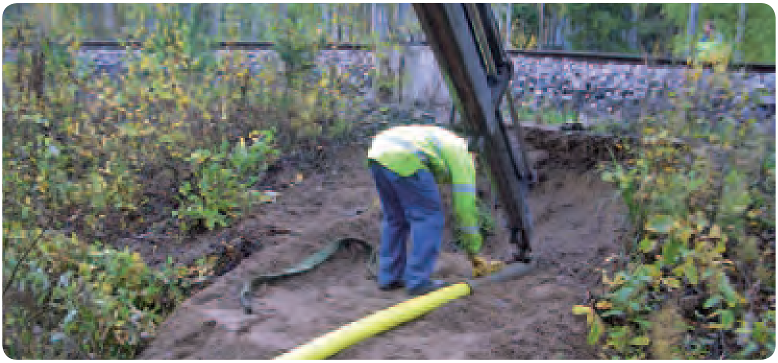


Figure 8.2.25. Preparing to mole Tripla pipe beneath a rail line. Moling distance 15 m.

Figure 8.2.26. A completed pipe crossing.

Horizontal drilling for subsurface road crossings

Under-road installation is also commonly performed using the horizontal drilling method. A cable with a disc at one end is threaded through the Tripla duct pipe. The disc fits over the end of the pipe and enables the pipe to be pulled beneath the road via the horizontally drilled hole.

Figure 8.2.27. Tripla SN 16 (class A) duct pipe.

Figure 8.2.28. A 12 m road crossing carried out by horizontal drilling

Trench laying

The size of the pipe trench is determined according to the cable layout drawings, ensuring that all pipes, chambers and possible protective structures can be properly installed and compaction and casting work properly carried out. The trench must be no wider than the necessary working space requires. The guideline trench dimensions are presented later in this section. The walls must be sufficiently sloped to prevent danger of collapse and any stones that may be hazardous if dislodged must be removed.

The need for a bedding layer is determined according to the subsoil quality. If no foundation structures are needed, the pipes are laid, according to the subsoil quality, either on bedding or directly on the subsoil. The chosen method is specified site-specifically in the construction plan or site meetings. Direct ground laying is permitted on clay and on silty or sandy soils. Direct placement is also permitted on till soils with a maximum stone size of 16 mm. The trench must be cleared of roots and large stones, and the subsoil and embedment materials must not be frozen. The trench bottom must be dug sufficiently level to minimise cable pulling friction caused by bumps and level variations. The trench bottom must also be loosened and raked to a depth of at least 15 cm to ensure a stoneless bedding. The bedding is then compacted by tamping or with a vibrating plate compactor.

The duct pipes must be cleaned or carefully inspected before blowing the pull-cord and pulling the cable. If the soil meets the above requirements, the pipes can be placed directly on the levelled trench bottom. Otherwise, a bedding layer of sand, gravel or crushed aggregate must be laid to a depth of at least 150 mm below the pipe. The maximum grain size of the natural aggregate to be used for the bedding is determined according to the outside diameter of the pipe. Before laying the bedding, the ready trench bottom must be cleared of large stones, levelled and compacted. The soil must be free of stones and rock to a depth of 15 cm below the bedding. The bottom must be levelled to ensure that the installed pipes are evenly supported along their entire length by a firm, stoneless base. In winter conditions the trench must be excavated in shorter stretches so

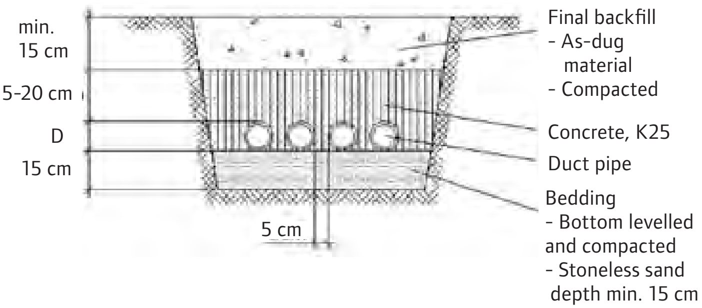


Figure 8.2.29. Concrete reinforced sand-embedded cable channel

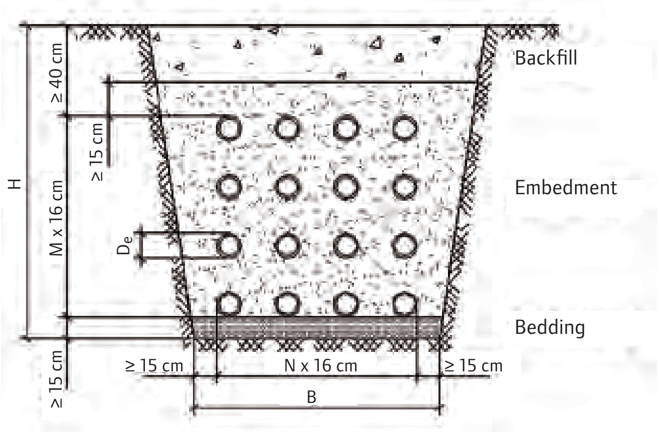
that the subsoil is not exposed for long enough to freeze.

If the cable channel is built through rock, the trench must be quarried to at least 15 cm below the level of installation. If the carrying capacity of the soil is insufficient with respect to the pipe system or the traffic load, the trench bottom must be reinforced. The reinforcement method must be specified in separate drawings.

Installation at temperatures below –20 C° must be carried out with caution due to the reduced impact resistance of the pipe in extreme cold conditions. The level of stormwater or groundwater in the trench must be kept low enough during installation to prevent pipe displacement due to buoyancy. Pipes can also be held in place by covering with embedment material intermittently along the line to prevent uplift. The embedment material placed around the pipe must be thoroughly compacted. Mechanical compaction can be used only after at least 30 cm backfill depth above the pipe crown. The pipe ends must be sealed with solid plugs.

Cable channels and duct trenches with sand backfill are used for sites subject to light loading:

- Parks and green areas and pedestrian and light traffic routes not subject to regular vehicle traffic.
- In heavy traffic areas in which sufficient pipe depth (min. 1 m) cannot be achieved, load distributing steel reinforced concrete slab reinforcement is required.
- Concrete slab reinforcement can also be



D_e = pipe outside diameter
N = pipe number horizontally
M = pipe number vertically
H = trench depth ≥ 40 + 11 + M x (De + 5 cm)
B = width of trench bottom ≥ N x 16 + 20 cm

Figure 8.2.30. Cross section of a sand-embedded cable channel

installed retrospectively if traffic routes are build across the cable. The slab must be 0.8–1 m wider than the trench bottom.

In shallow trench installations, the duct pipes can be encased in concrete for increased carrying capacity. The encasement thickness is specified case-specifically by the designer. As concrete pouring causes pipe uplift, the pipes must be kept in place during encasement.

The bottom-most pipes are laid on the bedding and covered with embedment material. To ensure sufficent lateral support from the embedment material, adjacent pipes must be laid at a minimum distance of 5 cm apart. The same minimum distance of 5 cm must also be ensured between pipe layers. The minimum embedment depth above the topmost pipe layer is 15 cm.

The as-dug material can normally be used for the final backfill. The material must not, however, contain humus, peat, mud, stumpwood, roots etc. or frozen soil. The backfill compaction requirement depends on the site conditions. In trafficable areas the backfill must meet the density requirements for road sub-base. If no backfill compaction is carried out, the backfill level must compensate for subsequent subsidence.

Where subsequent trench work is carried out adjacent to a sand-embedded line, loss of sand from around the duct pipes must be prevented. If such subsequent trench work is anticipated, the embedment sand can be hardened with cement during backfilling. The appropriate cement ratio is approx. 100–150 kg/m^3. Pipe supports are not used in sand embedded trenches as the difference in carrying capacity between the supports and the sand results in point loading.

Max. pipe no. vertically	Non-trafficable area H min. (40 cm)	Light traffic area H min. (80 cm)	Heavy traffic area H min. (100 cm)
1	67	107	127
2	83	123	143
3	99	139	159
4	115	155	175
5	131	171	191
6	147	187	207
7	163	203	223
8	179	219	239

Trench must be dug to minimum depth H, or in non-stony soils to depth H minus 15 cm.

Figure 8.2.31. Minimum depth for sand-embedded cable trenches with Tripla ø 110 duct pipe.

Transition wedge

Where a trench crosses from rock to loose soil, the change in carrying capacity of the trench foundation must be made gradual using a transition wedge structure. A transition wedge is also required for road crossings at the point where the under-road caseing pipe terminates within the road area.

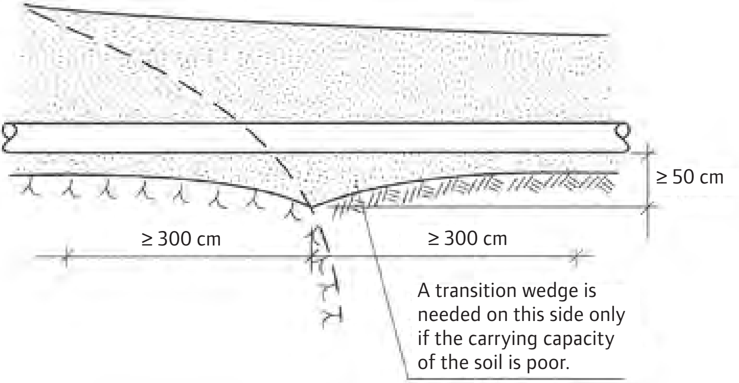


Figure 8.2.32. A transition wedge: a wedge-shaped bedding layer used to soften the carrying capacity transition between rock and loose soil.

Water crossings

Watercourse crossings are carried out using butt welded Uponor ProFuse pressure pipes to form an underwater cable duct. The pipes must be of the same diameter. The pipes are anchored to the bottom with concrete ballast weights. Cable boxes are installed at the shore line, above the high water level.

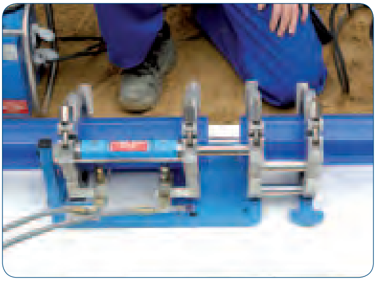


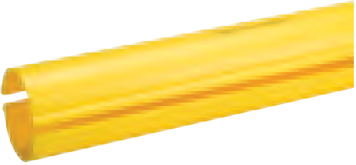
Figure 8.2.33. Butt-welding ProFuse pipes.

Split duct

Split smooth PE cable ducts are supplied in dimensions 56-160 mm.

Outer dim. mm	Inner dim. mm	Length m	Colour
56	50	3	Yellow
83	75	3	Yellow
110	100	3	Yellow
120	110	3	Yellow
160	138	3	Yellow
58	50	3	Orange
120	110	3	Orange

Table 8.2.34



Angle-adjustable split smooth PE cable ducts.

Outer dim. mm	Inner dim. mm	Length m	Colour
110	100	0,4	Yellow
110	100	1,0	Yellow
110	100	2,5	Yellow

Table 8.2.35

Uponor's split cable duct is used as protection for existing cables and for repairs in case of broken conduits

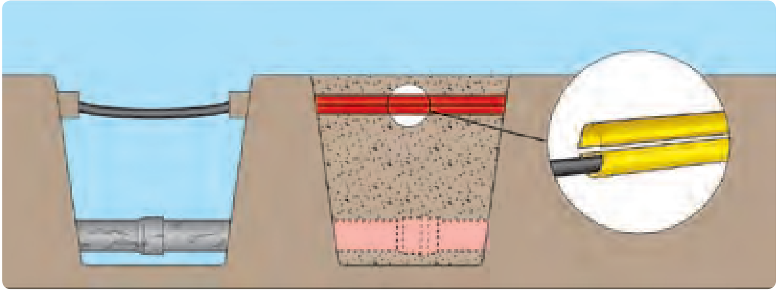


Figure 8.2.36

Cable cover

PE cable cover

Cable cover	Dim width mm	Length m	Colour	Text
Flat, ploughing	50	100	Yellow	Kraftkabel
Flat, normal	125	50	Yellow	Kraftkabel
Flat, normal	170	50	Yellow	Kraftkabel
Flat, normal	300	50	Yellow	Kraftkabel

Table 8.2.37

Cable cover

The cable cover effectively protects buried cables and conduits from excavation where hand tools are used.

Marker tape

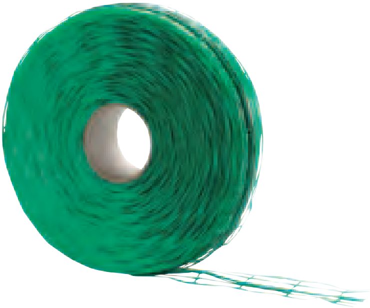
PE marker tape

Marker tape	Dim width mm	Length m	Colour	Text
Marking tape normal	50	250	Yellow	Kraftkabel
Marking tape normal	125	250	Yellow	Kraftkabel
Marking tape normal	125	250	Green	Svagström/ Opto
Marking tape normal	125	250	Orange	Telekabel
Marking tape ploughing	50	500	Yellow	Kraftkabel

Marker tape is used to mark the presence of cables or conduits in the ground.

Table 8.2.38

Marker netting



Polythene marker netting

Marker netting	Dim width mm	Length m	Colour	Text
Marker netting normal	100	500	Orange	Telecommunication cable
Marker netting normal	100	500	Green	Fibre optic cable

Table 8.2.39

Supplied with acid-resistant stainless steel tracer wire.

Marker netting for telecommunication

Marker netting is used to identify conduits and cables installed in the ground and to prevent accidental damage during excavation work.

The marker netting serves three purposes:

1. To warn of the existence of conduits or cables during excavation work.
2. To signal the state of cables and conduits, e.g. when a trench is reopened for repairs or for connecting a new link.
3. To identify covered cables and conduits.

Uponor warning netting has a special texture for ensuring a maximum warning effect. The longitudinal threads break across the diagonal when under tension. The break spreads randomly around the load point and always leaves visible sections of at least 20 cm on both sides of the digging bucket and trench. For the text to be legible in the event that excavation is necessary, the tape is punched between the lines of text and it is at that point that the tape breaks. The text, and therefore the information, thus remain always intact. The text on the warning netting is printed directly on the netting's centre tape.

Laying method/Installation

Fill height

The fill height refers to the backfill from the top of the cable or conduit to the final ground level.

In roads without permanent surfacing

"Roads" relates to installation in areas for roadways and when crossing roads.
Fill height: 0.55 m
Cable cover: Required. Normal cover conduits or normal flat covers can be used as cable covers.
Warning tape: Not required.
For telecommunications and low power cables, normal marking tape is always required.

In roads with permanent surfacing

"Roads" relates to installation in areas for roadways and when crossing roads.
Fill height: 0.35 m.
Cable cover: Required. Normal cover conduits or normal flat covers can be used as cable covers.
Warning tape: Not required.
For telecommunications and low power cables, normal marking tape is always required.

In road areas outside roadways

Fill height: 0.35 m.
Cable cover: Not required.
Warning tape: Normal marking tape required.

In ground that has not been worked

"Ground that has not been worked" relates to ground that is previously untouched and therefore holds no obstacles in the form of other cable installations, asphalt surfaces, intersections with conduits, etc.
Fill height: 0.35 m. In areas used by heavy machinery, the fill height should be increased.
Cable cover: Not required.
Warning tape: Normal marking tape required.

In ground that has been worked

"Ground that has been worked" relates to ground that has previously been disturbed and where obstacles may be present in the form of other cable installations, asphalt surfaces, intersections with conduits, etc.
Fill height 0.55 m.
Cable cover: Not required. The telecommunications company may require an normal flat cover in certain cases.
Warning tape: Normal marking tape required.

In pedestrian and cycle paths

Fill height: 0.25 m.
Cable cover: Normal flat cover required.
Warning tape: Not required.
For telecommunications and low power cables, normal marking tape is always required.

When using a fill height of 0.25 m, the installed cable must be not exceed 1 kV and should be fuse-protected at a maximum rating of 63 A.

In ground where the full installation depth cannot be met

When normal installation at 0.25, 0.35 or 0.55 m is not possible due to obstacles such as rock, stone and similar.
Fill height: Less than 0.25, 0.35 and 0.55 m. Cable cover: Conduit cover for difficult conditions may be used as cable cover.
Warning tape: Not required.

Installation above ground

Installation above ground may be employed when excavation would prove excessively problematic, e.g. in rock.
Cable cover: Extra strong conduit cover. The conduit must be black pressure-resistant conduit, of PE type, equipped with the embossed marking "Kraftkabel". The conduit is fixed using clamps designed for rock.
Warning tape: Not required.

Ploughing

Fill height: 0.25, 0.35 or 0.55 m depending on the type of ground in which the ploughing is to be carried out. Greater fill heights may be required for arable land.
Cable cover: Power cables require cable covers for all installations in roadways as well as pedestrian and cycle paths. For low power lines, cable cover is not required.
Warning tape: Always required for telecommunications cables. If a cable cover is used warning tape is not required.

Ducting

Conduits or other devices intended for installing cables and which allow the cable to be pulled in each direction.
Fill height: 0.55 m for cables of max. 24 kV and 0.9 m for higher voltages.
Warning tape: Not required.

Intersections with railways

"Track areas" relate to a distance of 8 m from the midpoint between the rails in either direction.
Fill height: Min 1.2 m under track areas, measured from the top of the rail.
Cable cover: Conduit of reinforced design, conduit cover for difficult conditions, required under track areas.
Warning tape: Not required.

Intersections with shipping lanes

The intersection must be as straight as possible between the two points of land.
Fill height: At landfall, min. 0.55 m below ground surface or low-water level. The cable may then be installed directly on the bottom and, where necessary, even deeper, to allow for prevailing ice conditions.
Cable cover: Normal, conduit cover for difficult conditions or particularly difficult conditions are required at landfall points down to 0.55 m below ground surface or low water level.
Warning tape: Not required.

Intersection between power and telecommunications cables

Telecommunication cables that intersect power cables must normally be installed above the power cable.

Fill height: If the installation depth for the telecommunication cable can be reduced from the normal 0.25, 0.35, 0.55 m, the power cable is installed at the normal installation depth of 0.35 or 0.55 m. If the telecommunication cable cannot be installed at a shallower depth, the power cable is installed deeper than usual, and min. 0.1 m below the telecommunication cable.
Cable cover: Normal, normal conduit covers or normal flat covers are required above power cables. Telecommunications cables only require normal marking tape.

