DRAINTUBE

Design guidance document for the protection of buildings against soil gas infiltrations

DRAINTUBE GAS

Originally prepared by Groupe Alphard inc.

Updated and modified by Afitex-Texel

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afitex-Texel
GEOSYNTHETICS

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1. Introduction

Draintube®, manufactured by AFITEX-Texel Geosynthetics inc., combines geosynthetic and pipe technology into a single product that has a variety of fluid management applications. Draintube® combines two or three layers of 100 percent polypropylene or polyester geotextile that are needle punched together with perforated corrugated polypropylene pipes inserted between the layers.

AFITEX-Texel is based in North America with manufacturing facilities in Canada. The company combines the expertise of AFITEXINOV and Texel. AFITEXINOV is a French company that has specialized in drainage products for over 25 years and is an industry leader throughout Europe. Texel is a Canadian company founded in 1967 that manufactures highest quality nonwoven materials. Draintube® has been used throughout Canada, the United States Europe and Africa for a great variety of projects and range of uses. More than 25 million square metres have been installed since 1992.

1.1 Applications

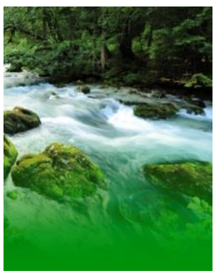
Draintube® has been successfully used on hundreds of projects around the world. The product is manufactured to adapt to project specific hydraulic characteristics and soil properties. Draintube® combines the separating and filtering performance of geotextiles with the drainage ability of perforated pipes. Although the purpose of this document is to describe the collection and evacuation of underground gases with Draintube® for building protection, there is a wide range of other applications. Examples of other Draintube® applications are provided below.

Roadwork and Civil Engineering

- Replaces crushed stone and geotextile separators to provide effective drainage for roads, parking lots, walls, tunnels, roof gardens, and other earthwork projects.
- Results in lower costs, faster construction, less excavation and/or backfill, and better performance.

Tailings and Mining Applications

- Provides liquid and gas drainage for waste storage covers/caps.
- Provides drainage for tailings dams, which increases the overall stability.
- Provides leachate drainage in metals extraction using heap leaching techniques.
- Promotes groundwater drainage under storage ponds.

Sports Field Applications	
	• Replaces the geotextile separators and the granular draining layer in natural and synthetic sports fields and provides effective drainage. • Results in cost reductions, an easier installation, variable design options, and improved performance.
Environmental Applications	
	• Provides liquid and gas drainage for landfill closures. • Replaces part of granular layer and protective geotextile within leachate collection system at the bottom of the landfill. • Provides groundwater and/or gas drainage under lined ponds. • Promotes vapor collection and removal from under buildings. • Provides landfill gas collection from below the cap and at the landfill surface, or replaces landfill gas collection trenches.

1.2 Purpose of this guidance document

The purpose of this guide is to offer a technical assistance for designing systems for the protection of buildings from underground gases (natural gas, biogas, carbon monoxide, radon, etc.) that can infiltrate buildings.

1.2.1 Landfill gas or underground gas

Landfill gas (LFG) is produced during the decomposition of putrescible material in landfills and of organic material in soils by microorganisms. LFG is typically 40 to 60 percent methane with the remainder consisting of carbon dioxide with limited amounts of nitrogen, oxygen, and other compounds. Methane is a greenhouse gas that has 21 times more of an impact on climate change than carbon dioxide.[1] LFG must be removed from the landfill to avoid odors, and to limit the migration of methane to the atmosphere or nearby structures, which would result in an explosive hazard.

[1] "Overview of Greenhouse Gases: Methane Emissions," United States Environmental Protection Agency, http://epa.gov/climatechange/ghgemissions/gases/ch4.html.

1.2.2 Radon

Radon is a radioactive gas found naturally in the environment. It is produced by the decay of uranium found in soil, rock or water. Radon is invisible, odourless and tasteless and emits ionizing radiation. When radon escapes from the earth into the outdoor air, it is diluted to such low concentrations that it poses a negligible threat to health. However, when radon is confined to enclosed or poorly ventilated spaces like buildings, it can accumulate to high levels and may pose a risk a health risk.

1.2.3 Volatile Organic Compounds (VOC)

VOCs are organic compounds containing one or more carbon atoms that have high vapour pressures and therefore evaporate readily to the atmosphere. There are thousands of compounds that meet this definition. Some, such as benzene and formaldehyde, are considered toxic and can affect health.

A major source of man-made VOCs are solvents that are used in paints and protective coatings. VOCs come from human activities in the areas of production, storage, transport, processing, use and combustion of petroleum and its sub-products, natural gas or coal.

There are five families of VOC:

1) <u>Alkanes</u> come primarily from petroleum products and contain hydrocarbons such as butane, ethane, heptane, hexane, octane, pentane or propane. As a general rule, alkanes have low reactivity and are less responsible than other VOCs for the formation of ozone.
2) <u>Alkenes and Alkynes</u>: These unsaturated hydrocarbons are characterised by a double bond (alkenes) or triple bond (alkynes) between the carbon atoms. They include acetylene, ethylene, isoprene or propylene. They are mainly used in the chemical industry and are generated while refining petroleum. Alkenes are more reactive than alkanes because of their double bond. Alkynes are even more reactive because of their triple bond.
3) <u>Aldehydes and Ketones:</u> These unsaturated organic compounds, also known as carbonyl compounds, are generated by incomplete burning of fuels and wood.
4) <u>Monocyclic aromatic hydrocarbons</u>: They are hydrocarbons having at least one benzene ring. They include benzene, naphthalene, styrene, toluene or xylene.
5) <u>Halogenated hydrocarbons:</u> This is the family of fluorinated, brominated or chlorinated hydrocarbons. These VOCs are present in the air because of their use in solvents, refrigerants, insecticides and aerosol propellants such as chlorobenzene, chloroform, vinyl chloride, freons R11, R12, R22, R114 or trichloroethylene. These compounds are relatively stable and can last in the atmosphere for a long time.

2. Subslab depressurization

Subslab depressurization (SSD) aims to reduce building occupants' exposure to toxic gases from the soil (contaminated soils or gases naturally present in the soil). To do so, a gas collection network is installed under the entire slab and connected to an exhaust pipe, 100 mm *(4 in.)* diameter min., installed vertically through the floor to the roof. Exhaust pipe penetration through the slab must be sealed to avoid any leakage. The drain must be independent of the plumbing system.

Type and design of the gas collection network are shown in the following sections.

In order to prevent subsurface vapors from entering homes and other buildings, mitigation solutions can be achieved by passive or active SSD.

In a passive SSD, the gas is drained from under the slab by the drainage system to a collector pipe connected to a vent, which extracts the gas from the building by natural draft.

Another option is to create an active SSD by adding a fan to the drain vent of the passive system in order to increase the extracted flow and achieve a lower sub-slab air pressure relative to indoor air pressure.

