FLOWTITE GRP Storage Sewer Systems
for Retaining and Treating Stormwater
The AMIANTIT Group is an international, growth oriented enterprise offering pipe systems for the areas of water, sewage, gas, oil and industry along with pipe technologies and water management of high quality throughout the world.

Thanks to the experience and commitment of all employees as well as the extensive product range, AMIANTIT occupies a globally significant market position. The enterprise therefore confidently aspires to international market leadership in this sector.

In response to the global challenges AMIANTIT has considerably extended its international activities in recent years. An important area is the development of pipe solutions for different applications. Based on its experience the Group offers optimised pipe systems in different materials. Depending on customer requirements and country we supply:

- GRP pipe systems (glass reinforced polyester pipes), made using different production methods under the names FLOWTITE, VECTUS and AMIREN,
- GRE pipe systems (glass reinforced epoxy) under the name AMIPOX,
- DIP systems (ductile iron pipes) under the name SADIP,
- as well as pipes made of concrete,

The enterprise also offers water management services.

AMIANTIT Germany GmbH has been producing glass reinforced pipe systems (GRP pipe systems) using the FLOWTITE winding method since 1993. This principle of continuous endless production permits the manufacture of pipes in standard lengths of 3.6 and 12 m and in nominal sizes from DN 100 to DN 4000.

The production company AMIANTIT Germany belongs to the AMIANTIT Group. Backed by the technical and financial resources of the Group, AMIANTIT Germany GmbH produces and distributes GRP pipe systems under the brand names FLOWTITE and AMIREN predominantly on the Western European market.

The use of the latest technologies places AMIANTIT Germany GmbH in a position to offer its customers the best product for every application. Decades of experience in different pipe projects in many countries has made the company an expert in the transportation and handling of water and sewage. Modern and effective production plants produce cost-favourable products of highest quality. GRP pipe systems from AMIANTIT Germany are a real alternative where economic efficiency, reliability and handling advantages are required.

FLOWTITE GRP pipe systems

Since the late sixties FLOWTITE has been present on the market and an international leader in GRP pipe technologies. The GRP pipes are made using the endless winding method and are available with diameters up to 4 metres, depending on plant. They are corrosion-resistant, lightweight and resistant in water and sewage systems. They are also easy and simple to handle and are manufactured to high quality standards.

The AMIANTIT Group manufactures FLOWTITE GRP pipe systems in many plants at numerous international locations.
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1 Systems for storing and treating stormwater

Today's wastewater systems distinguish between combined and separate systems.

The separate system has a wastewater sewer and a second sewer positioned alongside for stormwater. The wastewater system is primarily exposed to daily fluctuations caused by discharges from households and businesses. The greatest fluctuations, however, result from additional stormwater events. Short intervals alternate with long ones that can last many days and weeks. Sometimes, the stormwater sewer is required to accommodate a large volume of water in just a very short space of time. This is why stormwater retention tanks are employed for avoiding floods. They have the function of briefly storing the direct inlet of surface water and then discharging it into a local body of water in a delayed and controlled manner. Although it is possible to employ open ground basins, they are often not a practicable option, particularly in built-up areas. This is where underground solutions are called for, such as the one provided by a stormwater retention tank (SWRT).

We also encounter storage sewers in combined-water systems. However, they differ in terms of the function they perform as well as in the way they are constructed.

A combined system takes up wastewater and surface water in one sewer. The requirements placed on these storage systems are described in worksheet ATV-A 128, this being the body of rules on rating and designing stormwater discharge systems in combined-water sewers, and also explained in worksheet ATV-M 176 showing example configurations.