Intersections between power and telecommunication cables and cable terminal cabinets

Telecommunication cables are installed under power cables. The distance to the power cable must be min. 0.05 m.
Cable cover: Normal, normal conduit covers or normal flat covers are required above telecommunication cables.
The cover must be installed so that it covers at least 0.25 m from the power cables. Power cables require only warning tape or cable cover, depending on the fill height.

Intersection between power cables and gas pipelines

Power cables must normally be installed perpendicular to and above gas pipelines. The distance between the cable and gas pipeline must be at least 0.3 m up to 0.6 kV and 0.5 m for higher voltages. For gas pipelines with ≤10 kPa the distance can be reduced to 0.1 m.
Note. Plastic gas pipelines may only be heated to max. 20°C. If there is any risk that the power cable will generate higher temperatures, ground insulating board is required between the cable and gas pipeline.
Fill height: Min. fill height for the cable according to the relevant installation method. For example, 0.25 m. 0.35 m, 0.55 m.
Cable cover: Not required.
Warning tape: Power cable/gas pipeline.

Installing power cables above 24 kV up to 145 kV

Fill height: 0.9 m.
Cable cover: Required. Normal conduit cover or normal flat cover
Warning tape: Not required.

Combined installation of power cables from 0.4 to 145 kV

Power cables with a rated voltage > 24 kV are installed in the bottom of the trench.
Fill height: For power cables with a rated voltage > 24 kV the fill height must be at least 0.9 m.
Cable cover: Required.
Warning tape: Not required.

Excavation-free installation

"Excavation-free installation" relates to cable installations in conduits that are injected or drilled underground, or installation of cables in drilled holes in rock.
Installation depth: Conduits that are installed via excavation free installation, drilling, injection or similar, must be installed to at least the depth indicated for open trenches according to the type sheet.

For more information on excavation-free installation, refer to the publication that deals with this in more detail.

UPONOR INFRASTRUCTURE

OPTO CABLE DUCTING SYSTEM

Cable ducting system for protection of fibre optic cables – right through to the end user

8.3 Uponor Opto cable ducting system

Opto cable ducting system

Uponor's fibre optic cable ducting is manufactured in black polythene and has four longitudinal green stripes and clear marking as standard. Colours other than green can be manufactured on special request for large orders.

Uponor has two different types of conduit. It is extremely important to understand the difference between the different types in order to obtain conduit with the correct characteristics.

Conduit

Standard pipe

Standard Opto pipe has a smooth inner surface. The conduit is normally used for installing fibre optic cables over shorter distances.

Low friction pipe

Low friction pipe has also a smooth inner surface but with extremely low friction characteristics, a so-called "low friction conduit". This conduit is used for installing fibre optic cables over longer distances.

Installation

Conduits of dimensions 32/26, 40/32.6 or 50/40.8 are used for ploughing.

For installation in open cable trenches, 32/28 can be used if you pack around the conduit with material that is free of sharp stones.

Use "old" buried 110 conduit as empty conduit. This has room for four 32/28 conduits, so-called "sub-ducting".

UPONOR INFRASTRUCTURE

OPTO NET CABLE DUCTING SYSTEM

Uponor Opto Net ducting system for direct conduit burial makes for easy and economic installation

8.4 Uponor Opto Net cable ducting systems

The infrastructure for optical communication is based on a general network that links various geographic areas. In this way a so-called underground infrastructure is created, intended to meet our long-term capacity needs for fibre optic cabling. Long-term careful planning is required if the future fibre optic communication needs of public authorities as well as businesses and private households are to be met.

A distinctive feature of the Uponor Opto Net cable ducting system is that it is a secure and simple system which is quick and easy to install – factors that are important for both the line owner and the line contractor.

The Opto Net ducting system can be laid directly in the cable trench without any additional protection. Opto Net consists of up to 12 coloured microducts surrounded by a transparent thin orange casing that ensures simple handling and laying of the cable. Connection and branching of the network is carried out using connectors designed for direct burial without the need for costly junction boxes and branching conduit.

Uponor's Opto Net cable ducting system can be connected to other microduct solutions on the market. It is simple to supplement the system with separate ducts and thus increase capacity even more.

Opto Net microduct

The Opto Net microducts are made of HDPE material (high-density polyethylene) and are produced in 12 different colours to ensure easy identification.

The microducts' wall thickness, and hence its strength and stiffness, mean they can be used for direct burial. Given the dimensional ratios of diameter to wall thickness (SDR factor) a sensible balance has thus been created between the amount of material used and the need for strength and stiffness.

In the manufacture of the microducts, only pure (non-recycled) HDPE is used, which ensures that the internal duct surface is as smooth and uniform as possible. Fibre blowing can thus be performed with the minimum friction between cable and duct. The use of polyethylene, also ensures that the environmental impact is reduced as far as possible, since the material is fully recyclable and does not contain substances that are or may be critical to the environment and people.

Conduit dimensions

Uponor Opto Net cable ducting system

Uponor microduct Orange	Transparent orange casing Dimensions	
Dy/Di (mm)	Dy/Di (mm)	Number of ducts
7/3.8	7/3.8	4, 7, 12
12/8	12/8	4, 7
14/10	14/10	3, 7

Table 8.4.1

In order to ensure identification of each duct in the Opto-Net casing, each microduct has been colour-coded, cf. colour identification table.

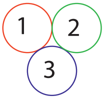
Colour identification of microducts

Duct number	Colours	
1	Red	🟥
2	Green	🟩
3	Blue	🟦
4	Gold	🟨
5	White	⬜
6	Grey	◼
7	Brown	🟫
8	Violet	🟪
9	Turquoise	🟦
10	Black	⬛
11	Orange	🟧
12	Pink	🟪

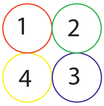
Table 8.4.2

The positioning of the ducts in the casing itself is specified in the overview below:

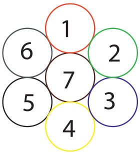
With 3 ducts
in the casing:



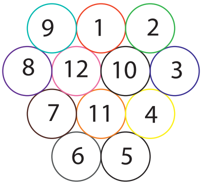
With 4 ducts
in the casing:



With 7 ducts
in the casing:



With 12 ducts
in the casing:



The positioning of the ducts is defined so that where let-off starts at the exchange, the duct sequence is clockwise as illustrated.

If several parallel Opto Net systems are installed, these can be distinguished by letter identification (A=system/casing 1; B=system/casing 2)

System and material data

Microducts			
Properties	**HDPE**	**Unit**	**Standard/test method**
Density	≥ 946	kg/m^3	ISO 1183
Coefficient of thermal expansion	0.13	mm/m · °C	
Yield stress	≥ 16	MPa	EN ISO 6259-1
Permissible tensile stress, short time	10	MPa	
Elongation at break	≥ 350	%	EN ISO 6259-1

Casing			
Properties	**LDPE**	**Unit**	**Standard/test method**
Density	≥ 930	kg/m^3	ISO 1183
Coefficient of thermal expansion	0.13	mm/m · °C	

Table 8.4.3

Opto Net is intended for direct burial in the ground. With regard to storage and warehousing, the material has been UV stabilised for one year's outdoor storage under UV load, typical of conditions in Nordic countries.

Connectors

There are two types of connectors for connecting the microducts. The first connector is a non-removable connector that can be used for direct burial in the cable trench. The connector is sufficiently stiff and strong for direct ground installation and is designed so that the double stainless steel crimp ring is placed furthest inside the connector behind the sealing ring itself. Equally, the connector's extra long insertion depth ensures that the duct does not get bent in the area of the connection. The connector itself is made of the same material as the microducts (HDPE) and with a wall thickness at least equivalent to that of the cable conduits. This means that the connector can resist the mechanical stresses that occur during direct burial.

The other type of connector is designed for connections that are mechanically protected in shafts for example, or else have some other type of mechanic protection.

System and material data

Connectors, black, non-removable	Material
Black connector body	HDPE
Red connector	Polyacetal POM
Sealing ring	Nitrile rubber
Double crimp ring	Stainless steel AISI 301/EN 1.4310
Max. air pressure on blowing	16 bar
Application	Directly in cable trench (additional protection not required)

Connectors, transparent, removable	Material
Transparent connector body	Polycarbonate
Red connector	Polyacetal POM
Sealing ring	Nitrile
Crimp ring	Stainless steel AISI 301/EN 1.4310
Max. air pressure on blowing	16 bar
Application	In shafts (mechanical protection required)

Table 8.4.4

Approvals and requirements specifications

There are currently no fully comprehensive EN standards or other international standards that are specifically aimed at HDPE microducting for the routing of fibre optic cables where this is intended for direct burial. There are, however, related standards that may be useful as reference. There will also be a number of factors that ensure long duct and conduit lifetime and ensure their suitability for the fibre blowing.

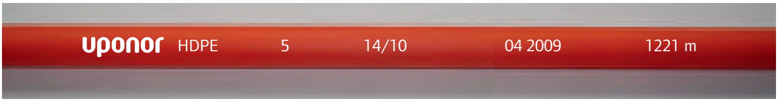
Marking

For marking of Uponor's Opto Net cable ducting system, see below.

uponor	**Opto Net**	**PE**	**7 x 7**	②	**04 2009**	**1221 m**
Manufacturer	Conduit system	Material	Number of microducts and their size	Place of manufacture ② = Hadsund	Date of manufacture month/year	Metre marking

Marking of microducts

For marking of Uponor's Opto Net microducts, see below.



uponor	**HDPE**	**5**	**14/10**	**04 2009**	**1221 m**
Manufacturer	HDPE	Batch number	External and internal diameter	Date of manufacture month/year	Metre marking

Figure 8.4.5

Installation

In connection with the handling and installation of Opto Net, the bend radii below apply. It should be noted that the system layout and design, in terms of achievable blowing lengths, should contain as few sharp bends as possible. In order to achieve optimum blowing length, bend radii below 1 m are not recommended, as these will reduce the blowing length.

Bend radii

Wound onto drum or reel (at 20°C)	**Min.0.4 m corresponds to a drum core of 0.8 m**
During laying: applies to Opto Net containing multiple microducts as well as single ducts	
from -20°C to -6°C: 28 x Dy*	
from -5°C to 10°C: 25 x Dy*	
from 11°C to 35°C: 22 x Dy*	

Dy = external diameter of microduct

* Please note that the specified radii are minimum radii for the microduct. Remember that small bend radii reduce the blowing length.

Table 8.4.6

Equally, when laying the conduit, the permitted tensile force for the Opto Net ducting must not be exceeded. The permitted tensile force is specified in table 8.4.7.

Permitted tensile force for the Opto Net system (N) at 20°C

Number of ducts	**Opto Net dimensions**		
	7/3.8	**12/8**	**14/10**
1	250	600	750
3			2250
4	1000	2400	
7	1750	4200	5250
12	3000		

Table 8.4.7

Handling of drums

It is important that the appropriate mechanical equipment is used and that due care be shown when transporting and handling drums, as well as on let-off.

Unloading from lorries must always be done with a crane or fork-lift truck. Do not tip the drum out of the vehicle.

Drums must be handled so that they always remain upright and that the load of the drum never rests on the conduits but always on the edges of the drum. There is a particular risk of damage to the conduits when unloading on unstable and uneven surfaces. You must therefore always ensure that unloading is done on a stable and even surface with good access conditions for further handling.

When letting off the conduit from the drum, it is important that a drum truck is used that is large enough handle the drum weight and that also has good ground clearance so that the conduit and drum can hang freely even on rough ground. You must also check that the dimensions of the fulcrum hole in the centre of the drum are equivalent to the axle used and that the drum turns freely and without difficulty on the axle. You must always let off the conduit from the top of the drum as this gives the best result in terms of subsequent utilisation of the conduits.

During let-off, the Opto Net system is completely free of tension and the conduits can thus be easily installed in the trench.

Rules for laying conduit and use of material

During planning and execution consideration must be given to the conditions in which the conduit will be laid. It is crucial that the conduits are able to resist the stresses to which they are exposed and that excavation, laying and refilling be carried out carefully.

A. Excavation

The bottom of the cable trench must be firm and even, as cavities may otherwise appear. In soft areas there is a particular risk of settlement appearing under the conduit once the trench is top-refilled and compacted above the conduit. In road areas or areas directly adjoining them, the cable trench must be designed and executed in such a way as to avoid undermining and settlement of road areas. In cohesive soils, construction work in the cable trench may be omitted.

B. Levelling course

The conduits are laid on a levelling course designed to get rid of irregularities and ensure that the conduits are provided with uniform and even support.

The thickness of the levelling course depends on the type and dimensions of the conduit. A course thickness of 5-10 cm will typically be suitable.

Materials for the levelling course should meet the following requirements:
There must be no grain sizes exceeding 16 mm.

- The percentage of grains between 8 and 16 mm must be no more than 10%.
- The material must not be frozen
- Sharp flint or equivalent materials must not be used

If the existing soil meets these requirements, excavation for a levelling course can be omitted.

The levelling course must not be compacted before the conduits are laid.

C. Surrounding fill

The surrounding fill must ensure that the pipeline is provided with sufficient support on all sides and that all loads can be transferred without damaging localised effects.

With applying the surround fill, the distance to the edge of the trench sufficient to allow use of suitable compaction material. Compaction is to be carried out in layers of max. 0.2 m thickness (fixed dimensions). Compaction of the materials is continued to min. 0.15 m above the top of the conduit and carried out as shown in figure 8.4.8.

The materials for the surrounding fill must meet the following requirements:

- There must be no grain sizes exceeding 16 mm.
- The percentage of grains between 8 and 16 mm must be no more than 10%.
- The material must not be frozen
- Sharp flint or equivalent materials must not be used

D. Top fill

The requirements for materials and application of top fill above the conduits will be dependent on the design of the conduit installation.

Cross section of cable trench

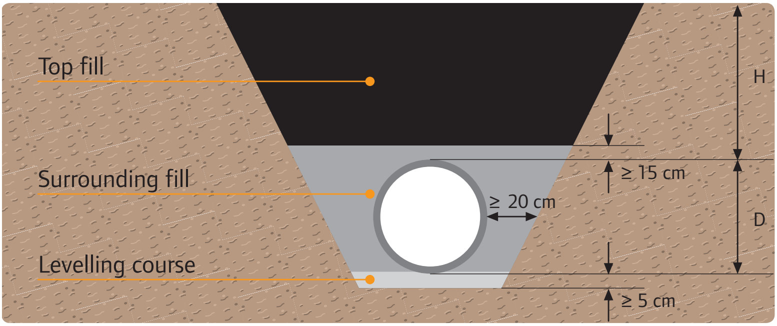


Figure 8.4.8

Reuse of excavated soil

The excavated soil will generally be reusable as surrounding and top fill material, as both non-cohesive and cohesive soil can be used.

Cohesive soil will usually lead to greater deformations than non-cohesive soil. The stone content in the surrounding fill material will also lead to localised deformations occurring.

If the excavated material meets the above requirements, and the requirements laid down for compaction are fulfilled, the material is suitable for reincorporation. We recommend that installation operations be carried out under strict supervision.

Experience obtained in connection with different construction methods/laying methods

In some cases it may be beneficial to use other laying methods than those of traditional conduit laying. Typical of these methods is that they only create a narrow cable trench in the case of chain excavation and ploughing methods, for instance, or none at all, in the case of soil displacement or tunnelling, for instance.

In all cases the possibility of detecting any damage occurring during the execution is reduced.

With chain excavation, it is very difficult to perform compaction and checks, and it is difficult to avoid the excavated materials becoming mixed together.

All these factors will affect the conduit structure and may fibre blowing very difficult, as well as resulting in severely reduced blowing lengths.

Other

Marking netting with tracer wire should be placed above the Uponor Opto Net in order to locate the optical fibre conduit in the future.

Avoid small bend radii wherever possible. Uponor recommends bend radii of a minimum. of 1 m, to allow for subsequent jetting of fibre cables.

Splicing of Uponor Opto Net

On longer installations just connectors for splicing of Uponor Opto Nets are used. Protective splicing boxes are not necessary because the direct burial Opto Net ducting and connectors are designed specifically for direct on-site burial. It is recommended that the connectors are placed offset from one another to avoid too much pressure on them.

If connectors are used that are not meant for direct burial on-site, mechanical protection around the connection must be used. Such protection may, for example, consist of a protective polyethylene conduit able to withstand the soil pressure.

Splicing with other microduct types

Uponor Opto Net can be spliced with other types of microduct using reducers. The following dimensions may be connected:

Uponor Opto Net dimension (mm)	Microduct (mm)	Reducer (mm)
7/3.8	5/3.8	7-5
12/8	10/8	12-10
14/10	12/9	14-12*

* NB. There will be a small edge of approx. 0.5 mm on the inside of the duct. Blowing is carried out from the end of the duct with the smallest internal dimensions to avoid the fibre cables getting jammed.

Table 8.4.9

Branching

Branching can be performed quickly and easily with Uponor Opto Net. Since the Opto Net cables have been designed for direct on-site burial there is no need for fittings or branch conduits to protect the connection.

NB. If connectors are used that are not meant for direct on-site burial, mechanical protection around the connection must be used. Such protection might, for example, consist of a strong polyethylene conduit, for example, that is able to withstand the soil pressure.

Branching must be performed in as gentle a bend as possible, and any radius less than 1 m should be avoided.

Fitting

1. Cut a hole of approx. 0.5 m in the Opto Net conduit, where the branching is to take place. Remove the casing, if necessary.

2. Find the cable in question by its colour.

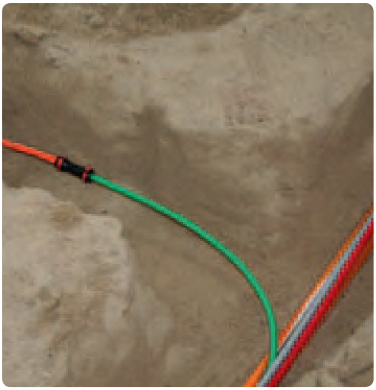
3. Cut the cable with Uponor conduit scissors. In order to get a clean cut you will need a good pair of scissors.