Charts are available in section 7 of this guide. They provide gas collection flow rates in passive conditions in function of the distance between collector pipes, the type of gas and the height of the vent. In cases where passive-system discharge rates are insufficient to draw the gases out, the charts also give the negative pressure needed by a fan-powered system to achieve the required extraction flow rates.

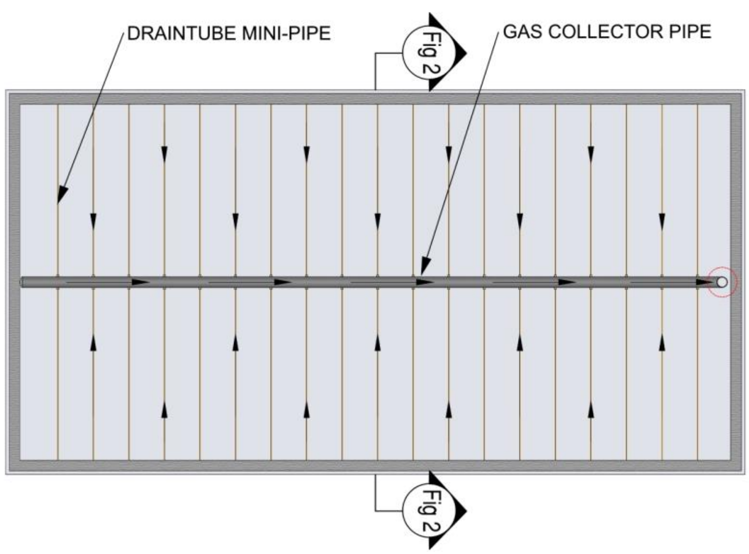


Figure 1 : Plan view - Depressurization system (passive or active) with Draintube®

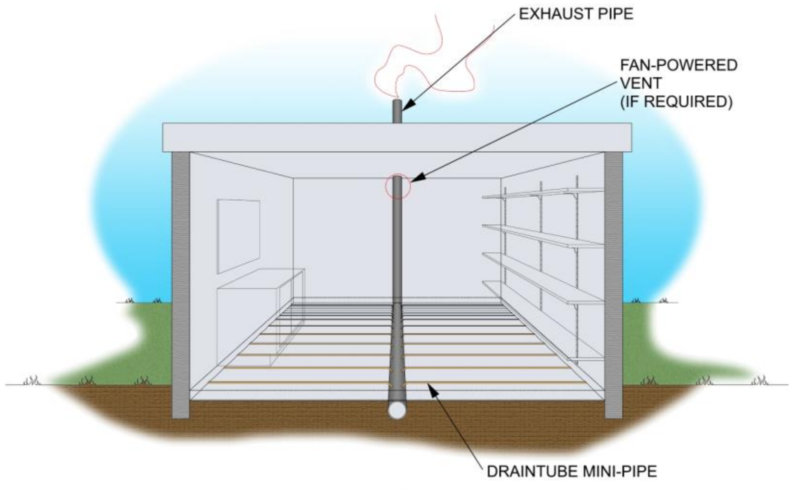


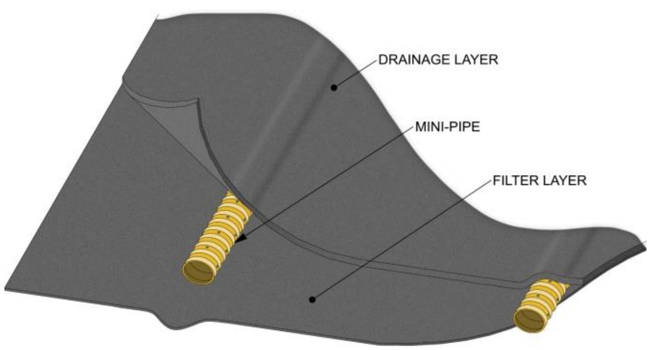
Figure 2 : Cross section - Depressurization system (passive or active) with Draintube®

3. Draintube® solution

3.1 Product description

DRAINTUBE GAS geocomposite is specially designed for draining fluids from under slabs. The geocomposite consists of two geotextile layers made of short synthetic staple fibers of polypropylene or polyester with perforated corrugated polypropylene mini-pipes, regularly spaced at 1 m *(40 in.)* intervals across the width of the product (figures 3).

The mini-pipes are 25 mm *(1 in.)* diameter and have two perforations per corrugation at 180° and alternating at 90°.



Figures 3 : Draintube® geocomposite

3.2 Manufacturing

Draintube® is produced in 3.98 m *(13.1 ft.)* wide rolls. Testing of Draintube® is performed at all stages of manufacturing to ensure uniform quality of the material. This program consists of mechanical and hydraulic tests at regular intervals on the geocomposite. The quality control program is available on request from the manufacturer. It may also be adapted to the requirements of each project.

Material specifications for the Draintube® products are presented on individual data sheets, available online and in Appendix 1.

3.3 Performance and Testing

Draintube® has been tested for a variety of performance applications including transmissivity, durability, and interface friction angle. The results of this research have been published and presented at several professional conferences and are available online or by request.

3.3.1 Transmissivity

Draintube® geocomposites allow effective drainage of liquids or gas, depending on the application. They can completely replace granular drainage layers.

The specific transmissivity for each product is stated on product data sheets, available online, and in Appendix 1. Draintube® has been tested under highly compressive loads. Results indicate that the transmissivity of the product is gradient sensitive rather than load or time sensitive. When the product is properly confined, increasing the normal load does not significantly affect the transmissivity.

For gas drainage, there is a direct relationship between the transmissivity in water or in air for this product. This relationship is explained in later sections.

3.3.2 Durability

Draintube® has an estimated durability of 80 to 165 years. These values were established by accelerated-aging tests carried out in laboratory. The report of these tests is available on request from the manufacturer.

3.3.3 Resistance to compressive loads

Draintube® can withstand high compressive loads while keeping its mechanical and hydraulic characteristics. It has been tested under loads up to 2 500 kPa *(50,000 psf)* for 1,000 hours. The report of these tests is available on request from the manufacturer.

3.4 Installation and Quality Assurance

One of the advantages of using this product is that there are only few elements to consider when installing it. Draintube® specifications and the manufacturer's installation guideline are provided in the appendix. They provide the requirements for transportation, storage, installation, connection, and repair recommended for the geocomposite.

The geocomposite must be installed on the designated surface and connected to the gas collection system following the installation instructions of the subslab depressurization system presented in this document.

If required by a construction quality assurance (CQA) plan, samples can be taken for compliance testing, although such testing is not required by the manufacturer. Each sample should be at least 600 mm *(2 ft.)* long and taken across the full width of the Draintube® roll.

We recommend, during installation, documenting the installation of the product, the connections made in the drain-collector system and the steps followed.

4. Subslab gas removal: DRAINTUBE GAS

DRAINTUBE GAS replaces the granular layer intended for subslab depressurization for gas collection and evacuation. The technical data sheet of the product is available in Appendix 1.