To limit the strain from torrential rainfall on both the combined-water sewer and sewage treatment plant, stormwater overflows are used that discharge excess stormwater into a drainage capacity, i.e., a neighbouring water course. The worksheet makes reference to the following:

- Stormwater overflow (SWO)
- Collection basin (CB)
- Sedimentation basin with overflow (SBO)
- Stormwater retention basin (SWRB)

The system employed depends on a number of factors. It is important to keep the volume of contaminants introduced into the drainage capacity as low as possible. Contaminants are retained mechanically. The ratio with which discharge mixes with surface water must be sufficiently high. Added to this are settlement processes as well as barriers, such as submerged walls and screening systems. Provided the conditions are met for discharging water from the combined-water system, it flows out of the system easing strain on the combined-water sewer. A storage chamber can also be positioned upstream or downstream of a stormwater overflow (SWO). This is where we speak of a collection basin (CB) or sedimentation basin with overflow (SBO). Both basin types are referred to collectively as stormwater overflow basins (SWOB).
The storage sewer pipe has the function of providing a previously defined and requisite storage capacity. In terms of volume, this capacity depends on the anticipated quantity of incoming water and on flow regulation at the discharge. Once full, the stormwater in most cases runs off via an overflow. The degree of contamination carried by inflowing water varies.

The surface and stormwater entering the separate system from street gullies contains sediments, i.e. sand, gravel and grit. These sediments can be retained by upstream settlement basins, manholes or troughs before they reach the storage systems.

A combined-water system must also contend with the faecal load from the integrated sewage. This is why no benefit is achieved by installing upstream retention systems. The storage sewer in the combined system is designed specifically for introducing sedimentation. As a result of the sewage component, a storage system of this type must, in particular, also be highly resistant to sulphurous gases as well as acids with a pH-value as low as 2.

2.1 Storage sewer pipe

Economically speaking, large diameters and long pipes are most efficient. They can be laid extremely quickly and store very high volumes. They are joined by a double bell coupling (PN 1). Highly rigid, the GRP material permits thin pipe walls, making it possible to reduce the necessary volume of excavated material to a minimum. Depending on conditions on site, the weight of the pipes generally allows them to be laid by crane or excavator.

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Table 1: Weight and storage capacity of FLOWTITE GRP pipes in relation to diameter and stiffness class
2.2 Inspection manhole with ladder

A storage sewer is accessible and passable, and must be at least 1m in diameter. Tangential entrances are often provided on the pipe for accessing the storage sewer. They can be configured with or without a berm.

Allowing for deposits, it is recommended to provide entrances without berm up to a nominal diameter of 2000 mm with a straight ladder, nominal diameters above this with an angled ladder. The height between the bottom rung and storage sewer floor should not exceed 0.30 m.

2.3 Static analysis to ATV-A 127

FLOWTITE storage sewer pipes are available in a variety of rigidity classes. On request, we will also compute the necessary pipe profile for you.

A comprehensive structural analysis programme is available on the Internet for those interested in optimising their installation at www.amitools.com. Simply log in free of charge and use the program whenever you wish.

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<tr>
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Table 2: Minimum soil cover for max. groundwater level – without additional measures
3 Sewer for storing stormwater – the modern alternative to stormwater retention basins (SWRB)

Sewer systems for storing stormwater collect roof and surface water from impermeable ground surfaces. They have the purpose of delivering these quantities of water after a delay either to a stormwater discharge system in the separate system or directly to an existing body of water. Storage systems are tank systems that only fill when a stormwater event occurs. Dry-weather discharge does not take place. Consequently, this overflow discharge is not used for "self-cleaning". Deposits in the stormwater storage sewer usually only consist of mineral sediments. Lying loosely in the GRP pipe, they are flushed out by the onset of a surge of stormwater. There are no constrictions (egg-shaped profile, kite profile, dry-weather channel etc.).

3.1 Stormwater retention tank – SWRT

These pipe reservoirs are laid in single as well as multi-line configurations. Provision of flow regulation is common to all stormwater retention tanks. In most cases, they are wet installed. Overflows with discharge weirs leading into a body of water are extremely rare. These are often emergency overflows in the closed system.