4. Fit the end cap at the end of the duct that is not to be used, to prevent water and dirt from entering. Remember to mark the insertion depth on the end of the duct.

5. Adjust the length on each Opto Net duct to the length of the end of the duct that is to be used.

6. Fit the connector to the end of the duct that is to be used. Remember to mark the insertion depth on the end of the duct.

7. Fit a single Opto Net duct into the connector and pull it through.

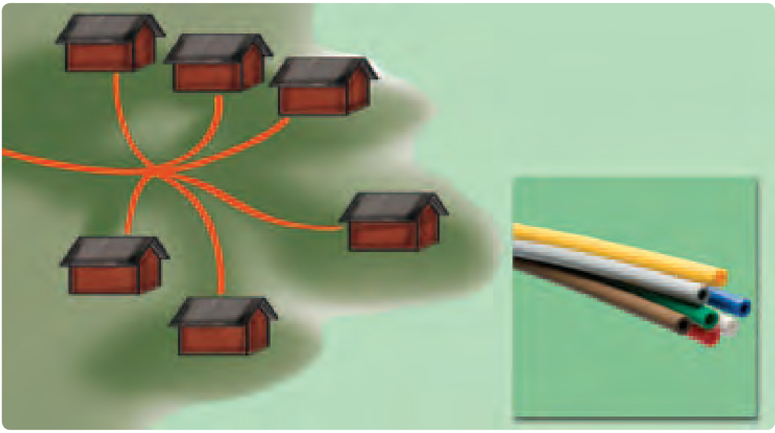


8. Branching is thus complete.

Splicing of Uponor Opto Net

With its thin casing, Opto Net is ideally suited for establishing a star network, and there is no need for additional components. The only requirement is that you have a clear idea of how the conduits are to be installed and the distances to the individual consumers.

In a star network, Opto Net is installed as the cable main trunk cable, and a central point between the properties or points that are to be connected is selected. The microducts are then cut to a suitable additional length, and the individual ducts are run the various consumers, thus reducing the need for connectors.



Routing Opto Net into previously installed protective conduit

Uponor Opto Net can be routed into previously existing conduits and is thus a cost efficient solution that does not require excavation. There are various options depending on the existing conduit design. In routing of this type, a sufficiently large number of cables should be installed. It can thus be difficult to route additional ducts since the duct and previously existing cables can get twisted and impede installation.

Capacity utilisation of a previously existing yet still empty 40 mm cable conduit can be done by pulling through a maximum of three loose ø12 mm Opto Net ducts – maximum pulling length is 300 metres.

Opto Net can also be pulled through larger protective conduits, e.g. ø110 mm conduit.

Dimensioning

The choice of conduit dimension is solely dependent on the desired or required capacity.

In subsequent cable installation the following rule of thumb applies:

The fill factor should not exceed 0.6 – a lower fill factor would be preferred as it would imply a longer blowing length than would be the case for the higher fill factor.

The fill factor (F_f) is calculated using the following formula:

$$F_f = \frac{(\text{cable diameter})^2}{(\text{duct internal diameter})^2}$$

Example:
Should you choose a 12/8 duct or a 14/10 duct with a cable diameter of 6.2 mm?

$$\frac{6.2^2}{8^2} = 0.6$$

$$\frac{6.2^2}{10^2} = 0.38$$

Therefore choose 14/10 for the duct.

Blowing length

Uponor's tests and experience shows that microducts can be jetted up to 2400 m when blowing with air.

The blowing length depends on a number of parameters and may therefore vary. Reasons for varying blowing lengths include the following:

- Friction coefficient between cable ducts and cables
- Number of horizontal bends and the bend radius of these
- Number of vertical bends (cavities) and the bend radius of these
- The cable's ring stiffness
- Blowing equipment
- Compressor pressure and airflow l/min

Test method

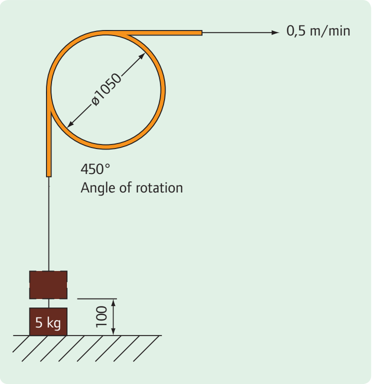


Figure 8.4.10

Friction coefficient

Friction coefficient is a measure of the friction resistance between two different surfaces and can be found using a simple test setup, cf. figure 8.4.10, where the required force for pulling a given cable through an Opto Net duct is measured and converted to a friction coefficient.

The method is simple and precise and can be implemented on both dry ducts as well as as ducts lubricated with a friction reducing lubricant.

Uponor has used this method for friction measurements on Opto Net conduits with different cable types. The measurements are carried out in different conditions – on cable ducts in the so-called dry condition and where the interior of the cable ducts has been lubricated with a thin layer of friction reducing lubricant used for cable blowing.

The value of the friction coefficient has a direct impact on the cable's blowing length, since a higher friction coefficient results in a longer blowing length.

Vertical/horizontal bends and bend radii

All bends in the Opto Net installation affect the installation length. Uponor recommends bend radii of a minimum of 1 m.

The cable's flexibility

Today's cables are usually suitable for installation in protective conduit such as Uponor Opto Net.

Blowing equipment

Contact the blowing equipment supplier and get expert advice on the choice of correct blowing equipment for Opto Net.

Compressor pressure and airflow

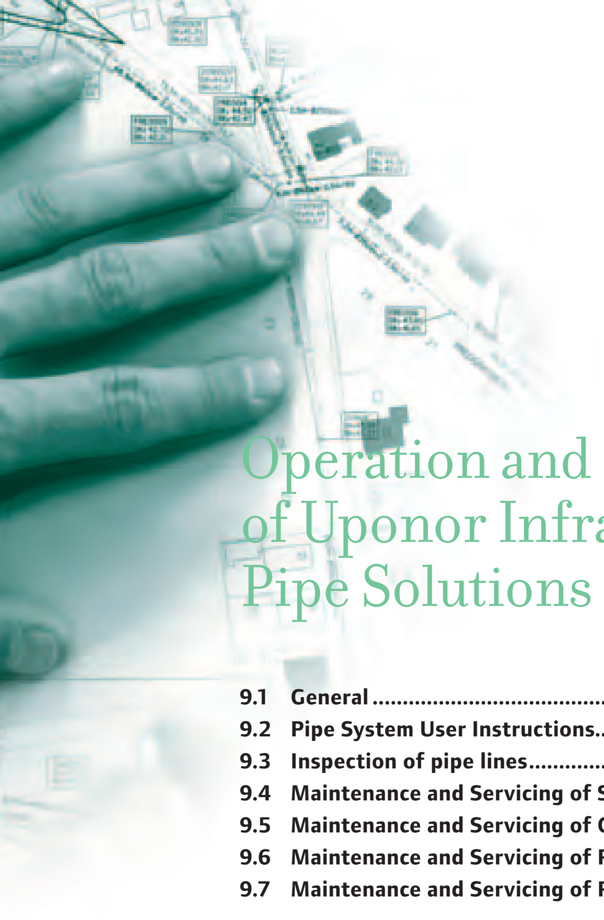
Contact the compressor supplier for the choice of suitable compressors for the installation of Opto Net. The blowing equipment supplier give an advice on all requirements for the compressor concerned.

Uponor recommends the following compressor specifications for installation over longer distances:

Compressor pressure = 16 bar
Airflow = approx. 1 m³/min

UPONOR INFRASTRUCTURE

OPERATION AND MAINTENANCE



Operation and Maintenance of Uponor Infrastructure Pipe Solutions

9.1 General

Regular maintenance plays a crucial part in ensuring the trouble-free operation of municipal pipe systems. Preventive maintenance measures reduce pipe system damage as well as repair costs. Appropriate system-specific instructions must be provided for the operation and maintenance of pipe systems.

Provision of operation and maintenance instructions

In accordance with environmental and health laws, regulations and guidelines, operation and maintenance instructions must be provided for water and drainage systems. Legislation also stipulates the penalties for failure to observe the required operation and maintenance measures. These regulations apply to designers, installers, owners and users of pipe systems.

System designers are responsible for drawing up the required instructions. In turn, contractors are responsible for supplementing them, by appending product-specific information and any text changes which arise during the construction phase.

Operation and maintenance instructions must serve the following objectives:

- ensured water supply
- waste- and stormwater removal using the appropriate methods
- appropriate use of public resources
- minimisation of drawbacks and hazards
- human and animal health and safety provision
- minimisation of risks to property

9.2 Pipe System User Instructions

A well-functioning, properly built and maintained pipe system is invisible to the user. As stated in their connection agreement, users are nevertheless obliged to observe the instructions and regulations issued by those responsible for building and maintaining the network.

Wastewater and stormwater drains

Users of waste- and stormwater drainage networks must be informed that it is forbidden to discharge harmful wastewaters or other substances, which may cause damage or be detrimental to trunk sewers, treatment facilities or receiving watercourses, into the sewer network.

Such instructions may also inform users that sewer networks can be damaged if substances such as paints, solvents, medicines, fats or other materials not contained in normal household wastewater, are discharged into the wastewater sewer. Authorities are required to provide users with clarification of where these and other harmful substances can be delivered for appropriate disposal.

Instructions on sewer network operation and use must include an operational description of the network, including updated drawings. These drawings must be updated with any changes made during construction or subsequent repair work, and must show the locations and sizes of all pipes and chambers. If, for example, during repair work, pipes or piping components made from something other than the original material are connected to the pipe system, such a change must be noted on the drawings. This information is important, because the durability of the pipe system, particularly with respect to pressure flushing, is determined based on its material type.

Instructions must also include the following:

- the maximum allowable flow rate into the system, for example when emptying basins or tanks
- information on which substances may or may not be discharged into the system
- wastewater temperature limits
- operating instructions for backflow valves and other components
- operating instructions for pumps, separators etc. in emergency situations.

Operating instructions for any system components affecting personal safety, or which might cause damage that is difficult to repair, must be located in the immediate vicinity of the component concerned.

In accordance with environmental regulations, whenever companies are required to obtain a licence for wastewater discharge into public sewer networks, such a licence may include specific wastewater management instructions in line with national legislation such as:

- maximum wastewater volumes
- maximum levels of specified substances
- inspection procedures
- inspection intervals

Waste- and stormwater pipe chambers

With respect to maintenance and general servicing, it is important that the location of all chambers and any other related key information, such as material type, connection sizes and possible special features, are marked on the drainage layout drawings. For information purposes, the drawings must also be fully updated with any subsequent changes, such as additional pipe connections. The instructions can also indicate any points in the network requiring closer or more regular monitoring.

Pressure systems

Critical inspection and maintenance points in water and sewerage pressure networks include pump houses, check valves, vent valves and vacuum release valves. The pump house or pumping station supplier is responsible for providing pump operating and service instructions, normally delivered as part of the handover documents.

9.3 Inspection of pipe lines

The most common condition inspection methods for pipelines are visual inspection via pipe chambers and TV inspection. Visual inspection, e.g. with an optical square, is possible where the line of view between chambers is straight, or where the point of inspection only includes the pipe section immediately adjacent to a single chamber. Joint tightness and crack testing of a pipeline can also be carried out by smoke testing.

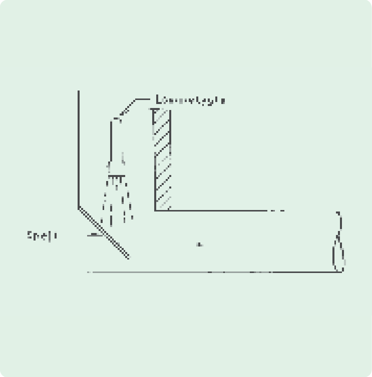


Figure 9.3.1

Cleaning hatches and inspection chambers

Regulation-compliant sewer networks are equipped with cleaning hatches and inspection/cleaning chambers with detachable covers, through which the sewer can be accessed for maintenance.

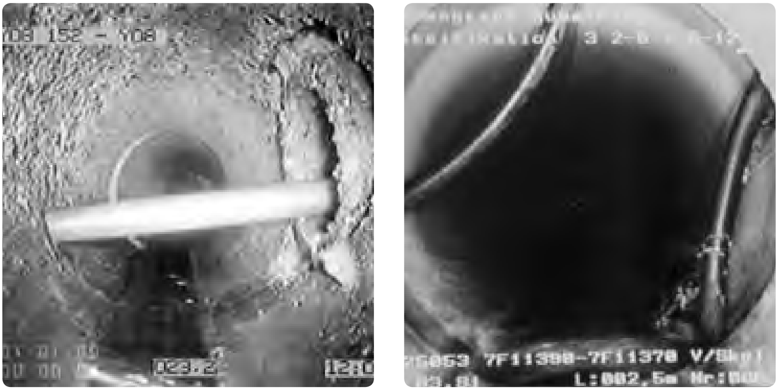
Sanitary lines must be equipped, for example, with separable bottom valves and a water trap, as well as a removable grating for access to the pipe system. Older systems also have cleaning plugs located on the water traps, through which the system can be cleaned.

Maintenance of underground pipe systems is primarily carried out via inspection chambers and inspection pipes installed along the network.

Figure 9.3.2

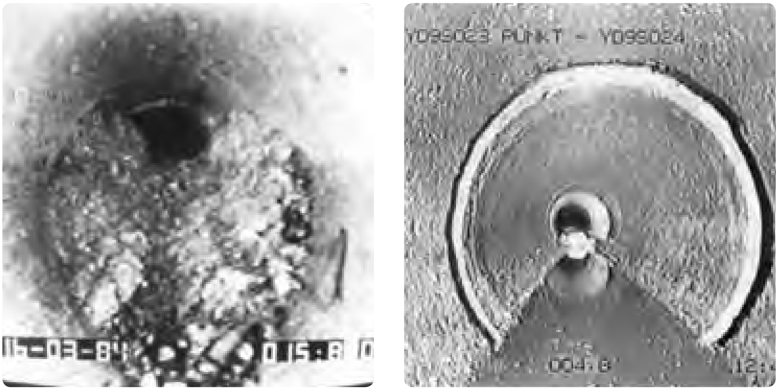
TV inspection

Closed Circuit TV inspection (CCTV) is the most commonly used and effective pipeline inspection method. It enables high-precision assessment of pipe damage, by using a self-driven robot camera to carry out close, in-situ inspection of pipeline details, including pipe junctions. A key benefit of TV inspection is that it provides highly detailed condition reports for subsequent maintenance and repair purposes, based on video post-analysis and precision mapping of points of damage. To achieve reliable video data, the pipeline must be pressure flushed prior to inspection.



Obstacle

Displaced joint materials



Hard deposit

Separated joint

Figure 9.3.3

Smoke testing

Smoke testing is an effective technique for identifying faulty joints and large cracks in storm drains, house drains and foul sewers. This method can also be used to identify possible storm drain connections to foul sewers as well as unmapped drain lines and inspection chambers.

Testing is carried out by releasing smoke canisters in the test pipe section and raising the air pressure in the pipeline, causing the smoke to seep out through the open pipe ends, pipe chambers and possible pipe faults. Suitable for soil-covered pipes only, this method is not effective for street areas, since asphalt and dense gravel pavings prevent the smoke from filtering out. The smoke used is non-toxic and non-staining.

Underwater pipelines

During the condition inspection of underwater pipelines, particular attention must be paid to the condition of the ballast weights. The location of underwater pipes must also be determined and checked against the drawings. Regular points of inspection for wastewater pipes include gas valves.

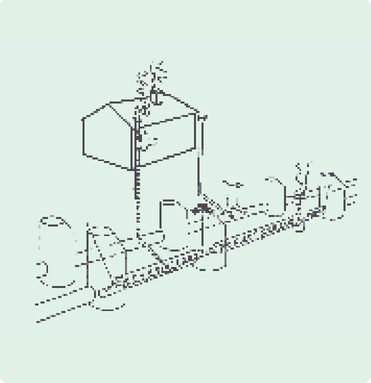


Figure 9.3.4. Smoke test

Pipeline location

The precise location of pipelines belonging to old networks is sometimes unknown. To locate and accurately position pipelines, a transmitter is fed into the line and its progress is monitored above ground with a receiver. Metal detectors are often used to locate buried manhole covers.

9.4 Maintenance and Servicing of Sewer and Storm Drains

Minor operational faults occur in all sewer networks from time to time; these can usually be remedied through provisional intervention. If, however, the cause of the disorder is a blockage recurring frequently at the same location, the fault will need to be investigated and proper repairs carried out. Recurring blockages are normally caused by faults in the pipeline and usually first appear soon after installation. Typical causes include an insufficient pipe gradient, poorly installed joints, or pipe damage during installation. Another common cause is contamination of the line with construction waste during installation, e.g. through open-ended drains or pipe ends. It is therefore extremely important to keep drainage point socket junctions and open ends plugged throughout the build stage. In addition, sewer networks must be carefully flushed after installation or before commissioning, to enable the early detection of possible faults.

Fat drained into the sewer from kitchen sinks is also a common cause of blockages. Hot fat easily drains past the sink trap, only to solidify upon contact with the cold drain. Most build up occurs inside the building, but will eventually also accumulate in the horizontal underground drain. Blockages like this often occur after years of use, indicating that the pipe system was fully functional after installation. Fat deposits can usually be removed by cleaning the pipe system with special fat removal tools. If the system cannot be effectively cleaned, the pipes must be replaced. Drainage water from dishwashers equipped with descaling systems, together with other wastewater, can cause lime scaling that is so dense, particularly in concrete pipe systems, that it is difficult to remove.

The most common maintenance procedures required for stormwater systems are pipe cleaning and the unblocking of frozen pipes and chambers. Root penetration through broken joints can also cause blockage problems.

Pipe cleaning

The most common cleaning method is pressure flushing, which is used for both foul and storm drains. In cases of root blockage or hard deposits, the appropriate mechanical tools are used.

Pipe thawing

Thawing of frozen pipes and chambers is normally carried out using hot steam and/or water. When using this technique, it is important to remember that different plastics have different temperature resistances. When thawing pipes, care must be taken that the pipe is not heated in any one place for too long, as this can damage the pipe material and the seal.

The maximum operating temperatures per material type are given in Table 2.2 of the Materials and Service Life chapter.