Figures 4 and 5 show a typical cross section of the subslab installation using DRAINTUBE GAS geocomposite. If required, a 150 mm *(6 in.)* thick soil layer may be placed on top of the product before placing the vapor barrier.

The Draintube® mini-pipes are connected to a collector pipe, which is connected to an exhaust pipe, 100 mm *(4 in.)* diameter minimum, installed vertically through the floor to the roof. Exhaust pipe penetration through the slab must be sealed to avoid any leakage. The drain must be independent of the plumbing system. Junctions of the concrete slab with foundation walls, posts or other penetrations must be sealed with a waterproof concrete sealant.

The geomembrane is unrolled directly on DRAINTUBE GAS. The geotextile layers of DRAINTUBE GAS protect the geomembrane against subgrade puncture.

The use of Draintube® coupled with the installation of an EVOH geomembrane under concrete slabs provides additional protection against migration of toxic gases into buildings. EVOH geomembranes are more than 100 times less permeable than typical polyethylene vapor retarders against Methane, Radon, and other harmful VOCs.

The contractor's installation procedure must ensure continuous contact between the geomembrane and the geocomposite without tension or wrinkles in order to avoid damage or residual tension. Geomembrane panels are joined together and fixed to the vertical walls (foundation walls, posts, etc.) to ensure the sealing of the overall surface. Any holes in the geomembrane must also be sealed to avoid leakage. All plumbing, conduit, support columns or other penetrations that come through the geomembrane shall be sealed around.

A fan-powered vent can be added to the passive system to increase the extracted flow and achieve a lower sub-slab air pressure relative to indoor air pressure (figure 2).

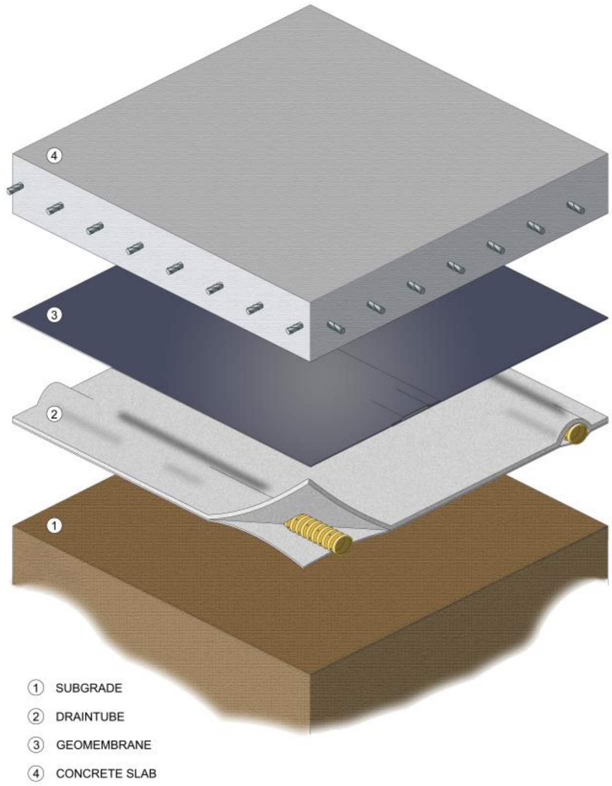


Figure 4 : Typical cross section with Draintube®

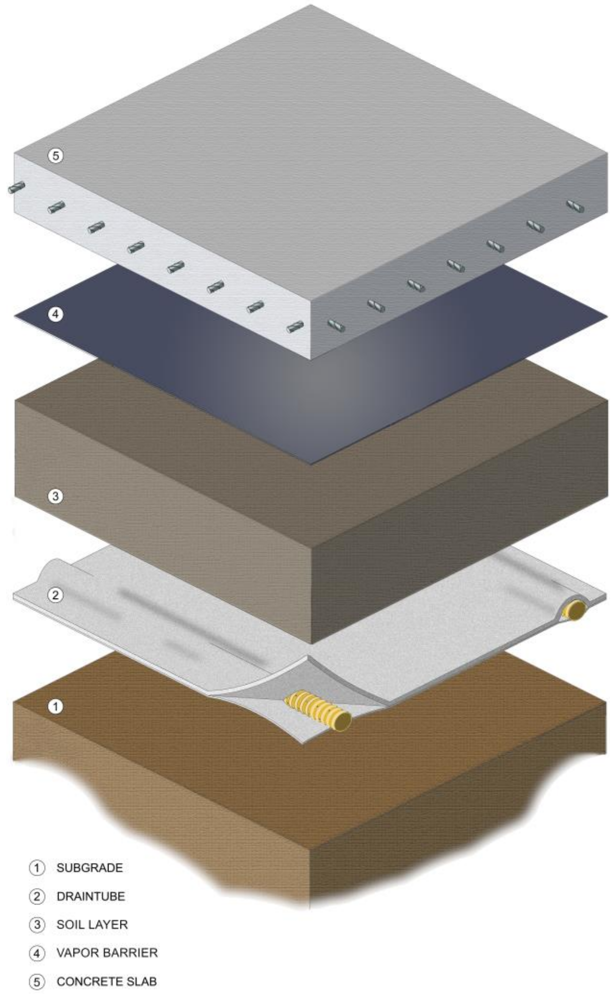


Figure 5 : Typical cross section with Draintube® and Soil layer

The DRAINTUBE GAS specifications are provided in Appendix 2. Installation Guideline is provided in Appendix 3. Typical details are available in Appendix 4 and on request in CAD format.

5. Subslab depressurization system installation

5.1 Draintube® geocomposite

The geocomposite is unrolled directly on the subgrade, perpendicular to the collector pipes. The product's filter layer is in contact with the soil and the geofilm (if used) is on top (figures 6). Draintube® storage, handling and installation must be performed in accordance with the specifications and the manufacturer's installation guidelines available in the appendix.

Figures 6: Draintube® installation on the subgrade

Connections between rolls are made by overlapping the geotextile layers and mechanical connection of the mini-pipes as described in the installation guidelines in the Appendix 3. The mini-pipes must always be confined between the geotextile layers of the geocomposite to avoid any contamination with soil particles (figure 7).

Figure 7: Mini-pipes between geotextiles

Posts or other obstacles related to the geometry of the building requiring cutting of the geocomposite must be treated in order to maintain flow continuity in the mini-pipes.

When a geomembrane is installed directly over Draintube®, it must be done in accordance with the manufacturer's installation guidelines.

5.2 Gas collector pipes and exhaust pipes

Gas collector pipes must be installed in accordance with the design of subslab depressurization system. Exhaust pipes are positioned at the end or at the center of the concrete slab according to the constraints related to the layout of the building (figures 8). In active subslab depressurization, a fan-powered vent will be added to the exhaust system. In most cases, collector and exhaust pipes consist of 100 mm *(4 in.)* diameter PVC pipes.