Drawing: Stormwater retention tank with integrated manholes – end plate with 300 mm nominal diameter inlet, 2800 mm nominal diameter reservoir pipe, end plate in outlet, prepared for wet-installed flow control system, with emergency discharge and emergency overflow, tangential inspection manhole with ladder

Photo: Integrated wet installed flow control system

Photo: Separate semi-dry installed flow control system
### 3.2 Battery tank systems

Battery tank systems provide the means of quickly laying stormwater retention systems over large areas. Two, four or more lines can be interconnected. They can be adapted in any way to suit the prevailing terrain using moulded GRP components (elbows). Small “barriers” can be used for evenly charging them with stormwater and continuously flushing them.

![Photo: Three-line stormwater storage sewer. GRP storage sewer pipe in 2500 mm nominal diameter](image1)

![Photo: Lübbenau stormwater retention basin, capacity 1200 m³, 2500 mm nominal diameter](image2)

![Photo: Gdansk Airport stormwater retention basin, capacity 4800 m³, 2700 mm nominal diameter](image3)

![Drawing: Battery tank system with separate flow control chamber](image4)
3.3 Cisterns for utilising stormwater

Used as cisterns, stormwater tanks are not configured with any flow control system. Incoming water is stored and put to a later use, e.g. as fire-fighting or process water.

In addition to the pipe reservoir, these systems are provided with at least one inspection manhole and, in many cases, also with a pump sump. In rare cases, they also have an overflow.
The storage sewer is a special form of stormwater overflow basin (SWOB). In most cases, it consists of the storage pipe, a flow control chamber and stormwater overflow manhole. Resulting from the different shape of tank – from basin (mostly round or angular) to pipe – it is very long and narrow. A storage sewer with overhead discharge (SSOD) performs the same function as the collection basin. When a stormwater event begins, fouled pipelines are initially flushed clear. This initial, heavily soiled flushing surge enters the tank. Once full, the water begins to discharge via a stormwater overflow. In particular, it is new incoming stormwater that is discharged here.

The water accumulation phase is also accompanied by sedimentation, i.e. with heavy matter sinking, light matter rising. A submerged wall keep suspended matter back, preventing it from flowing into the drainage capacity.

The second version, storage sewer with invert discharge (SSID), does not base contamination retention on “catching” but almost entirely on sedimentation. With this principle, which follows that of the sedimentation tank with overflow, it is important not to exceed the maximum permissible flow rate of 0.5 m/s. In addition to this, the storage volume must be increased by 50 %. As a result, this storage sewer is far longer. Sedimentation takes place over a long distance in the pipe reservoir. The combined water is discharged at the lower end, i.e. upstream of the flow control system.

Sedimentation, i.e. the settlement of deposits, in a storage sewer is a process that is welcomed and necessary. These deposits must be removed again in a dry-weather phase. This means that flat-bottomed basins must always be cleaned. This is where the dry-weather discharge that takes place lends itself in a storage sewer in the main section. Combining this with a pipe made of glass-fibre reinforced plastic (GRP) optimises flow properties and, as a result, also flushing properties.

Large-diameter pipes are also flushed clear even in conjunction with a very low volume of water and shallow gradient. Studies covering a period of many years have returned values for FLOWTITE storage sewers that are so good as to render additional cleaning facilities or constricted pipe profiles with dry-weather channels unnecessary. We refer to this as the self-cleaning behaviour of a GRP storage sewer. And for us to achieve behaviour as positive as this, it is necessary to observe the following general conditions.

In many places, modern storage sewers for combined water are used instead of classic stormwater overflow
basins (SWOB) made of steel-reinforced concrete. They consist of non-corroding GRP storage pipes that optimise flushing behaviour.