The thawing temperatures per plastic type are as follows:

PE	+ 80 °C
PP	+ 80 °C
PVC	+ 70 °C

The same temperatures apply to pipe chambers and chamber materials.

Mechanical tools are not recommended for unblocking frozen pipes, since they can damage the pipes. Thawing is most commonly required for stormwater systems, particularly culverts.

9.5 Maintenance and Servicing of Chambers

Waste- and stormwater pipe chambers perform an important function in network maintenance. Regular maintenance and servicing of chambers can considerably reduce the need for pipe cleaning and repair work. In the case of wastewater sewer inspection chambers and inspection pipes, items requiring regular inspection normally include the chamber covers and the tightness of the risers and other joints. Key maintenance procedures for storm and land drain chambers include cover condition inspection and regular emptying and cleaning of the silt trap.

The cover sections of chambers located in trafficable areas are subject to high mechanical stress. Cover sections are also susceptible to displacement by frost heave, and should therefore be regularly inspected. Proper re-adjustment of pipeline covers must also be ensured during road pavement work. The installation instructions provided for the chamber must be followed whenever corrective maintenance is carried out.

Stormwater chambers

In the case of stormwater chambers, the most important maintenance task is emptying the silt trap. This prevents solids from being washed into the pipe system and ensures free drainage flow. The condition of grate covers must also be monitored and damaged covers replaced as soon as possible.

If a chamber freezes due to cold air circulation in the pipe system, thawing must be carried out using the appropriate measures, such as steaming. Mechanical ice removal can damage the chamber. Freezing can be prevented by equipping the chamber with the appropriate freeze protection.

Land drain chambers

The most important maintenance task for land drainage pipe chambers is emptying the silt trap. Since land drains must be kept separate from other drainage water, chamber covers must be regularly inspected for damage.

9.6 Maintenance and Servicing of Pressure Sewer Systems

Effective pressure sewer system operation depends on having the pump discharge head, flow rate, pipe sizes, pump running time and pumping frequency at the correct ratios. In long pressure sewers, air venting and vacuum release must be managed effectively. Vent valves and release valves should be regularly condition monitored and serviced. Faulty valves must be replaced as necessary.

Wastewater pressure sewers are mainly cleaned by pressure flushing, combined with pigging. In special cases, TV inspection is also required.

The above instructions apply to both wastewater and stormwater pressure systems.

9.7 Maintenance and Servicing of Pressure Pipe Systems

In municipal water supply networks, sediment accumulates on pipe bottoms over time, while deposits can build up on the inside walls. Both of these must be removed at regular intervals, using the following methods:

- flushing in the flow direction
- counter-flow flushing
- compressed air pulse cleaning
- pigging
- chemical cleaning and shock chlorination

The above maintenance aspects must be accounted for during the design stage, to ensure that the network is adequately furnished with flushing branches, flushing valves, water and fire hydrants and water holding tanks.

In long pressure systems, provision must also be made for either manual or automatic air venting. In addition, vacuum release valves must be installed at sufficiently regular intervals.

The cleaning methods used are the same as for pressure sewers.

UPONOR INFRASTRUCTURE

HANDLING

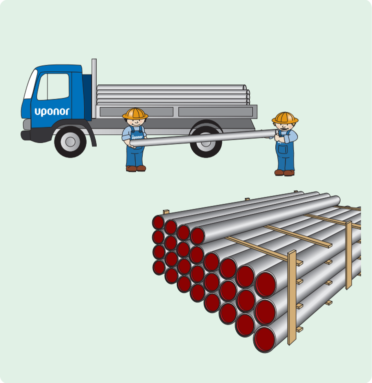
10 Handling

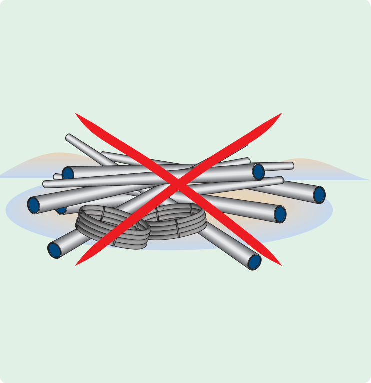
Damage during transport and unloading on site can be largely avoided by handling the products with care and taking the following, simple precautions. Unload the materials as close as possible to the job site, to avoid unnecessary carrying.

Keep pipes and fittings in their original packaging for as long as possible, for ease of handling and to protect them during transport, handling and storage.

The impact resistance of PVC reduces in cold temperatures. For this reason, handling PVC products in temperatures below -15 °C should be avoided. PE and PP pipes are highly resistant to extreme temperatures and can be handled without problems, down to at least -20 °C.

Unnecessary damage can be avoided by handling and transporting pipes and fittings with care.

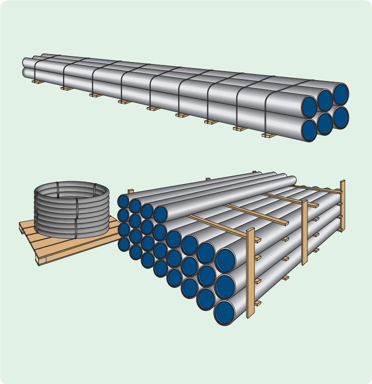




Pipe loads delivered in wooden frames must be unloaded by crane using slings of sufficient width, or by fork-lift truck. Loose pipes must be unloaded individually.

Pipes, pipe bundles and pipe coils must never be thrown or tipped from the truck. Avoid dragging wherever possible.

Transport



To avoid loading the socket ends, socket pipe bundles are carefully stacked at the plant so that the sockets extend beyond the bundle frame. In bundles not stacked by the manufacturer, pipes may extend beyond the truck platform by no more than one metre.

In a correctly loaded pipe bundle, the rearmost frame should rest on the truck platform.

Because black PE pressure pipes scratch easily, extra care should be taken to avoid surface damage during handling and transport.

Storage

Pipe bundles and loose pipes must be stacked on a level base. The pipes should be kept for as long as possible as-delivered, on their factory pallets or in coils.

Pipe bundles in their original packages must be stacked by resting the bundle frames on top of each other (frame battens together). The maximum stack height is four bundles. Loose pipes of the same size can be stacked a metre high. To avoid placing a load on the sockets, loose socket pipes must be stacked so that the sockets extend beyond the stack ends. Store pipe coils upright or on pallets.

Double-wall pipes and ribbed pipes should be stored so that the packages are unloaded from the side. This is because moving them lengthwise is difficult due to the pipe structure.

Pipes stored for long periods should be protected from sunlight, since UV and heat can cause the outsides of pipes to fade in colour. However, sun-faded pipes are fully up to standard in all other respects. On the other hand, heat can cause permanent deformation in pipes that are incorrectly stacked.

uponor

UPONOR INFRASTRUCTURE

ON-SITE INSPECTION OF UPONOR PRODUCTS

11 On-site Inspection of Uponor Products

Product deliveries must be inspected as soon as they arrive at the point of delivery. Check the waybill to verify that the consignment is complete. To avoid damaging the products, handle and store the products with care.

It is important that all product deliveries are inspected upon delivery because, after reception, responsibility for the materials transfers to the receiver. Key issues for checking are the product markings, surface scratches and ovality. The products must meet the standard requirements set for each pipe and material type. Any faults or damage must be noted on the waybill. Notification of damage in transit must be made within seven days of the date of receipt.

Pipe deformation can occur during handling and long-term storage. Pipes showing deformation must be checked carefully.

The depth of surface scratches or gouges must always be measured. As a rule, if the scratch depth exceeds 10% of the wall thickness, the pipe should not be used. However, this requirement may vary depending on the purpose of use of the pipe.

During transportation and unloading, there is an ever-present risk of pipe damage. Such a risk can be reduced by minimising the amount of moving and carrying needed prior to installation. The best way to achieve this is to unload as near to the point of installation as possible.

During handling, damage to pipes and fittings can be virtually eliminated by observing the following golden rules:

1. Never unload by tipping.
2. Use lifting slings of sufficient width when loading, unloading and transferring pipes by crane.
3. Never drag pipes or fittings along the ground.
4. Use appropriate vehicles for pipe transport.
5. Keep pipes away from sharp edges.
6. Avoid twisting uncoiled pipe during handling.
7. Always handle PVC products with care. Do not handle PVC products at all in temperatures below -15 °C.
8. Note down all claims, damage in transit and missing items on the waybill.

Acceptance inspection

Work site:	Project number:
Developer:	
Date:	Inspected/approved by:

Material	**Supplier**	**Quantity delivered**	**Quantity approved**	**Quantity rejected**	**Location of rejected items**	**Waybill no.**

Table 11.1

UPONOR INFRASTRUCTURE

TERMS, SYMBOLS AND ABBREVIATIONS

12. Terms, Symbols and Abbreviations

This section provides explanations and definitions of key terms, symbols and abbreviations used in the design and installation of Uponor pipe systems.

Term	Symbol/abbreviation	Unit	Definition
BLT			Box Loading Test (test used to simulate ground loading at different temperatures).
CE	CE		CE marking (or CE mark). Declares that the product meets EU safety, health and environmental requirements (cf. Construction Products Directive).
CEN			European Committee for Standardization (Comité Européen de Normalisation).
DIN	DIN		German standard (Deutsche Industrie Norm).
DIS			Draft International Standard.
DS	DS CERTIFICERET		Danish standard (Dansk Standard).
EAS			European Acceptance Scheme (EAS) for products in contact with drinking water.
Elastomers			Rubber and rubber-like substances.
Separate sewerage			Sewerage system comprising two separate flows, one for wastewater and one for storm and land drainage water.
ETA	ETA DANMARK		European Technical Approval.
Ethylene	H-C-H		A gas formed by steam cracking crude oil. A common constituent of many thermoplastics.
Ethylene propylene rubber.	EPDM		Material used mainly for sealing large socket joints.
Europa Norm	EN		European standard.
FI	FI		Finnish certification and standardisation body.
INSTA-CERT	INSTA-CERT DS · NS · FI · P		Nordic certification body comprising the certification bodies DS, NS, FI and SP.
ISO	ISO		International Organization for for Standardization

Term	**Symbol/abbreviation**	**Unit**	**Definition**
Self-cleaning capacity			Capacity of a pipe system to carry solids in the water flow without sedimentation.
Flexible joint			Joint that enables a degree of axial displacement and angular deflection between connected pipe ends. Refer to standard DS 421.
Wastewater normal flow rate		dm^3/s	The rate of drainage flow to drainage installation, e.g. from a floor gully or other drainage point.
Wastewater			Biologically, chemically, physically or thermally contaminated water which cannot be classed as stormwater or land drainage water.
Drainage flow rate	q	dm^3/s	The total volumetric rate of flow of wastewater, storm water and/or land drainage water in a pipe.
Chamber			Collective term for pipe inspection chambers, catchpits, manholes, sampling chambers, stormwater chambers etc.
Roughness			A value used in the Colebrook-White equation. 0.00025 m for steel and plastic pipes 0.00040 m for cast iron pipes 0.00100 m for clay and concrete pipes
Collection capacity			The maximum amount of material that a trap or separator can collect.
Size			The external dimensions of a component. With respect to cylindrical pipes, the pipe size refers to the pipe's outside diameter. For Uponor pipes, a 'minimum diameter' of 600 mm refers to the inside diameter.
Height		m, mm	
Manhole			A pipe chamber that enables personnel access for the inspection and maintenance of adjoining pipes.
Design stress	s	MPa, N/mm^2	The Minimum Required Strength (MRS) value divided by the safety factor (design coefficient) C.
Design flow rate	d		The rate of flow of wastewater, storm water and/or land drainage water.
Monomer			A single molecule, e.g. ethylene.
MRS	MRS		Minimum Required Strength value. Used to indicate long-term material strength under continuous conditions. The value represents the minimum material strength after a 50 year service life at 20°C.
NCS, Nemko	Nemko		Nemko Certification system (former Norsk Standard).
Nominal ring stiffness	SN	kN/m^2	
Nominal size	DN		
Nominal pressure	PN		Maximum constant pressure (bar) at +20 °C.
Nitrile rubber	NBR		Petrol and oil resistant rubber.

Term	Symbol/abbreviation	Unit	Definition
NKB	NKB		Nordic Committee on Building Regulations (NKB)
Nordic Poly Mark			Quality mark granted to INSTA-CERT certified products.
NS			Nominal size. Used to indicate separator/trap capacity.
NS			Norsk Standard. A Norwegian standard.
Sampling chamber			Pipe chamber used for taking and measuring water samples.
Overall service coefficient			Safety factor (cf. minimum required strength)
Backwater			Temporary increase in drainage system water level due e.g. to sudden heavy rainfall.
Backflow valve			Manual or automatic non-return valve to prevent backflow along a pipeline or into a building (flood prevention).
Surface water			Collective term for stormwater and other drainage waters which contain minimal contamination and which drain from ground or building surfaces.
Groundwater			Water located beneath the ground surface.
Polyethylene	PE		-(H-C-H)+(H-C-H)- A polyolefin thermoplastic.
Polycarbonate	PC		A non-breakable, electrically insulating and low flammability material.
Polymer			A large molecule formed from numerous smaller molecules (monomers) bonded together.
Polymerisation			In the polymerisation process, a monomer such as ethylene is heated to approx. 300 °C at high pressure (approx. 2,000 bar) in the presence of a catalyst. After a given reaction time a polymer is produced, in this case polyethylene.
Polypropylene	PP		-(H-C-H)+(H-C-CH3)- A polyolefin thermoplastic.
Polyvinyl chloride (un-plasticised)	PVC		-(H-C-H)+(H-C-Cl)- Rigid PVC, to which no plasticisers/phthalates have been added. Also known as PVC-U. Thermoplastic
prEN			Proposed European Standard.
Pumping station/ pump house			An installation used for pumping drainage water, comprising at least one pump located in a collection tank or chamber.
Receiving watercourse			A water body, e.g, sea or lake into which, subject to a permit, drainage water can be discharged.
Pipeline length	L	m	The total length of a pipeline in metres.
Vertical sewer			A sewer with a gradient of more than 1,000 ‰.
Rapid crack propagation	RCP		Test conducted to monitor crack development.

Term	Symbol/abbreviation	Unit	Definition
Trunk sewer	i		Pipeline to which house drains connect and via which drainage water is delivered to a treatment facility or receiving watercourse.
Stormwater chamber			A pipe chamber that collects surface water via a grate cover and underground inlet pipes. Stormwater chambers are equipped with a silt trap and possibly also a water trap.
Land drainage water			Groundwater and absorbed surface water drained from the soil via an underground drain system.
Rainfall intensity	i		Value used in calculating the design rainfall rate. 110 l/ha, probability per year = 1 140 l/ha, probability per year = 1/2 230 l/ha, probability per year = 1/10 Refer to standard DS 432.
Combined sewer			A sewerage system combining wastewater, stormwater and land drainage water in a single pipe system.
Inside diameter		mm	
Slow crack growth	SCG		Test conducted to monitor slow crack development.
Styrene-butadiene rubber	SBR		A rubber type commonly used in water and sewer pipe sockets.
Melt mass-flow rate	MFR		Indicates the viscosity of a polymer in the melt phase.
Technical Research Institute of Sweden	SP		Swedish certification body.
Household wastewater			Household wastewater includes all wastewater from domestic households, including household sewage. It is discharged by domestic households, offices, retirement homes, hotels, schools, public buildings and other similar non-industrial sources. Momentary rises of up to 95–100 °C in household wastewater temperatures are permitted (for max. two minutes).
Inspection chamber			A pipe chamber providing access to connected pipes for cleaning and inspection tools and devices, e.g. for flushing and TV inspection.
Thermoplastic elastomer	TPE		TPE seals can be joined directly onto the pipe socket during production.
Density	p	kg/m^3	1,000 kg/m^3 = water ProFuse 950 kg/m$^{3.}$
Product certification	SBC		Special requirements for certification.
Filling ratio			In vertical pipes, the filling ratio is defined as a proportion of the internal cross-sectional area of the pipe, with the pipe defined as being full when the flow is fully distributed across this area, against the inside walls of the pipe.
Horizontal sewer			A sewer with a gradient of max. 1,000 ‰.

Term	Symbol/abbreviation	Unit	Definition
Standard dimension ratio	SDR		Ratio between pipe diameter and wall thickness.
Drainage coefficient	f	(numerical value)	The discharge rate, i.e. the total amount of drainage water passing through a pipe section per unit time.
Drainage installation			Any part of the drainage system located within the building or the building plot.
Pipe gradient			The pipe steepness ratio with respect to the vertical and horizontal.
Drainage point			Installation, device or appliance from which water is drained.
Sewerage system			Collective term for drainage installations, house drains, trunk sewer etc.
Force	N	N, kN	
VTT			Technical Research Centre of Finland

UPONOR INFRASTRUCTURE

TECHNICAL LITERATURE

13. Technical literature

A list of the publications referred to in the Uponor Technical Manual, and of other relevant publications, is presented below.