Figures 8: Collector pipes and exhaust pipes

Collector pipes must be installed in a small trench allowing them to be below the final level of the foundation of the concrete slab. In case of a soil layer over the Draintube®, the collector pipe is then confined in this layer and a trench is not needed.

5.3 Draintube® connection to the collector pipe

The mini-pipes of Draintube® are directly connected to the collector pipe using the Quick Connect system (figures 9) in accordance with the specifications and the manufacturer's installation guideline available in the appendix.

Figures 9: Draintube® connection to the collector pipe using the Quick Connect system

When building geometry does not allow for continuous flow in the geocomposite's mini-pipes because of walls or other obstacles, additional collector pipes must be installed and connected to the exhaust network.

If construction features do not permit the use of the Quick Connect system, overlap connection solutions are used. In that context, the collector pipes shall be perforated to allow gas to migrate from Draintube® to the exhaust system.

5.4 Sealing of joints

Joints between the concrete slab and the adjacent walls, posts or vertical exhaust pipes can be sealed as described in figure 10.

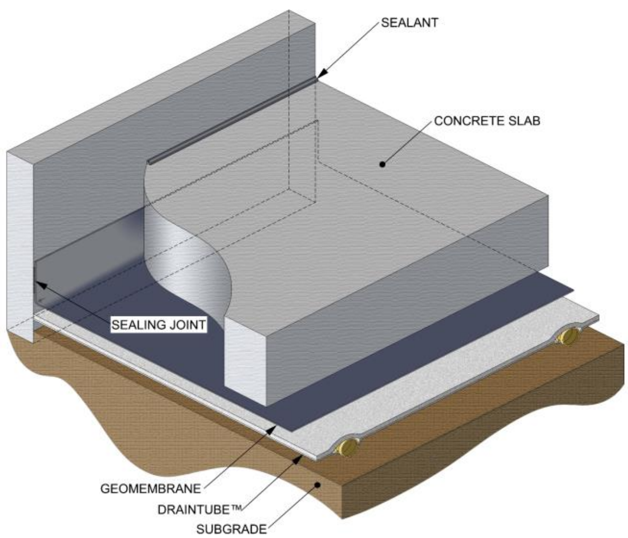


Figure 10: Junction of a geomembrane and an adjacent wall

5.5 Concrete slab

A protective geotextile may be laid over the vapor barrier or the geomembrane before the installation of the reinforcement rods and casting the concrete slab (figure 11).

Figure 11: Casting of the concrete slab on the geomembrane

6. Design and efficiency of Draintube® as part of the SSD

Design methodology for subslab depressurization using Draintube® as well as performances associated to this type of application are presented in this section.

The aim of the gas drainage layer is to migrate the gases to the collector pipes and then outside the building using the exhaust pipes. This exhaust system avoids the accumulation of gas under the slab that could eventually infiltrate the building.

The following sections will help the designer of the system with the design of a passive or active SSD using Draintube®. Several cases are considered depending on the type of gas or/and different building configurations.

For projects requiring higher drainage capacities or geocomposites with characteristics not defined in this guide, the manufacturer will propose a project-specific Draintube® geocomposite (higher mini-pipe density in the product, specific geotextile layers, etc.).

6.1 Gas drainage in passive conditions

Figures 12 and 13 give the gas discharge rate per unit area of DRAINTUBE GAS as part of the SSD system in passive conditions considering the drainage length for different exhaust heights. Figure 12 is in SI units and figure 13 in Imperial units.

The drainage length is the maximum distance drained for gases in Draintube® to the collector pipe. If Draintube® is connected on both sides to collector pipes, the length of drainage will be half the distance between the two collector pipes. Δz is the exhaust height given for several types of buildings.

These charts help determine the maximum length of drainage (or the half distance between two collector pipes) for a passive SSD when the type of gas and the generated flow rate are known.

Conversely, for a given distance between two collector pipes, it is possible to determine the maximum gas flow rate per unit area that can be evacuated. The results for Air gas are given in the chart; the same table for other gases can also be provided by the manufacturer on request.