Inspection manholes are integrated. Both the discharge and flow regulation systems are also made of GRP. They are compact, prefabricated assemblies that are individually tailored to the specific application. Equipped with ladders, manholes come with a GRP-laminated channel, berms as well as other assemblies. Flanges and/or mounting plates allow the operator to install flow regulation systems and other mechanisms. Buoyancy protections and cover plates are normally included.
4.1 GRP pipe profiles – particular demands of combined water

While water is accumulating, flow rate in the pipe reservoir is still very low, preventing any flushing from taking place. Sediments remain in the pipe. The GRP pipe is distinguished by its exceptional flushing behaviour. With the storage sewer operating in the main section, it is possible to take advantage of the energy of water from dry-weather discharge. The base of the storage sewer is flushed clear over a period of time governed by the prevailing quantity of water, gradient and pipe diameter. Graph 1 shows the flushing behavior of FLOWTITE storage sewers.

This means it is normally possible to configure the storage sewer with a circular GRP pipe, giving the advantage of providing an attractive cost-benefit analysis. This optimises use of the capacity provided while at the same time making the pipe easy to walk through.

Although a storage sewer pipe in GRP with additional dry-weather channel can be provided with profiling, this should only be done if absolutely necessary.

This design is only used on very shallow gradients – in situations beyond the flushing capacities given in Table 2. This is only where the constricted dry-weather channel is flushed clear, the berm remaining heavily fouled after sediment removal. Without independent cleaning, negotiability is poor.

The kite profile commonly encountered in storage sewers is normally not necessary in the GRP storage sewer pipe either. Despite providing good passability, the benefit of using dry-weather discharge in the GRP storage sewer for cleaning the full width of the base is no longer given.
4.2 Stormwater discharge – Basin overflow

With the reservoir chamber full, the overflow structure starts to empty the storage sewer. The overflow is installed upstream or downstream of the storage sewer. Depending on the system selected, that of the collection basin or sedimentation basin with overflow, this produces an SSOD, i.e. storage sewer with overhead discharge, or SSIV, storage sewer with invert discharge.

One important parameter is the length of the discharge weir. It must be matched to the maximum volume of stormwater to be anticipated. Discharge rates range between less than 100 l/s and several 1000 l/s. Wherever possible, the water should flow off under gravity (non-pressurised) without any excessive backwater. Overflow height (h-BÜ) can be significantly reduced by selecting a long weir. Knowing this, a weir of several metres in length is selected wherever possible.

The most common and also simplest form is a long, straight weir. However, weirs also exist that are straight on both sides, curved, semi-circular and completely circular. The circular weir is particularly suitable for prefabricated manholes in GRP. With water flowing from the outside in, we speak of cup inlet, from the inside out, of central overflow.

The manhole structures for discharging stormwater are prefabricated entirely from GRP. The manhole jacket is monolithic and made of GRP. The berms and channels are also either made of GRP segments or moulded using lightweight concrete and then laminated with GRP to make them resistant to corrosion. The manhole is transported to the construction site equipped with a ladder and all the necessary pipe openings, flange connections and other outlets. The cover is an integral part of the component. The concrete cover plates can be lined in GRP by way of option. This provides corrosion resistance and a long service life. A manhole in a nominal diameter of 3000 mm is constructed in "lightweight" design. Weighing approx. 5 t, can therefore be placed by excavator.

Drawing: Discharge manhole with central overflow
Central overflow

One discharge option frequently used is the system with central overflow. This is a prefabricated manhole with through-flowing pipe/channel and top-mounted "overflow". Water rises through this central overflow, then spills over a circular weir, collects in a circumferential gap and is fed from both sides (right and left) into the discharge manhole. Depending on diameter, this produces a weir length multiplied by the factor Pi = 3.14. This being so, an overflow diameter of only 2 m produces a weir with an edge length of no less than 6.28 m. A system of this type can be integrated in a manhole with a nominal diameter of 3000 mm. Providing the same hydraulic discharge capacity, it is significantly more compact than a straight, long weir.