- Uponor, Kunnallistekniset putkistot, Asentajan käsikirja (Uponor, Municipal Pipe Systems, Installer's Manual) (In Finnish).
- Uponor, Kunnallistekniset putkistot, Suunnittelijan käsikirja (Uponor, Municipal Pipe Systems, Designer's Manual) (In Finnish).
- RIL 77 Thermoplastic pipes installed underground or under water. Laying instructions. Association of Finnish Civil Engineers RIL ry, 2005
- SFS Handbook 102, Plastic pipes. Finnish Standards Association SFS, 2nd Revised Edition, 2005
- Kunnallisteknisten töiden yleinen työselostus 02, KT02, Suomen Kuntaliitto, 2002 (General Work Description for Public Utility Construction 02, KT02. Association of Finnish Local and Regional Authorities, 2002) (in Finnish)
- Muoviputkijärjestelmät, Muoviteollisuus Ry, 2003 (Plastic Piping and Ducting Systems, Finnish Plastics Industries Federation 2003) (in Finnish)
- Viherrakentajan käsikirja, Timo Soini, 2005 (A Landscaper's Handbook, Timo Soini, 2005) (in Finnish)
- Rakennuspohjan ja piha-alueiden maarakenne- ja kuivatusopas, MaKu 2001 (A Guide to Soil Structure and Drainage for Building Foundations and Green Areas, MaKu 2001. Finnish Ministry of the Environment, Finnish Association of Consulting Firms SKOL, Finnish Geotechnical Society, Innogeo Oy 2000) (in Finnish)
- Tien kuivatustarvikkeet, Suunnittelu- ja valintaperusteita, (Road Drainage Equipment, Design and Selection Criteria, Finnish Road Administration 1993) (in Finnish)

14. Standards

Product standards for building sewerage systems

EN 1329-1:2000)	Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure. Unplasticised polyvinyl chloride (PVC-U). Part 1: Specifications for pipes, fittings and the system.
ENV 1329-2:2001	Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure. Unplasticised polyvinyl chloride (PVC-U). Part 2: Guidance for the assessment of conformity
EN 1451-1:2000)	Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure. Polypropylene (PP). Part 1: Specifications for pipes, fittings and the system.
ENV 1451-2:2001	Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure. Polypropylene (PP). Part 2: Guidance for the assessment of conformity

Product standards for land drainage systems

EN 1451-1:2000)	Plastic piping systems for non-pressure underground drainage and sewerage. Unplasticised polyvinyl chloride (PVC-U). Part 1: Specifications for pipes, fittings and the system.
ENV 1401-2:2000	Plastic piping systems for non-pressure underground drainage and sewerage. Unplasticised polyvinyl chloride (PVC-U). Part 2: Guidance for the assessment of conformity
ENV 1401-3:2001	Plastic piping systems for non-pressure underground drainage and sewerage. Unplasticised polyvinyl chloride (PVC-U). Part 3: Guidance for installation
EN 1456-1:2001	Plastics piping systems for buried and above-ground drainage and sewerage under pressure. Unplasticised polyvinyl chloride (PVC-U). Unplasticised polyvinyl chloride (PVC-U). Part 1: Specifications for piping components and the system
CEN/TS 1456-2:2003	Plastics piping systems for buried and above-ground drainage and sewerage under pressure. Unplasticised polyvinyl chloride (PVC-U). Unplasticised polyvinyl chloride (PVC-U). Part 2: Guidance for the assessment of conformity
EN 1852-1:1997 + EN 1852-1/A1:2002	Plastic piping systems for non-pressure underground drainage and sewerage. Polypropylene (PP). Part 1: Specifications for pipes, fittings and the system.

ENV 1852-2:2000	Plastic piping systems for non-pressure underground drainage and sewerage. Polypropylene (PP). Part 2: Guidance for the assessment of conformity
CEN/TS 1852-3:2003 + CEN/TS 1852-3/A1:2005	Plastics piping systems for non-pressure underground drainage and sewerage. Polypropylene (PP) Part 3: Guidance for installation
EN 12666-1:2006	Plastics piping systems for non-pressure underground drainage and sewerage. Polyethylene (PE) Part 1: Specifications for pipes, fittings and the system
CEN/TS 12666-2:2006	Plastics piping systems for non-pressure underground drainage and sewerage. Polyethylene (PE) Part 2: Guidance for the assessment of conformity
EN 13244-1:2003	Plastics piping systems for buried and above-ground pressure systems for water for general purposes, drainage and sewerage - Polyethylene (PE) Part 1: General
EN 13244-2:2003	Plastics piping systems for buried and above-ground pressure systems for water for general purposes, drainage and sewerage - Polyethylene (PE) Part 2: Pipes
EN 13244-3:2003	Plastics piping systems for buried and above-ground pressure systems for water for general purposes, drainage and sewerage - Polyethylene (PE) Part 3: Fittings
EN 13244-4:2003	Plastics piping systems for buried and above-ground pressure systems for water for general purposes, drainage and sewerage - Polyethylene (PE) Part 4: Valves
EN 13244-5:2003	Plastics piping systems for buried and above-ground pressure systems for water for general purposes, drainage and sewerage - Polyethylene (PE) Part 5: Fitness for purpose of the system
CEN/TS 1852-3:2003 + CEN/TS 1852-3/A1:2005	Plastic piping systems for non-pressure underground drainage and sewerage. Polypropylene (PP). Part 3: Guidance for installation
EN 12666-1:2006	Plastics piping systems for non-pressure underground drainage and sewerage. Polyethylene (PE). Polyethylene (PE). Part 2: Guidance for the assessment of conformity.
EN 13244-1:2003	Plastics piping systems for buried and above-ground pressure systems for water for general purposes, drainage and sewerage. Polyethylene (PE). Polyethylene (PE). Part 1: General
EN 13244-2:2003	Plastics piping systems for buried and above-ground pressure systems for water for general purposes, drainage and sewerage. Polyethylene (PE). Polyethylene (PE). Part 2: Pipes
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EN 13244-4:2003	Plastics piping systems for buried and above-ground pressure systems for water for general purposes, drainage and sewerage. Polyethylene (PE). Part 4: Valves
EN 13244-5:2003	Plastics piping systems for buried and above-ground pressure systems for water for general purposes, drainage and sewerage. Polyethylene (PE). Part 5: Fitness for purpose of the system
CEN/TS 13244-7:2003	Plastics piping systems for buried and above-ground pressure systems for water for general purposes, drainage and sewerage. Polyethylene (PE). Part 7: Guidance for the assessment of conformity
EN 13476-1:2007	Plastics piping systems for non-pressure underground drainage and sewerage. Structured-wall piping systems of unplasticised poly (vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE). Polyethylene (PE). Part 1: General requirements and performance characteristics
EN 13476-2:2007	Plastics piping systems for non-pressure underground drainage and sewerage. Structured-wall piping systems of unplasticised poly (vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE). Polypropylene (PP). Polyethylene (PE). Part 2: Specifications for pipes and fittings with smooth internal and external surface and the system, Type A
EN 13476-3:2007	Plastics piping systems for non-pressure underground drainage and sewerage. Structured-wall piping systems of unplasticised poly (vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE). Polypropylene (PP). Part 3: Specifications for pipes and fittings with smooth internal and profiled external surface and the system, Type B
EN 13566-1:2003	Plastics piping systems for renovation of underground non-pressure drainage and sewerage networks. Part 1: General
EN 13566-2:2006	Plastics piping systems for renovation of underground non-pressure drainage and sewerage networks. Part 2: Lining with continuous pipes
EN 13566-3:2003	Plastics piping systems for renovation of underground non-pressure drainage and sewerage networks. Part 3: Lining with close-fit pipes
EN 14758-1:2006	Plastics piping systems for non-pressure underground drainage and sewerage. Polypropylene with mineral modifiers (PP-MD). Part 1: Specifications for pipes, fittings and the system
prCEN/TS 14758-2	Plastics piping systems for non-pressure underground drainage and sewerage. Polypropylene with mineral modifier(s) (PP-MD). Part 2: Guidance for the assessment of conformity.
CEN/TS 14758-3:2006	Plastics piping systems for non-pressure underground drainage and sewerage. Polypropylene with mineral modifier(s) (PP-MD). Part 3: Guidance for installation
	Plastics piping systems for buried and above-ground pressure systems for water for general purposes. Drainage and sewerage - Polyethylene (PE) Part 3: Lining with close-fit pipes

EN 14758-1:2006	Plastics piping systems for non-pressure underground drainage and sewerage - Polypropylene with mineral modifiers (PP-MD). Part 1: Specifications for pipes, fittings and the system
prCEN/TS 14758-2	Plastics piping systems for non-pressure underground drainage and sewerage. Polypropylene with mineral modifier(s) (PP-MD). Part 2: Guidance for the assessment of conformity.
CEN/TS 14758-3:2006	Plastics piping systems for non-pressure underground drainage and sewerage. Polypropylene with mineral modifier(s) (PP-MD). Part 3: Guidance for installation

Product standards for household water systems

EN 1452-1:2000	Plastics piping systems for water supply. Unplasticised polyvinyl chloride (PVC-U). Part 1: General
EN 1452-2:2000	Plastics piping systems for water supply. Unplasticised polyvinyl chloride (PVC-U). Part 2: Pipes
EN 1452-3:2000	Plastics piping systems for water supply. Unplasticised polyvinyl chloride (PVC-U). Part 3: Fittings
EN 1452-4:2000	Plastics piping systems for water supply. Unplasticised polyvinyl chloride (PVC-U). Part 4: Valves and ancillary equipment
EN 1452-5:2000	Plastics piping systems for water supply. Unplasticised polyvinyl chloride (PVC-U). Part 5: Fitness for purpose of the system.
ENV 1452-6:2002	Plastics piping systems for water supply. Unplasticised polyvinyl chloride (PVC-U). Part 6: Guidance for installation
ENV 1452-7:2001	Plastics piping systems for water supply. Unplasticised polyvinyl chloride (PVC-U). Part 7: Guidance for the assessment of conformity
EN 12201-1:2003	Plastic piping systems for water supply. Polyethylene (PE). Part 1: General
EN 12201-2:2003	Plastic piping systems for water supply. Polyethylene (PE). Part 2: Pipes
EN 12201-3:2003	Plastic piping systems for water supply. Polyethylene (PE). Part 3: Fittings
EN 12201-4:2003	Plastics piping systems for water supply. Polyethylene (PE). Part 4: Valves
EN 12201-5:2003	Plastic piping systems for water supply. Polyethylene (PE). Part 5: Fitness for purpose of the system.
CEN/TS 12201-7:2003	Plastics piping systems for water supply. Polyethylene (PE). Part 7: Guidance for the assessment of conformity

Product standards for land drainage systems

DS 2077.1:1983	Plastic pipes. - Drain pipes and fittings - Requirements
DS 2077.2:1983	Plastic pipes. - Drain pipes and fittings - Testing and inspections
SFS 5211	Plastic pipes. PVC field drainage drainage systems.
SFS 5675	Plastic pipes. Double-wall pipe drainage pipes and pipe fittings.

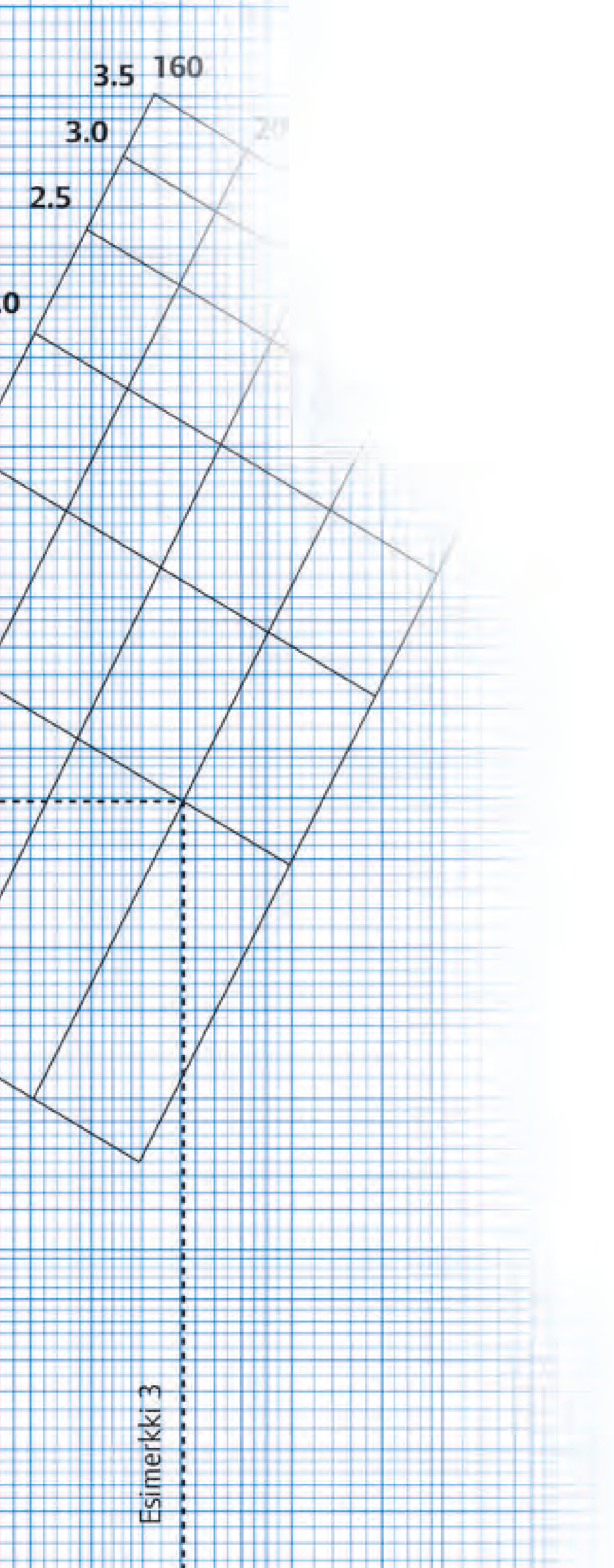
Product standards for cable ducting systems

EN 50086-2-4:1995	Conduit systems for electrical installations. Part 2–4: Particular requirements for conduit systems buried underground.

Testing and other standards

EN ISO 527-1:1996	Plastics. Determination of tensile properties. Part 1: General principles
EN ISO 527-2:1996	Plastics. Determination of tensile properties. Part 2: Test conditions for moulding and extrusion plastics.
EN 681-1:1996 **+ EN 681-1/A1:1998** **+ EN 681-1/AC:2002** **+ 681-1/A2:2003** **+ EN 681-1/A3:2005**	Elastomeric seals. Materials requirements for pipe joint seals used in water and drainage applications. Part 1: Vulcanised rubber
EN 681-2:2000 **+ EN 681-2/A1:2003** **+ 681-2/A2:2005**	Elastomeric seals. Material requirements for pipe joint seals used in water and drainage applications. Part 2: Thermoplastic elastomers
EN 681-3:2000 **+ EN 681-3/A1:2003** **+ 681-3/A2:2005**	Elastomeric seals. Material requirements for pipe joint seals used in water and drainage applications. Part 3: Cellular materials of vulcanised rubber
EN 681-4:2000 **+ EN 681-4/A1:2003** **+ 681-4/A2:2005**	Elastomeric seals. Material requirements for pipe joint seals used in water and drainage applications. Part 4: Cast polyurethane sealing elements
EN 728:1997	Plastics piping and ducting systems. Polyolefin pipes and fittings. Determination of oxidation induction time.
DS 735:1982	Colours for identification purposes
EN 744:1995	Plastics piping and ducting systems. Thermoplastics pipes. Test method for resistance to external blows using the round-the-clock method.
EN ISO 1133:2005	Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics.
EN ISO 1183-1:2004	Plastics. Methods for determining the density of non-cellular plastics. Immersion method, liquid pyknometer method and titration method.
EN ISO 1183-2:2004	Plastics. Methods for determining the density of non-cellular plastics. Part 2: Density gradient column method.

EN ISO 1183-3:1999	Plastics. Methods for determining the density of non-cellular plastics. Part 3: Gas pyknometer method.
EN 1277:2004	Plastics piping systems - Thermoplastics piping systems for buried non-pressure applications - Test methods for leaktightness of elastomeric sealing ring type joints.
EN 1411:1996	Plastics piping and ducting systems. Thermoplastics pipes. Determination of resistance to external blows by the staircase method.
EN 1437:2002	Plastics piping systems. Piping systems for underground drainage and sewerage. Test method for resistance to combined temperature cycling and external loading.
DIN 2501-1	Flanges; Connecting Dimensions
SFS 3115:en **(SFS 3115:E:1976)**	Plastic pipes. Tightness test for pressure pipes.
ISO 7005-1:1992	Metallic flanges. Part 1: Steel flanges
EN ISO 9001:2000	Quality management systems - Requirements
EN ISO 9080:2003	Plastics piping and ducting systems. Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation.
EN ISO 9969:1995	Thermoplastics pipes. Determination of ring stiffness.
EN ISO 14001:2004	Environmental management systems — Requirements with guidance for use.
EN 14741:2006	Thermoplastics piping and ducting systems. Joints for buried non-pressure applications. Test method for the long-term sealing performance of joints with elastomeric seals by estimating the sealing pressure.
DIN 52612-1	Testing of Thermal Insulating Materials; Determination of Thermal Conductivity by the Guarded Hot Plate Apparatus; Test Procedure and Evaluation.



uponor

UPONOR INFRASTRUCTURE

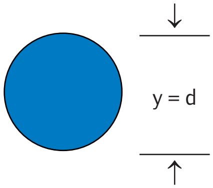
DESIGN CHARTS

Design Charts, Appendices 1.1–9

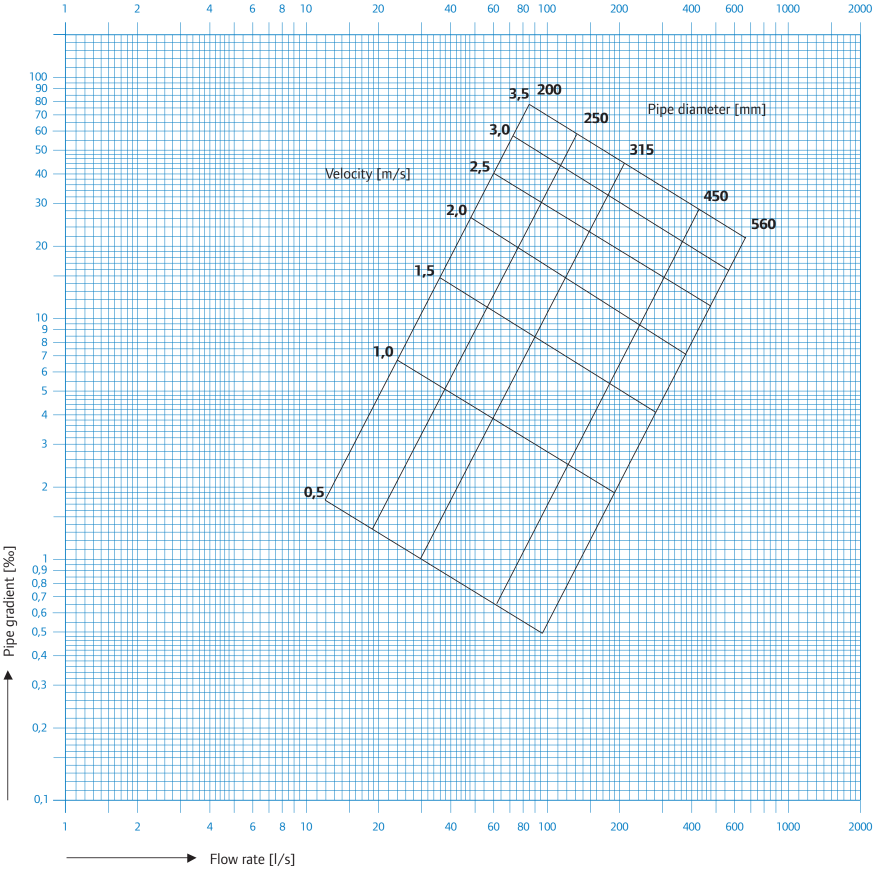
Appendix 1.1

Design chart for full
Ultra Rib 2 pipes.