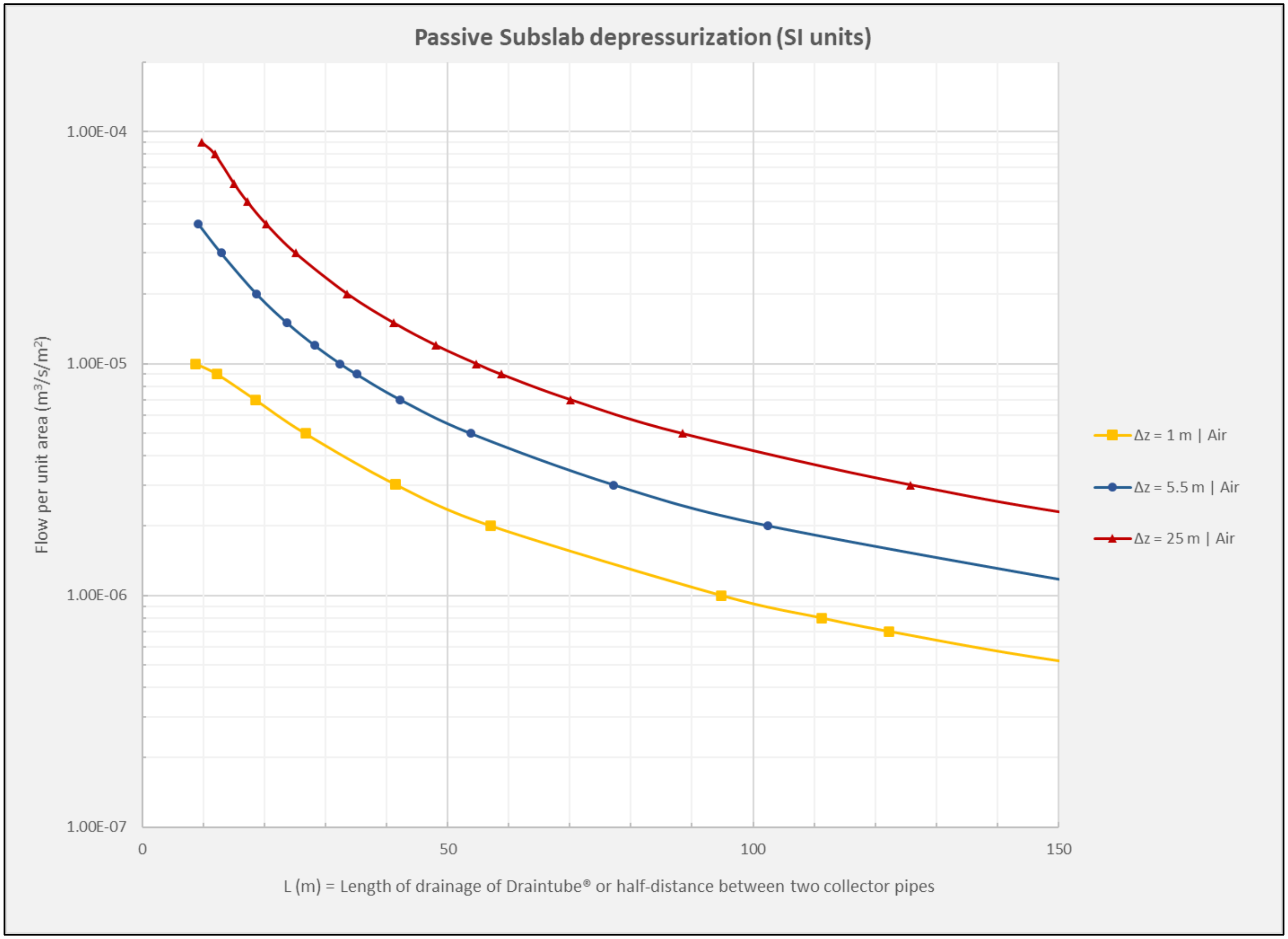


Figure 12: Discharge capacity of DRAINTUBE GAS in passive condition – SI units

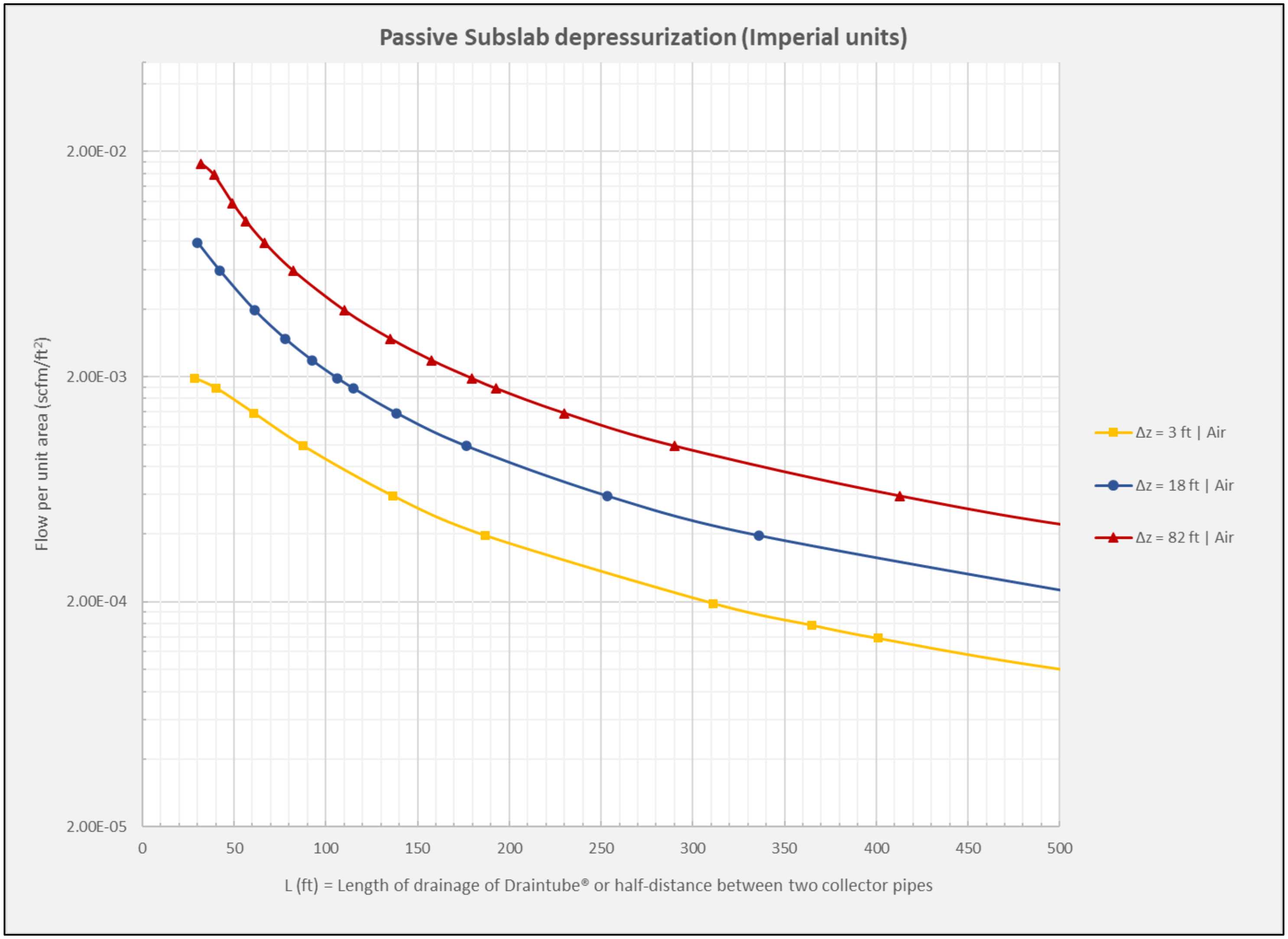


Figure 13: Discharge capacity of DRAINTUBE GAS in passive condition – Imperial units

6.2 Gas drainage in active conditions

Figures 14 and 15 give the Air gas discharge rate of DRAINTUBE GAS as part of the SSD system in active condition, in relation to the length of drainage or the half distance between two collector pipes and the negative pressure applied. Figure 14 is in SI units and figure 15 in Imperial units.

These charts will help determine the maximum drainage length (or the half distance between two collector pipes) for an active SSD when the applied negative pressure and the generated gas flow rate are known. Or for a given distance between two collector pipes, the charts give the maximum gas flow rate per unit area that can be evacuated as a function of the negative pressure applied.

Flow and head losses are governed by the Draintube® mini-pipes and considered in the calculations. Head losses in the collector pipes and their connections are neglected.

Other charts with other gases are available on request from the manufacturer.