A design program complying with the DWA (German Association for Water, Wastewater and Waste) code of practice has been created for optimising the overflow structure with central overflow. It allows for rates at which water flows and rises. This makes it possible to compute the Hydraulic Analysis in a very short time. The user is provided with the results in the form of a data sheet.
4.3 Contaminant retention system

The classic storage sewer retains contaminants by barriers, such as direct and indirect submerged or chamber walls. Allowance is also made for the rates at which water flows and rises. Taking this into account in designing the storage sewer produces a sufficient contaminant retaining result, as is the case for the central overflow.

Some conditions, e. g. very small drainage capacities, also demand additional measures for retaining contaminants mechanically. Most of these involve a variety of screening systems. Preventing them from immediately fouling and clogging up, rendering them ineffective, they normally require a cleaning facility.

Mechanical cleaning necessitates energy from outside. This can be an electrically operated system or also one that uses discharge water to drive a waterwheel. Hence, screens of this type work with moving and/or mechanical components. These must be maintained and serviced accordingly.

The long straight weir has proven to be the simplest form of weir for a screening system. Depending on the system used by the manufacturer, it can be installed directly on or upstream of the discharge weir. A horizontal, passable GRP pipe in a nominal diameter of 2400-3000 mm serves as the structure’s jacket.

The GIWA screen has shown to be highly effective. To begin with, it consists almost entirely of plastic, not only making it resistant to corrosion but also low in weight and highly efficient.
4.4 Facilities for cleaning the storage sewer

Commercially available systems, such as flushing dumps, can be used for cleaning fouled sewer pipes. Flushing dumps are integrated in the terminal manholes.

They are particularly important and necessary in a storage system in the side branch, i.e. wherever there is no self-cleaning dry-weather discharge. A flushing dump is filled during the retaining event and is capable of emptying by tipping after the system’s water level lowers. Water flushes dirt particles deposited on the base the storage sewer pipe down to the lowest point.
4.5 Flow-control chamber

The flow-control chamber accommodates the control gear. Employing a system of flow regulation, its task is to prevent a maximum discharge rate from being exceeded. Modern mechanical systems regulate this independently of water level and thus pressure in the storage sewer. Electrically operated flow-control systems are commonly used today as well. These are interconnected with several storage sewer systems and activated when required by the treatment plant.

We distinguish between wet, semi-dry or dry installed flow-control systems. Manholes are either supplied:

a) ready prepared for installing a flow-control system with flange / mounting plate on site,
b) with integrated flow-control system laminated in at the factory

Manholes can be supplied for all common flow-control systems.
4.6 Pumping station – pump manhole and pneumatic systems

In some cases, a pumping station replaces the flow-control chamber. Often, pump manholes are used with two wet-installed pumps. Depending on pump size, the manholes have a nominal diameter 1500-3000 mm. In large manholes, the pump sump is moulded.

Pump manholes are heavily exposed to corrosion. This is why all components, including the steel-reinforced cover plates, are finished entirely in GRP or lined with GRP.

Depending on water volume and distance it is transported over, pneumatic systems are also recommended for conveying water. Differing in scope and equipment, systems of this nature demand a different type of installation. This is where prefabricated GRP modules can be used to provide an individually tailored system on site in a very short time. Low module weight, high rigidity and reliability of GRP push-fit assemblies coupled with the ease with which they can be machined are just a few of the benefits.
4.7 Cascade sewers with storage capacity and overflow – the solution for storage sewers in hillside situations