Chart based on the
Colebrook-White equation.



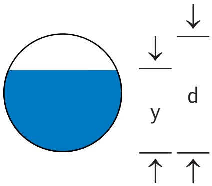
y = water level
d = inside diameter
Roughness coefficient k = 0.00025 m
Filling ratio y/d = 1.0
Water temperature t = 10 °C



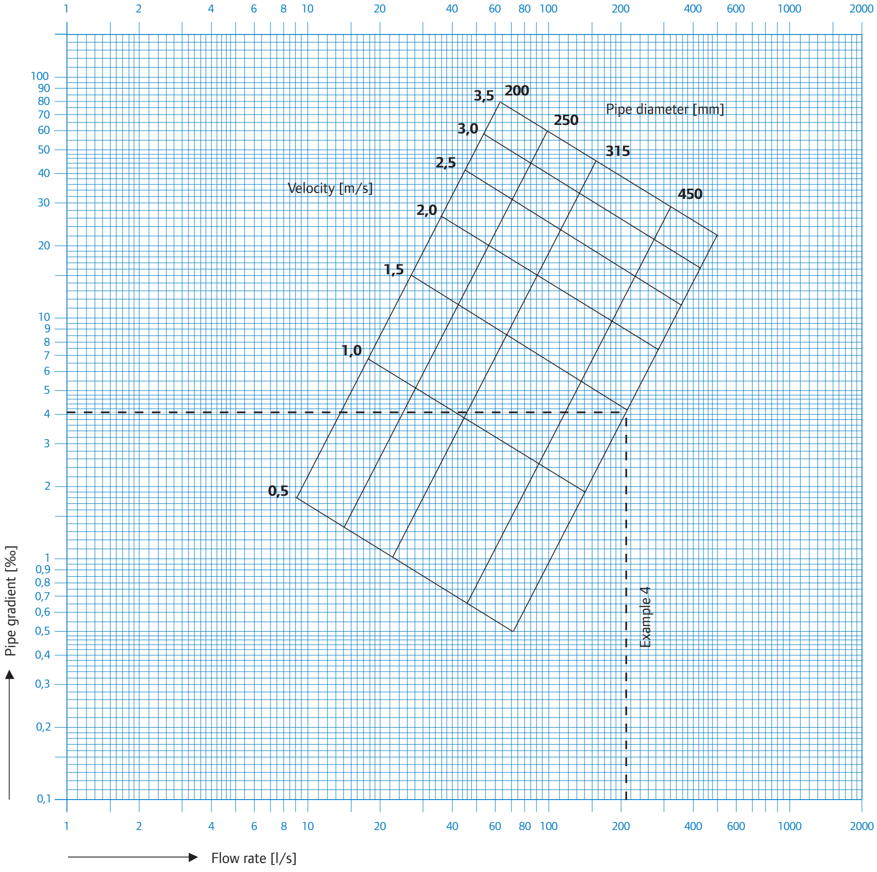
Appendix 1.2

Design chart for 70 % full
Ultra Rib 2 pipes.

Chart based on the
Colebrook-White equation.



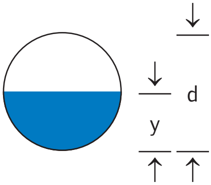
y = water level
d = inside diameter
Roughness coefficient k = 0.00025 m
Filling ratio y/d = 0.7
Water temperature t = 10 °C



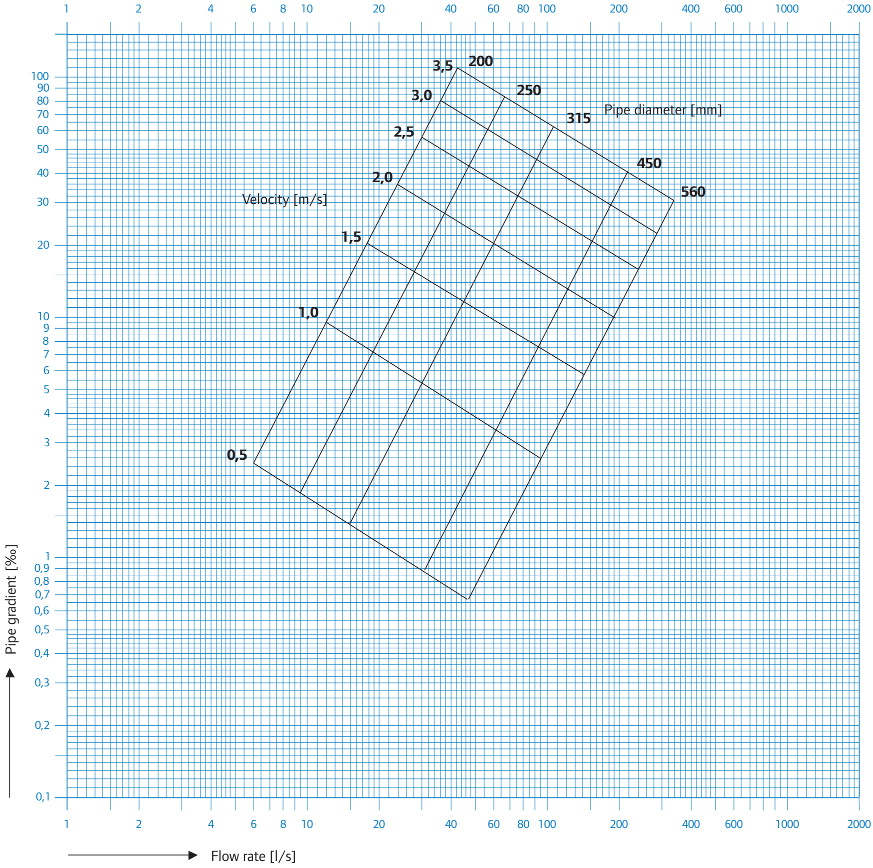
Appendix 1.3

Design chart for 50 % full
Ultra Rib 2 pipes.

Chart based on the
Colebrook-White equation.

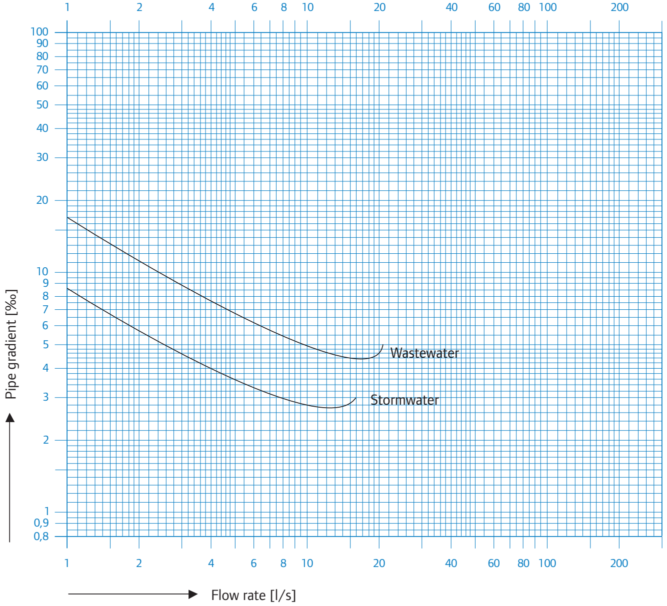


y = water level
d = inside diameter
Roughness coefficient k = 0.00025 m
Filling ratio y/d = 0.5
Water temperature t = 10 °C



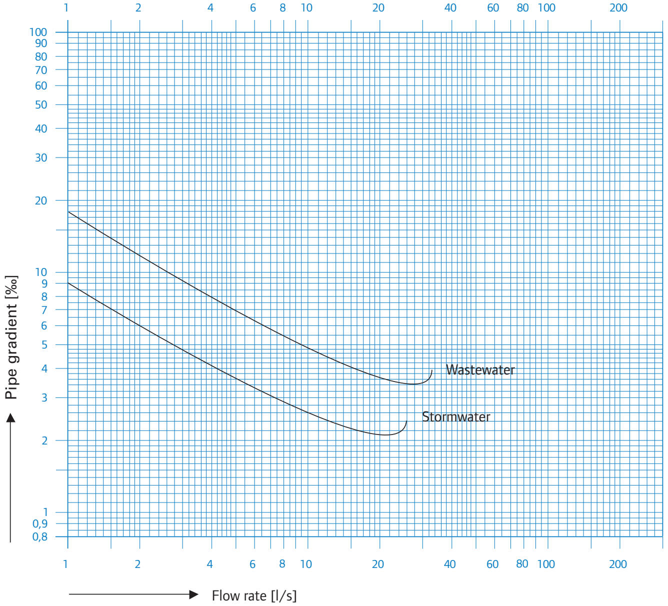
Appendix 2.1

Self-cleaning
capacity chart for
ø 200 pipe
Ultra Rib -2



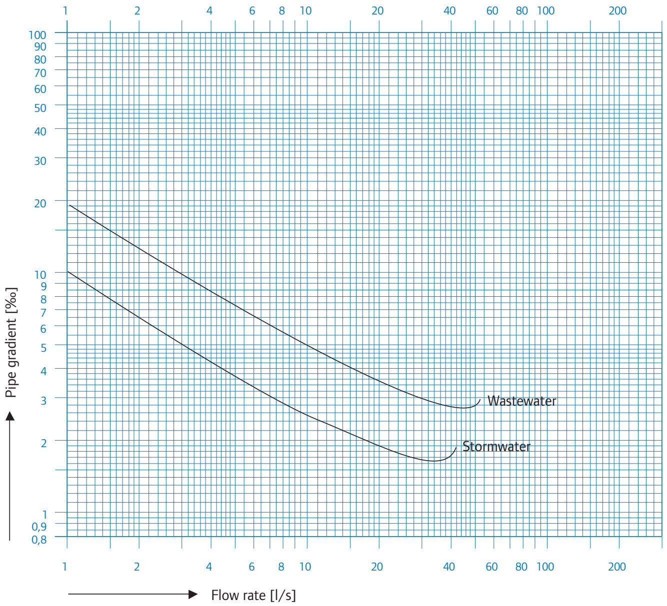
Appendix 2.2

Self-cleaning
capacity chart for
ø 250 pipe
Ultra Rib -2



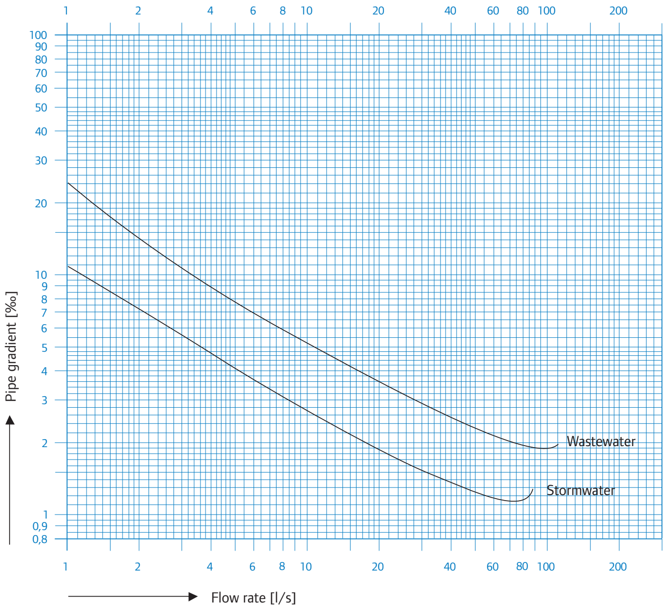
Appendix 2.3

Self-cleaning capacity chart for ø 315 pipe Ultra Rib -2



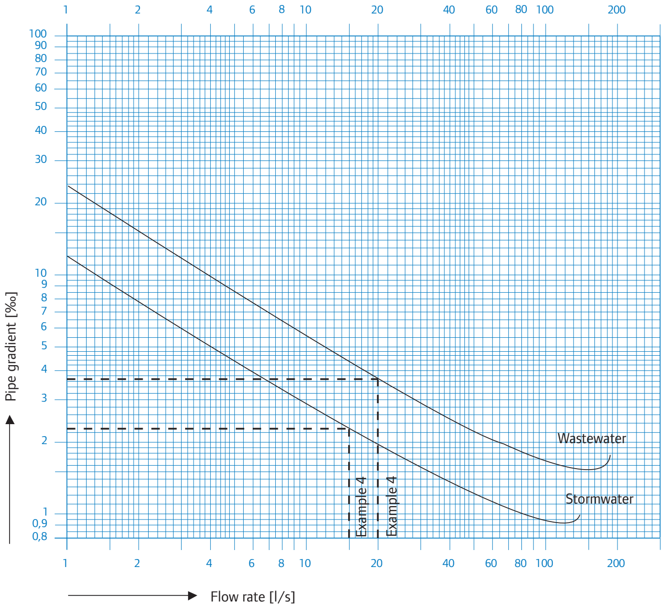
Appendix 2.4

Self-cleaning capacity chart for ø 450 pipe Ultra Rib -2



Appendix 2.5

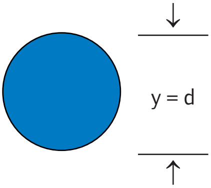
Self-cleaning capacity chart for ø 560 pipe Ultra Rib -2



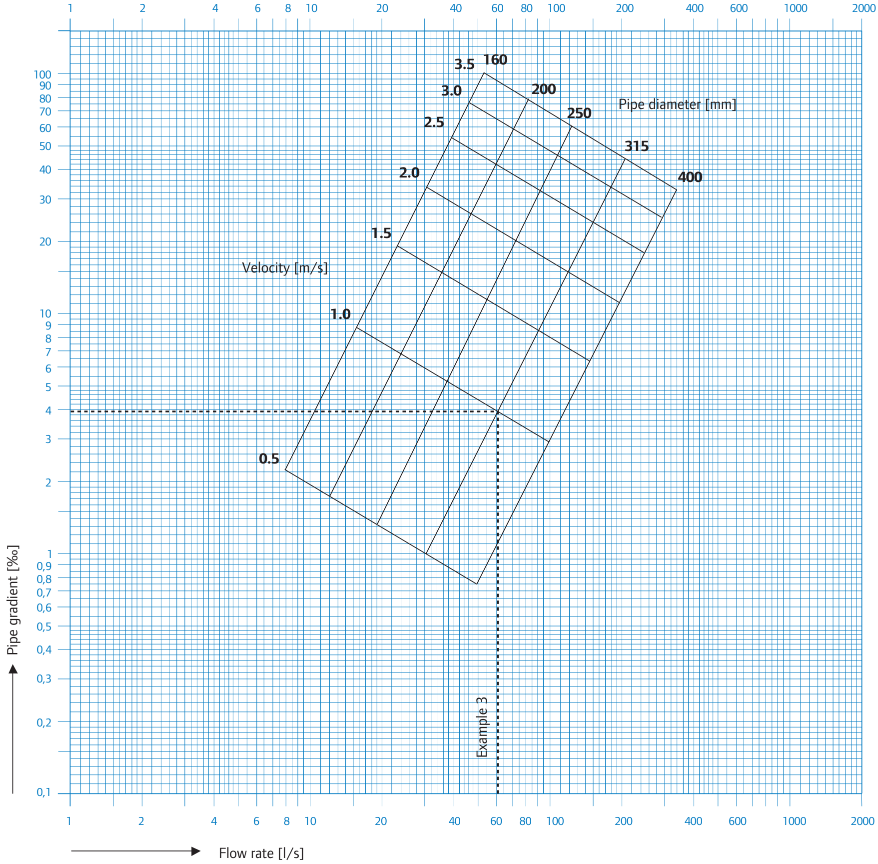
Appendix 3.1

Design chart for full Dupplex pipes.

Chart based on the Colebrook-White equation.



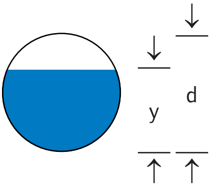
y = water level
d = inside diameter
Roughness coefficient k = 0.00025 m
Filling ratio y/d = 1.0
Water temperature t = 10 °C



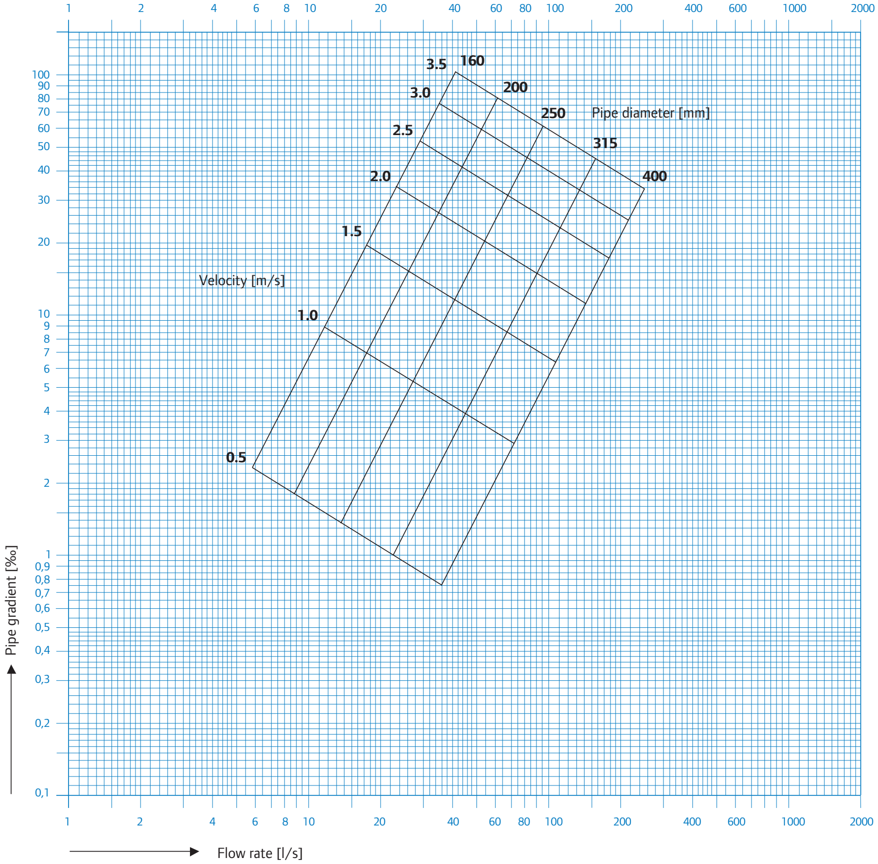
Appendix 3.2

Design chart for 70 % full Dupplex pipes.