Unit converter:

100 mm of water = 7.36 mm Hg = 980 Pa = 0.142 psi

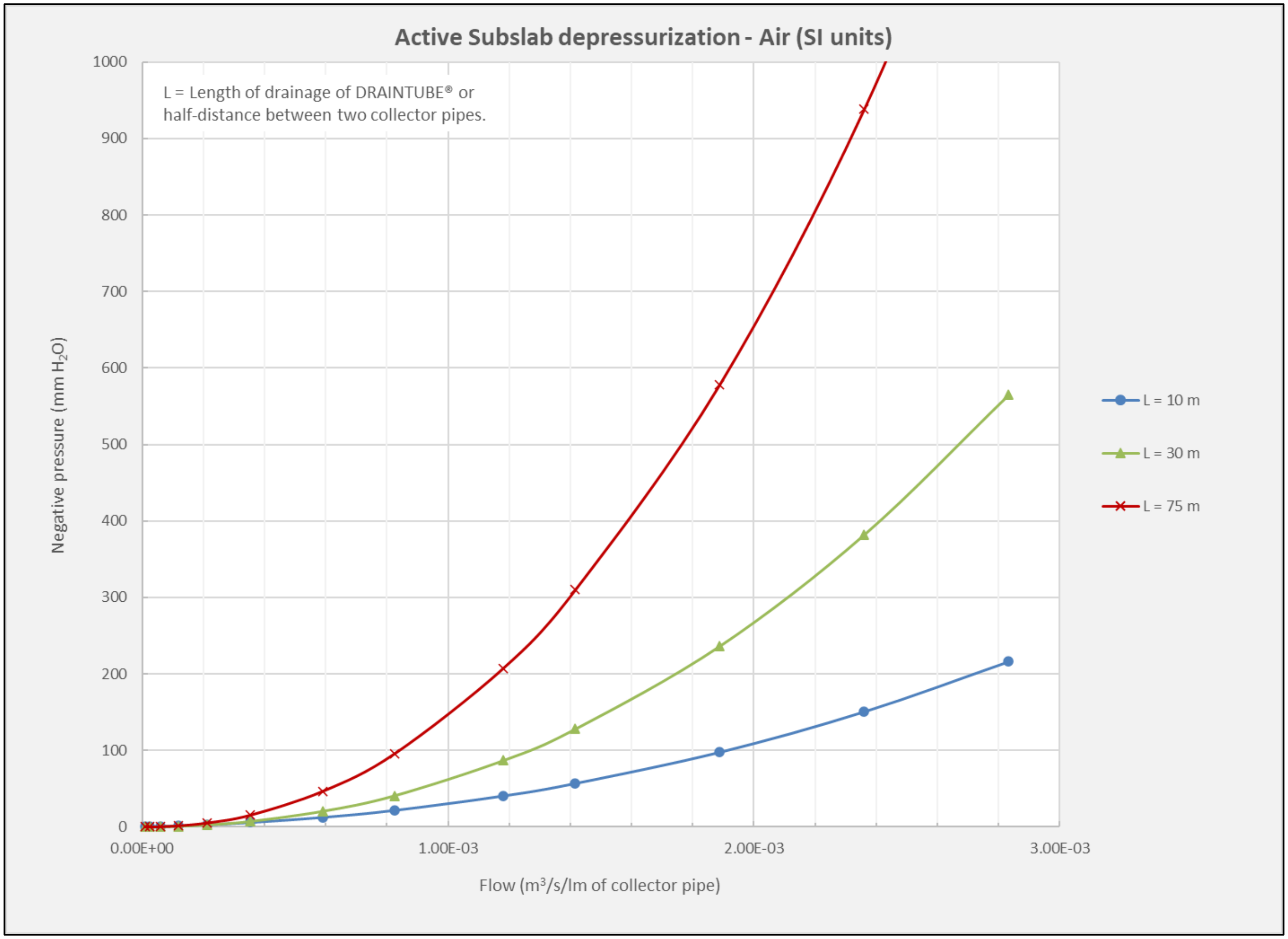


Figure 14: Air discharge capacity of DRAINTUBE GAS in active condition function of negative pressure applied – SI units

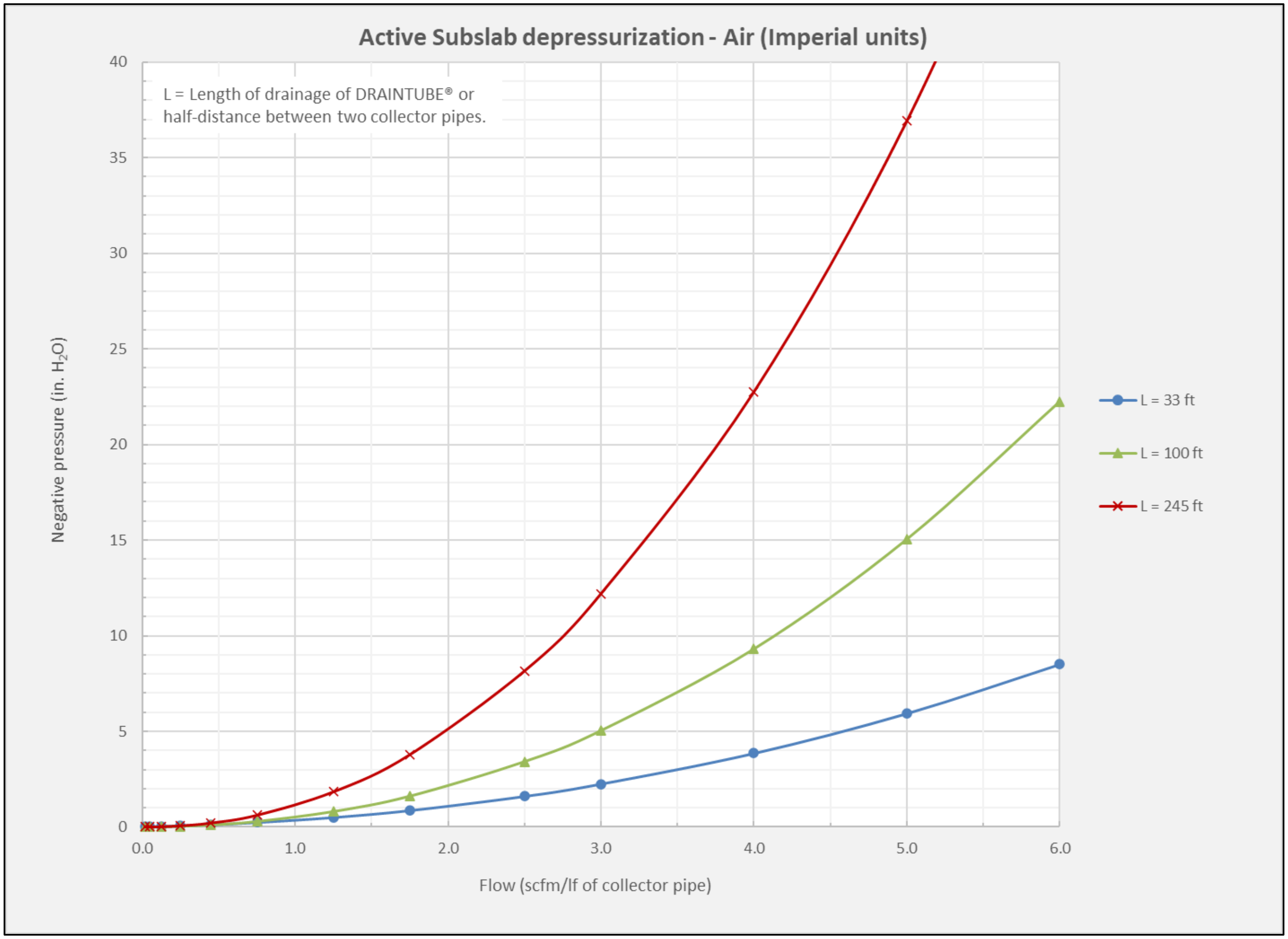


Figure 15: Air discharge capacity of DRAINTUBE GAS in active condition function of negative pressure applied – Imperial units

6.3 Comparison of Draintube® with a granular layer

Draintube® geocomposite can be used instead of a granular layer and perforated-pipe network traditionally considered for subslab depressurization under buildings. In fact, DRAINTUBE GAS offers greater capacity and greater efficiency in evacuating gas than a crushed stone layer.