The cascade sewer is used on hillsides in mountainous situations. One problem with storage sewer systems with invert discharge (SSIV) is having to make the weir high enough for completely filling the upstream storage volume. This is why they are often only partly filled. As a result, they fail to provide sufficient capacity, merely leaving the option of constructing a large basin in cast-in-situ concrete in the side branch and providing it with extensive cleaning facilities. This is where the construction of a cascade system is beneficial. A step-like storage sewer is created that only discharges when completely full. This is not a problem with overhead discharge (OHD). All this requires is to place pressure-tight covers on all floodable openings. The situation with invert discharge, however, is entirely different. Here, the weir is significantly lower than the level of water accumulating in the cascades higher up. This is where the answer is found in a prefabricated cascade sewer with storage capacity and overflow. In terms of design, this is constructed in such a way that the storage space fills from the lowest point upward in step-like fashion. Only when all chambers are completely full does invert discharge commence. The system works purely mechanically, i.e. without external energy, such as electricity. In particular, this provides the capability of constructing a storage sewer in remote areas. Cascades also offer a cost-effective means of constructing long storage sewers. Cascades ensure that the storage pipe is completely filled, particularly in conjunction with invert discharge. Installation depth and excavated material are reduced to an absolute minimum.
Properties – Benefits

CSO systems made of FLOWTITE GRP pipes are characterized by following outstanding properties:

- Deliveries include a compact, full system consisting of pipes and spools
- The high manufacturing flexibility allows tailor-made, individually designed systems
- The well engineered locking system results in low completion times
- Short construction times enable huge cost savings
- The low weight allows installation with standard construction site equipment. Special vehicles such as construction cranes are usually not necessary, even not for big projects and executions.
- The use of glassfibre reinforced plastic makes the delivered systems corrosion resistant
- The patented locking systems guarantee 100 % leak tightness of the installation
- The extremely smooth inner surface and an excellent flow coefficient results in a high self cleaning capacity

These arguments make FLOWTITE combined overflow systems an easy to maintain, long living and cost-efficient product.

What happens in the storage sewer?

Inside storage sewers, faecal content produces an anaerobic sulphurous gas that turns into sulphuric acid with a pH-value well below 7.2 (neutral).

The material used for making a storage sewer must be resistant to sulphuric acid with a pH value of 2-7.

To achieve this, the GRP storage systems from AMIANTIT are only produced from:

- acid-proof resin,
- acid-proof glass,
- acid-proof, inert quartz sand, free of calcium carbonate

FLOWTITE GRP storage sewer pipes and manholes are resistant to pH values from 2-12.
Designing a storage sewer

Please send the filled-in form sheet to the fax number listed at the back page of this brochure.

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**DOCUMENTS**

1. Ground plan
2. Longitudinal section of the ground and the pipeline (optional)
3. Construction drawings if available

**DATA**

1. **Installation data**
   - 1.1 Traffic load
   - 1.2 Minimum groundwater level
   - 1.3 Maximum groundwater level
   - 1.4 Additional data (soil expertise etc.)

2. **Hydraulic data**
   - 2.1 Storage capacity \( V = \)
   - 2.2 Maximum discharge volume \( Q_{\text{max}} = \)
   - 2.3 Maximum limited flow \( Q = \)
   - 2.4 Dry weather flow \( q_t = \)
   - 2.5 Additional data

3. **Fixed points**
   - 3.1 Type of flow regulator
   - 3.2 Type of discharge system
   - 3.3 Additional components (f.i. sand trap)
   - 3.4 Subsequent systems (pump station/gravity sewer/...)
   - 3.5 Additional solid retention system
   - 3.6 Further requirements
This handbook is intended as a guide only. All values listed in the product specifications are nominal. Unsatisfactory product results may occur due to environmental fluctuations, variations in operating procedures, or interpolation of data. We highly recommend that any personnel using this data have specialised training and experience in the application of these products and their normal installation and operating conditions.

The engineering staff should always be consulted before any of these products are installed to ensure the suitability of the products for their intended purpose and applications. We hereby state that we do not accept any liability, and will not be held liable, for any losses or damage which may result from the installation or use of any products listed in this handbook as we have not determined the degree of care required for product installation or service. We reserve the right to revise this data, as necessary, without notice.

We welcome comments regarding this handbook.