Chart based on the
Colebrook-White equation.



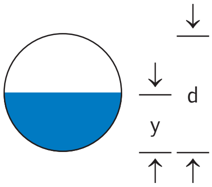
y = water level
d = inside diameter
Roughness coefficient k = 0.00025 m
Filling ratio y/d = 0.7
Water temperature t = 10 °C



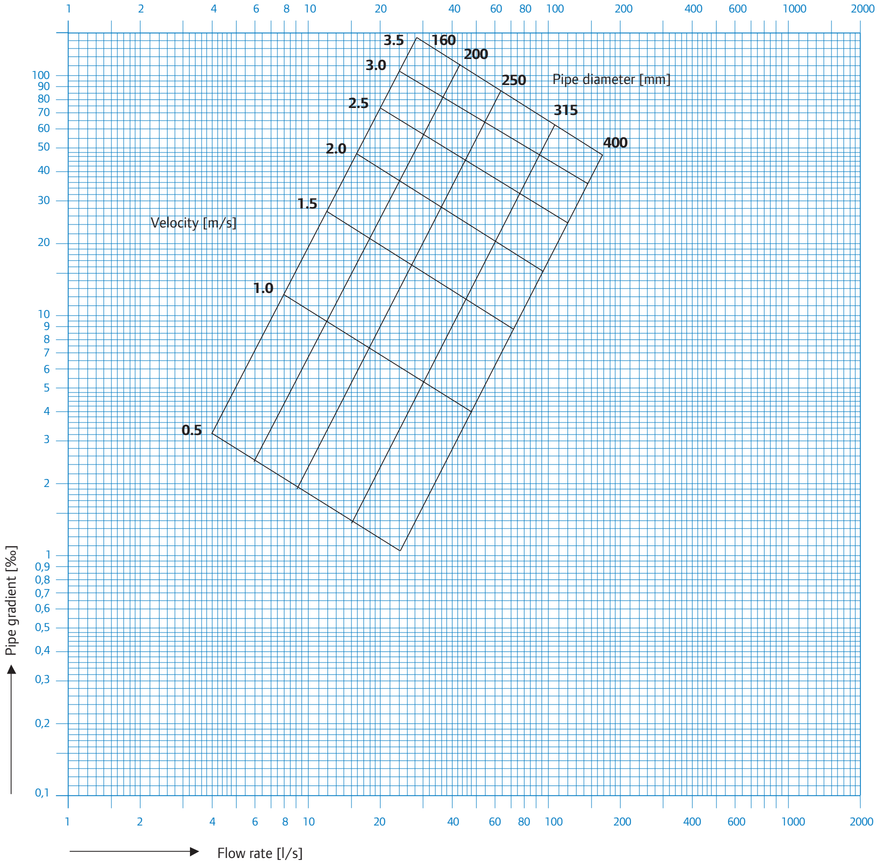
Appendix 3.3

Design chart for 50 % full Dupplex pipes.

Chart based on the
Colebrook-White equation.

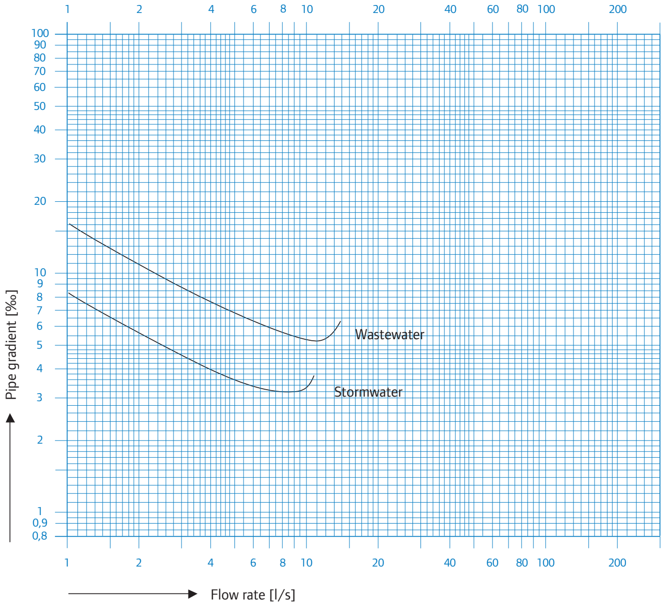


y = water level
d = inside diameter
Roughness coefficient k = 0.00025 m
Filling ratio y/d = 0.5
Water temperature t = 10 °C



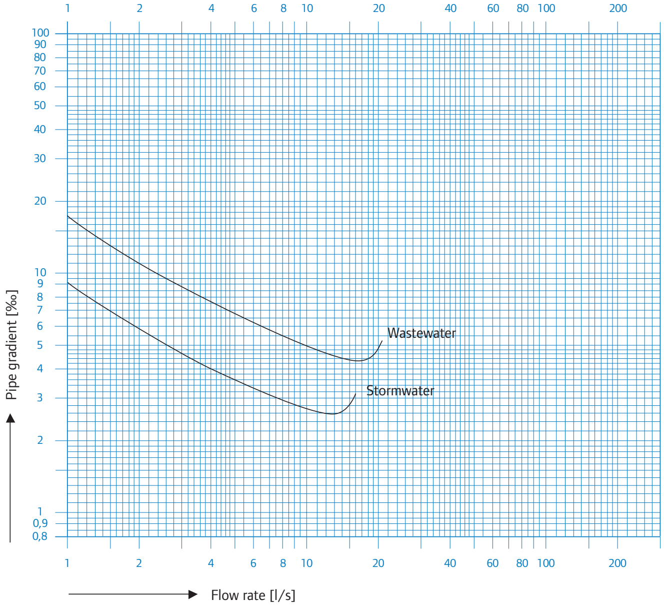
Appendix 4.1

Self-cleaning capacity chart for ø 160 Dupplex



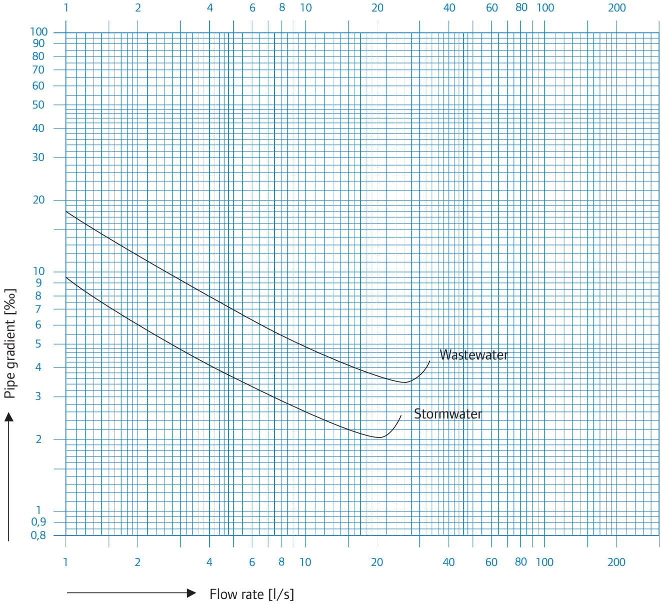
Appendix 4.2

Self-cleaning capacity chart for ø 200 Dupplex



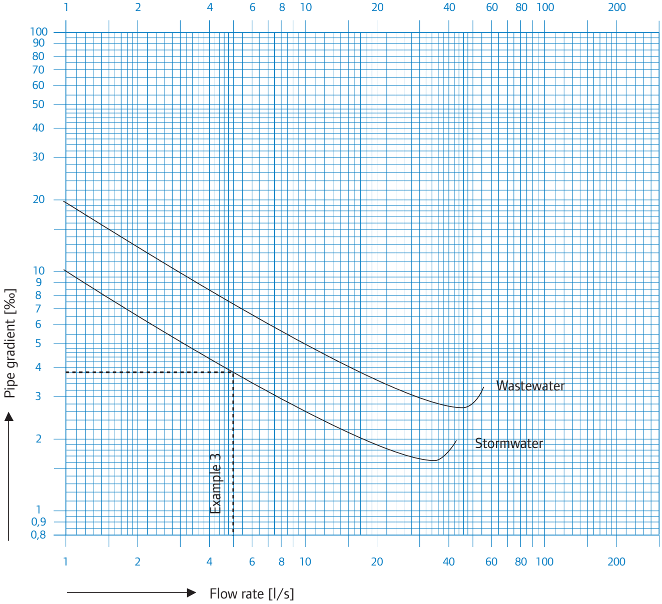
Appendix 4.3

Self-cleaning
capacity chart for
ø 250 Dupplex



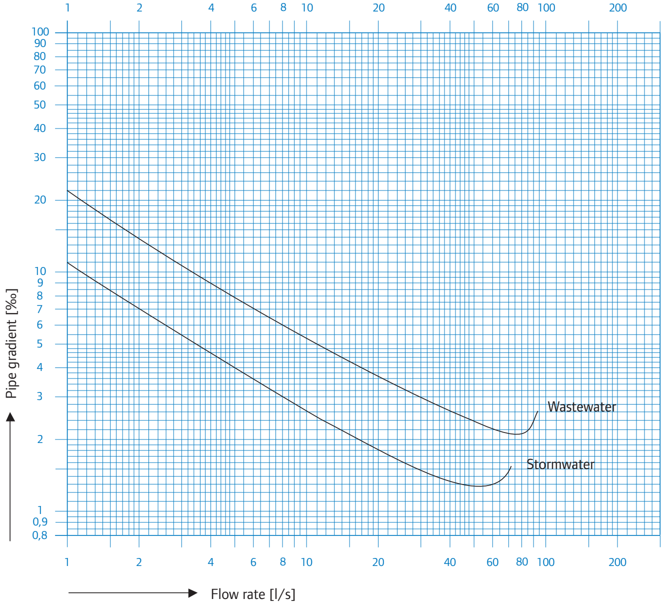
Appendix 4.4

Self-cleaning
capacity chart for
ø 315 Dupplex



Appendix 4.5

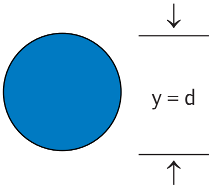
Self-cleaning
capacity chart for
ø 400 Dupplex



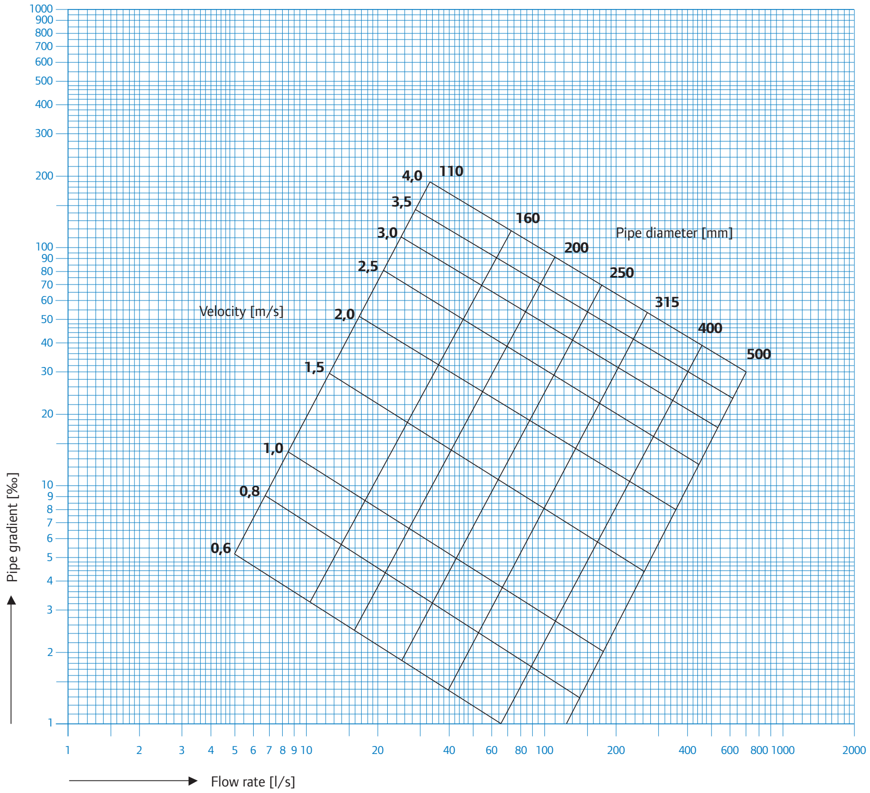
Appendix 5.1

Design chart for full PVC pipes
with SN 8 ring stiffness.

Chart based on the
Colebrook-White equation.



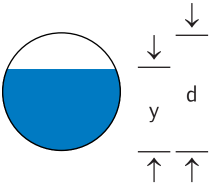
y = water level
d = inside diameter
Roughness coefficient k = 0.00025 m
Filling ratio y/d = 1.0



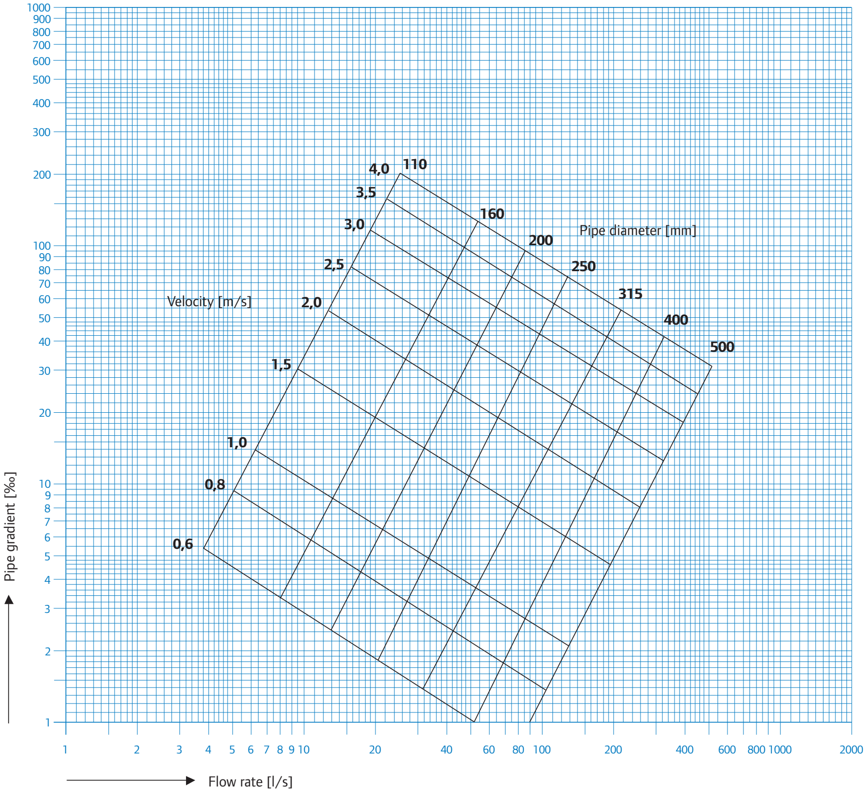
Appendix 5.2

Design chart for 70 % full PVC pipes
with SN 8 ring stiffness.

Chart based on the
Colebrook-White equation.



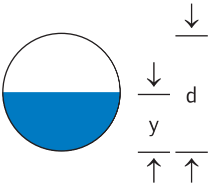
y = water level
d = inside diameter
Roughness coefficient k = 0.00025 m
Filling ratio y/d = 0.7



Appendix 5.3

Design chart for 50 % full PVC pipes with SN 8 ring stiffness.

Chart based on the Colebrook-White equation.

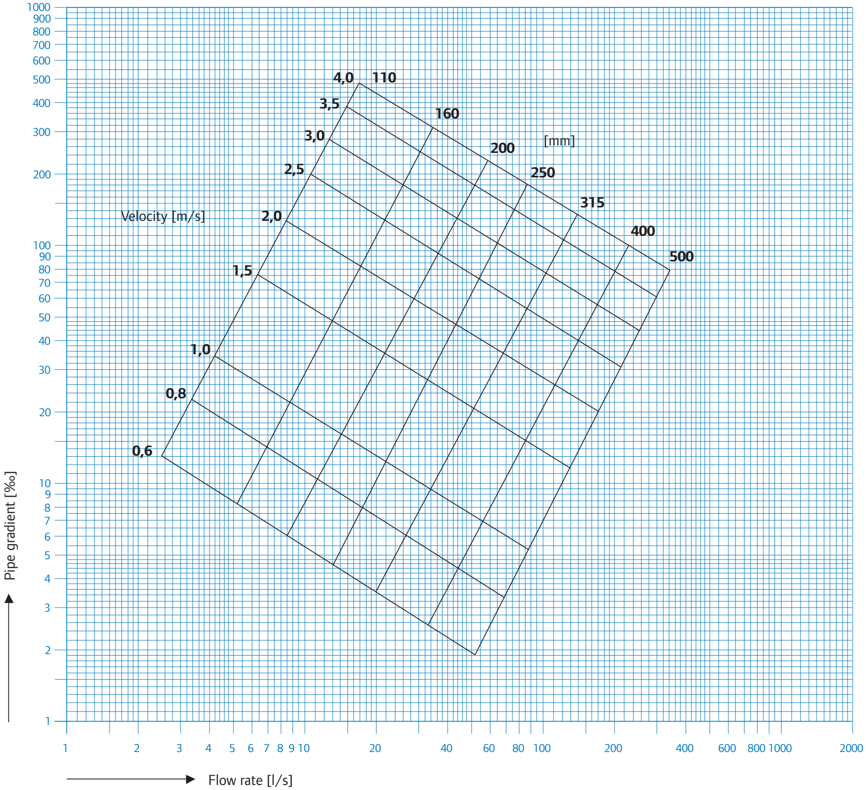


y = water level

d = inside diameter

Roughness coefficient k = 0.00025 m

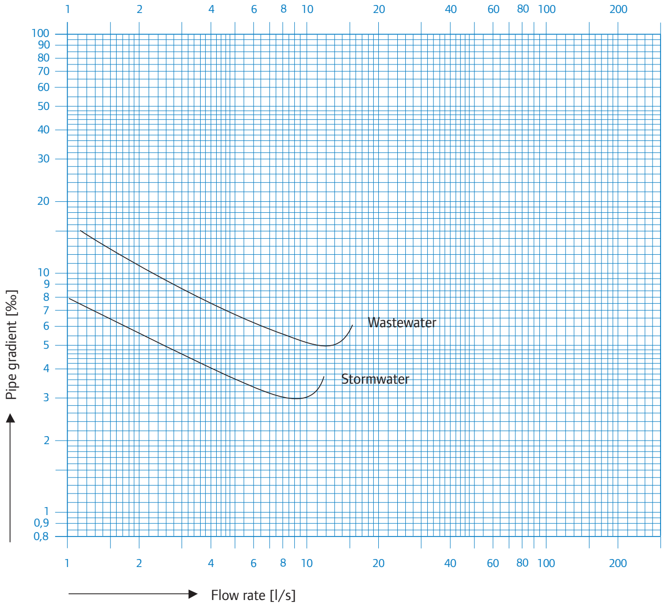
Filling ratio y/d = 0.5



Appendix 6.1

Sewer System
PVC SN 8.