Figures 16 and 17 compare the gas flow capacity of DRAINTUBE GAS geocomposite in passive conditions to a clean aggregate layer for several thicknesses and give the factor of safety of the geocomposite solution. Gas flows have been calculated using an exhaust height of 1 m *(3 ft.)* above the drainage geocomposite and a maximum drainage length of 75m *(246 ft.)*. If Draintube® is connected on both sides to a collector pipe, the length of drainage will be half the distance between the two collector pipes.

The granular material considered is a crushed aggregate meeting Size #5 specifications as defined in ASTM C33-90. This aggregate is in the range of ½’’to 1’’ diameter, as described in the EPA/625/R-92/016 Radon Prevention in the Design and Construction of Schools and Other Large Buildings document. The air hydraulic conductivity of the granular material is considered inferior or equal to 0.07 m/s *(0.23 ft/s)*, this is obtained from its water hydraulic conductivity considered inferior or equal to 1 m/s *(3.3 ft/s)* and a ratio between water conductivity and air conductivity of 14.8 (kwater/kair = 14,8[2]).

[2] Richardson and al., "*Gas transmission in geocomposite system",* GFR Magazine, Vol. 18, No. 2, March 2000.

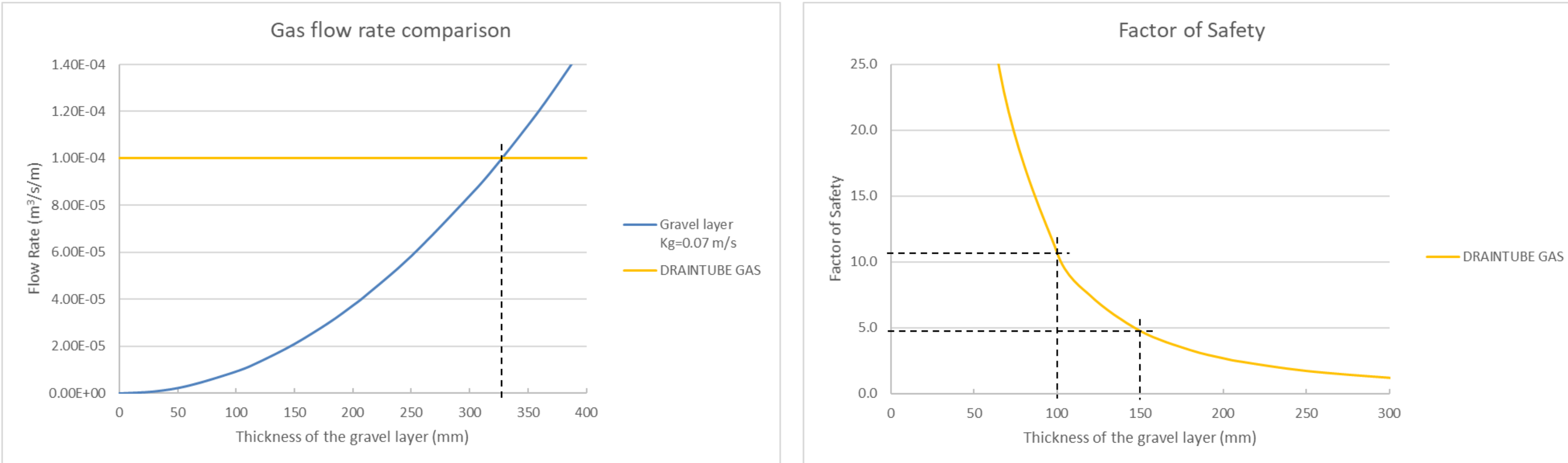


Figure 16: Gas flow capacity of a granular layer vs DRAINTUBE GAS – SI units

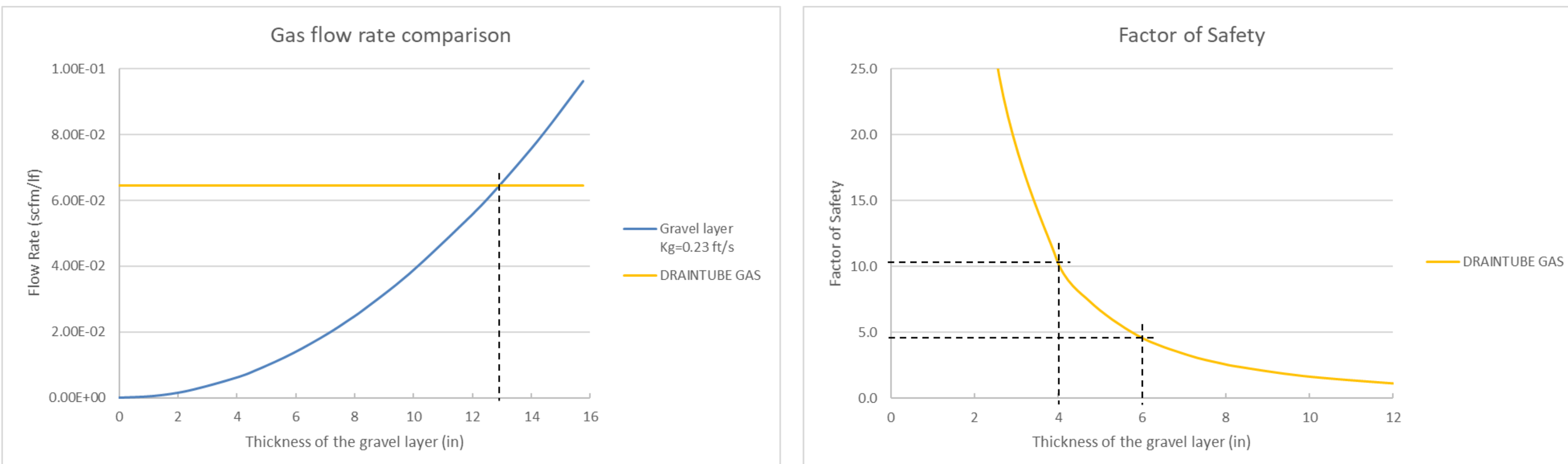


Figure 17: Gas flow capacity of a granular layer vs DRAINTUBE GAS – Imperial units

7. Legal aspect of this document - Responsibility

The present study aims to help the designer of the project in its evaluation of the proposed drainage material. The results of this study may not be used for the definitive design of the project without a preliminary written confirmation by an expert in one or several technical domains that concern the present project. Afitex-Texel geosynthetics inc. will not assume any responsibility of any nature whatsoever due to any damage, claim from any person or malfunction of the product.