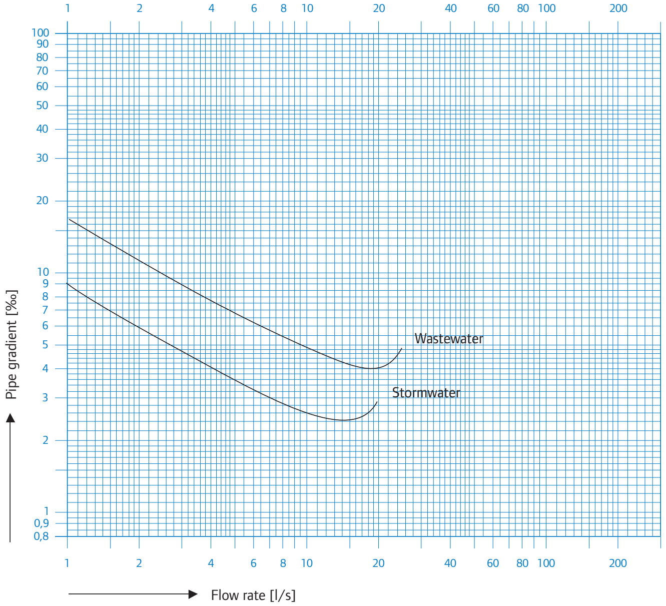
Self-cleaning capacity chart for ø 160 pipe



Appendix 6.2

Sewer System
PVC SN 8

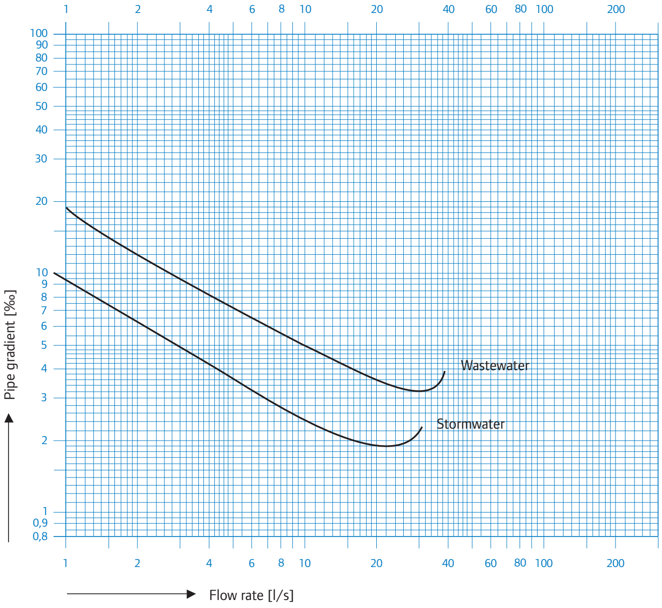
Self-cleaning capacity chart for ø 200 pipe



Appendix 6.3

Sewer System
PVC SN 8.

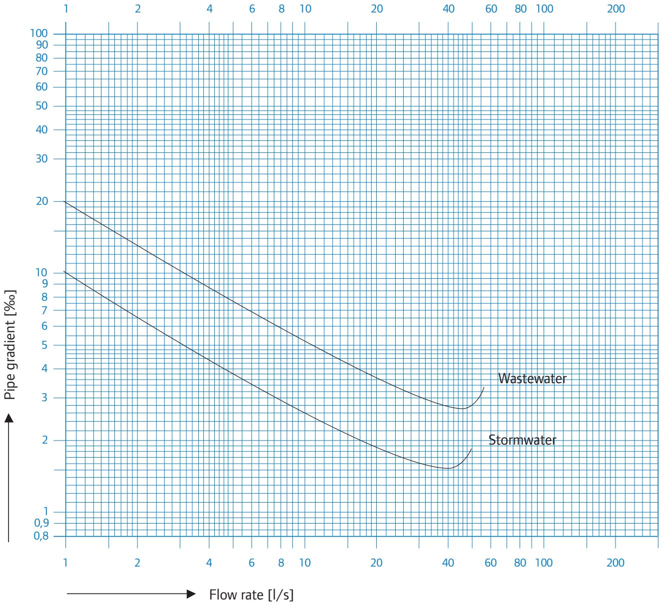
Self-cleaning
capacity chart for
ø 250 pipe



Appendix 6.4

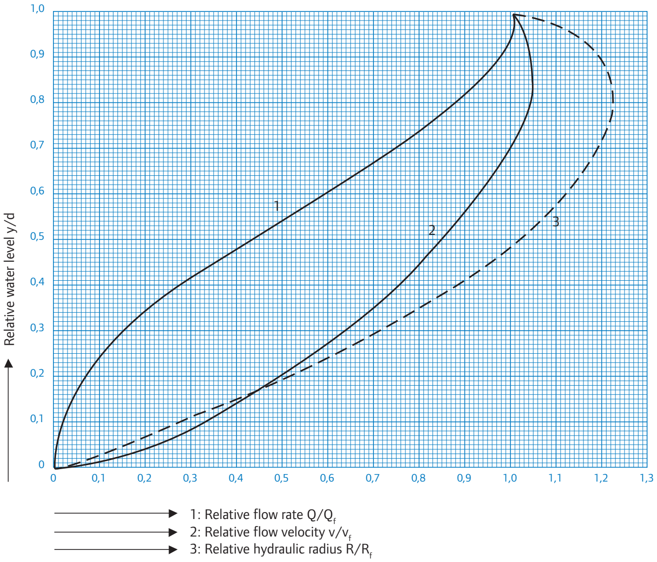
Sewer System
PVC SN 8.

Self-cleaning
capacity chart for
ø 315 pipe



Appendix 7

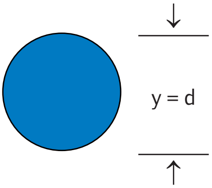
Design chart for Uponor PVC underground drainage pipes; full to part-full conversion



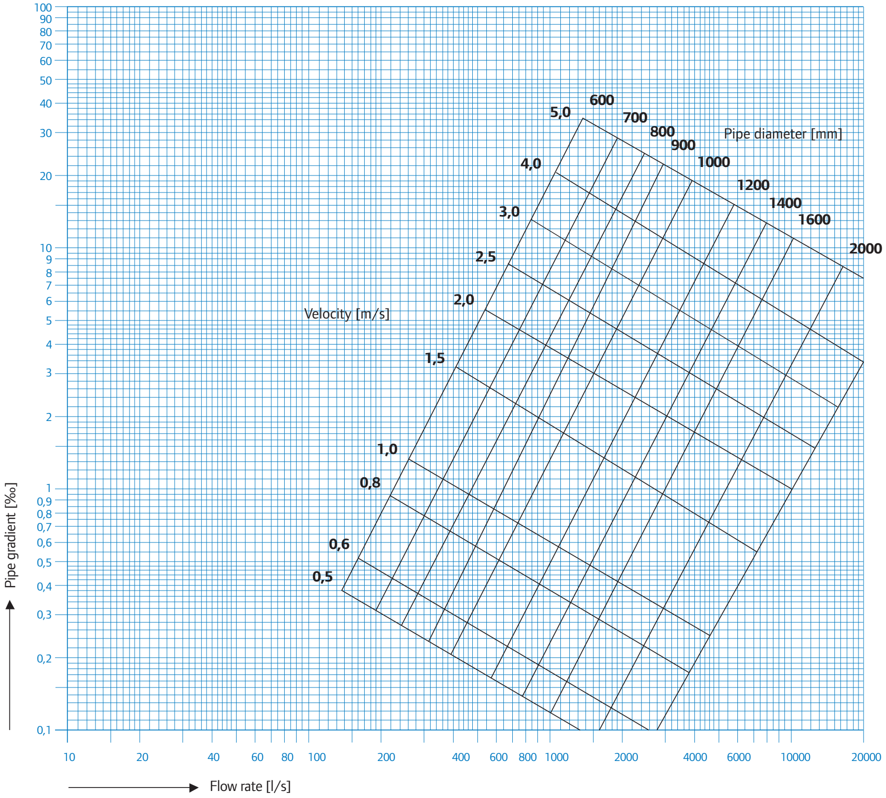
Appendix 8.1

Design chart for full Uponor Sewer System SW pipes

Chart based on the Colebrook-White equation.



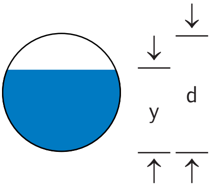
y = water level
d = inside diameter
Roughness coefficient k = 0.00025 m
Filling ratio y/d = 1.0
Water temperature t = 10 °C



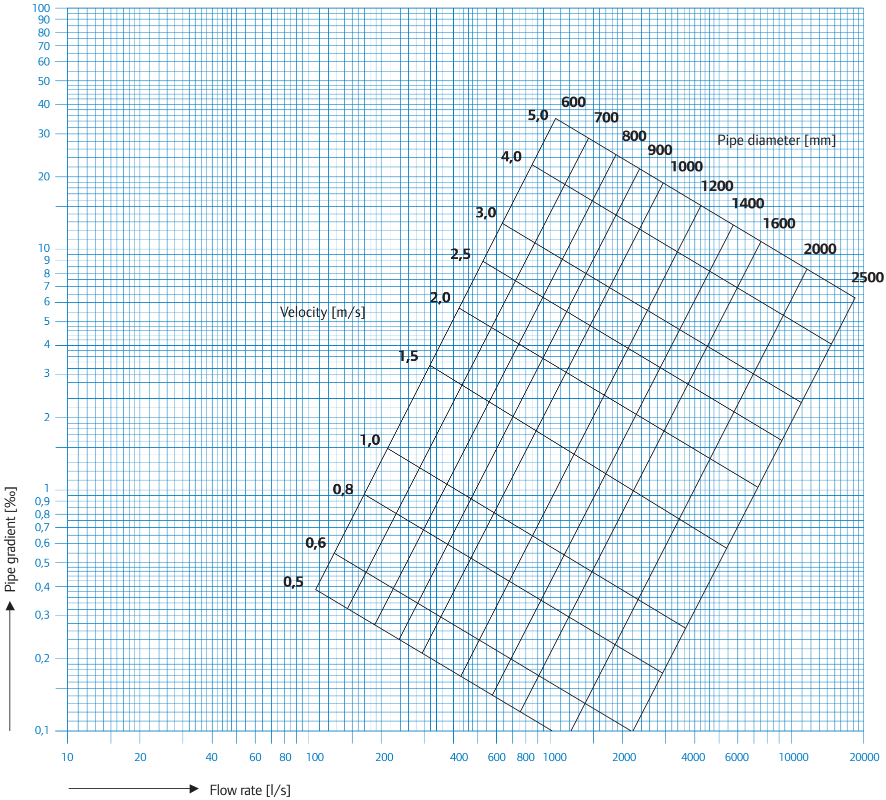
Appendix 8.2

Design chart for 50 % full
Uponor Sewer System SW pipes.

Chart based on the
Colebrook-White equation.



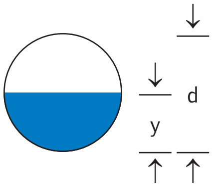
y = water level
d = inside diameter
Roughness coefficient k = 0.00025 m
Filling ratio y/d = 0.7
Water temperature t = 10 °C



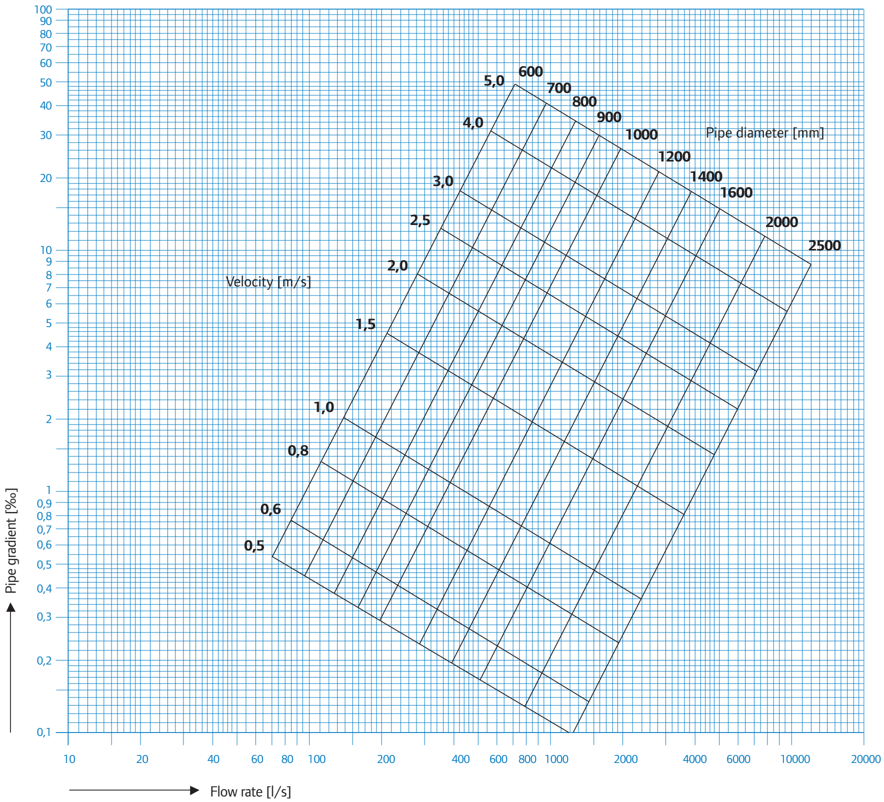
Appendix 8.3

Design chart for 50 % full
Uponor Sewer System SW pipes.

Chart based on the
Colebrook-White equation.



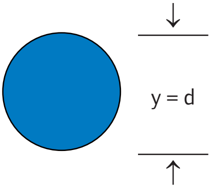
y = water level
d = inside diameter
Roughness coefficient k = 0.00025 m
Filling ratio y/d = 0.5
Water temperature t = 10 °C



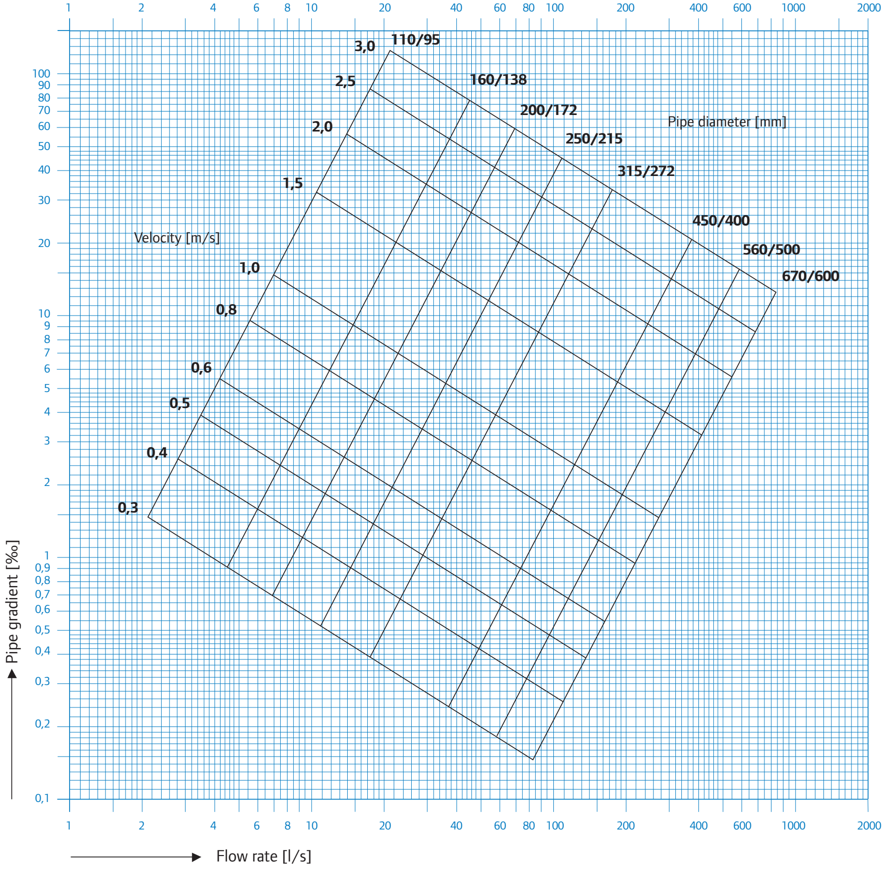
Appendix 9

Design chart for full Uponor Stormwater System DW pipes.

Chart based on the Colebrook-White equation.



y = water level
d = inside diameter
Roughness coefficient k = 0.00025 m
Filling ratio y/d = 1.0
Water temperature t = 10 °C



NOTES