This study is based on specific parameters which must be controlled during the construction of the project. Consequently, without limitation, the results of the study and the performance of the product can vary or be affected by the one or more of the following parameters:

- the slope of the infrastructure and\or the drainage system,
- the length of flow,
- the flow to be drained,
- the permeability and the thickness of the foundation material,
- the compatibility of the geotextile with the backfill granular soils,
- the percentage of fines in the granular soil used,
- the perfect functioning of the peripheral drainage systems,
- the adequate design of the equipment that is connected with the drainage system allowing the flow to be drained.

If the parameters of calculation as presented above and used in the present study are not respected during the construction of the project, the performances of the drainage system can vary in a significant way in comparison with what has been calculated. In the same manner, the compatibility of granular materials and filter (geotextile) will have to be such that it allows the geotextile to preserve its hydraulic properties (permeability) in the time. The clogging or contamination of the geotextile or the obstruction of mini-drains can lead to an important decrease of the performances expected from the proposed drainage system.

Appendix 1: DRAINTUBE GAS technical data sheet

DRAINTUBE GAS

TECHNICAL DATASHEET

ASTM D4439 Terminology	Multi-linear drainage geocomposite
Composition	Polypropylene and/or Polyester
Main function	Gas collection

The product consists of two geotextile layers comprised of short synthetic staple fibers of polypropylene or polyester needle-punched together with perforated corrugated polypropylene pipes regularly spaced inside. The pipes have two perforations per corrugation at 180° and alternating at 90°.

Property	Test Method	Reference	Metric	Imperial
Geotextile				
Mass per unit area	ASTM D5261		100 g/m^2	3 oz/yd^2
Grab Tensile Strength	ASTM D4632	MD/CD	135 N	30 lb
Grab Elongation	ASTM D4632	MD/CD	50 %	
CBR Puncture Strength	ASTM D6241		500 N	112 lb
Apparent Opening Size (AOS)	ASTM D4751		0.180 mm	80 US Sieve
Permittivity	ASTM D4491		1.8 sec^{-1}	
Water Flow Rate	ASTM D4491		6 927 $l/min/m^2$	170 $gal/min/ft^2$
Perforated Pipe				
Outside Diameter	ASTM D2122		25 mm	1.0 in
Pipe stiffness at 5% deflection	ASTM D2412		3 000 kPa	435 psi
Spacing between pipes	N/A	1 pipe per meter of width	1 m	40 in
Geocomposite				
Geocomposite Transmissivity [1]	ASTM D4716 / GRI GC15	Normal load = 480 kPa (10,000 psf) Hydraulic gradient = 0.02 Seating time = 100 h	2 x 10^{-3} m^2/sec	9.7 gal/min/ft
Dimensions				
Roll Width	N/A	-	3.98 m	13.06 ft
Roll Length	N/A	-	75 m	246.06 ft

Properties are minimum average roll values except AOS which is maximum average roll value, Outside Diameter which is nominal value and Transmissivity which is typical value.
1 - Transmissivity measured on a 250 mm wide specimen with one pipe in the middle of the sample in the longitudinal direction, installed as follows : sealed sand / geocomposite / geomembrane / sealed sand. The given transmissivity is obtained from a linear relationship between the number of pipes and the measured transmissivity.
Our quality management system is certified by ISO-9001 standard.
Our internal laboratory is certified by the Geosynthetic Accreditation Institute - Laboratory Accreditation Programm (GAI-LAP).

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Appendix 2: DRAINTUBE GAS specifications

SECTION [*insert Section Number*]
DRAINTUBE DRAINAGE GEOCOMPOSITE

PART 1 – GENERAL

1.1 SCOPE OF WORK

A. This specification covers the requirements for the manufacture, fabrication, supply, and installation of Draintube Drainage Geocomposite. The Draintube Drainage Geocomposite and its individual components shall meet or exceed the requirements of this specification. The manufacture, handling, storage, and installation shall be performed in accordance with the procedures provided in this specification.

B. Contractor shall provide all labor, materials, tools, and equipment and perform all operations necessary to furnish, deploy, and install Draintube Drainage Geocomposite in the areas indicated on the Drawings or as required by ENGINEER or OWNER.

1.2 REFERENCES

A. ASTM International (latest version):

1. D2122 Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
2. D2412 Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
3. D4491 Standard Test Methods for Water Permeability of Geotextiles by Permittivity
4. D4533 Standard Test Method for Trapezoid Tearing Strength of Geotextiles
5. D4632 Standard Test Method for Grab Breaking and Elongation of Geotextiles
6. D4716 Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
7. D4873 Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
8. D5261 Standard Test Method for Measuring the Mass per Unit Area of Geotextiles
9. D6241 Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe

B. CAN/ONGC standard (latest version):

1. 148.1 No.10 Geotextiles - Filtration Opening Size

1.3 QUALIFICATIONS

A. Installer shall have demonstrated experience in the installation of Draintube Drainage Geocomposite, have installation staff trained by the manufacturer, or work under the guidance of the manufacturer's representative.

B. CONTRACTOR shall be trained and experienced in field handling, storing, deploying, and installing geosynthetic materials. Alternatively, CONTRACTOR shall engage an experienced Subcontractor who shall meet the experience requirements.

C. CONTRACTOR shall demonstrate at least four years of experience in sewing geotextiles and shall have completed at least four projects that required geotextile sewing. Alternatively, CONTRACTOR shall engage an experience Subcontractor or manufacturer's agent who shall meet the experience requirements.

1.4 QUALITY ASSURANCE

A. A representative of OWNER or ENGINEER shall observe and document the unloading, storage, deployment, and installation of the Draintube Drainage Geocomposite.

B. If required by a Construction Quality Assurance (CQA) Plan, then OWNER or ENGINEER shall obtain samples of the Draintube Drainage Geocomposite for conformance testing. Each sample shall be at least 600 mm (2 feet) long, taken across full width of the geocomposite roll for each type of material furnished for Project.

1.5 WARRANTY

A. Installation shall be warranted against defects in workmanship for a period of 1 year from the date that the installation is deemed complete.

1.6 SUBMITTALS

A. CONTRACTOR shall submit to ENGINEER for approval the manufacturer's data indicating that the properties of the proposed Draintube Drainage Geocomposite conform to the requirements of this Specification.

B. CONTRACTOR shall submit to ENGINEER the manufacturer's quality control test results for the Draintube Drainage Geocomposite produced specifically for the project and certification that the material meets the requirements of this Specification at least 15 days prior to installation of the material.

C. CONTRACTOR shall submit to ENGINEER the following at least 15 days prior to installation:

   1. Drawings showing geocomposite sheet layout, location of seams, direction of overlap, and sewn seams.

2. Description of proposed method of deployment, sewing equipment, sewing methods, and provisions for holding geocomposite temporarily in place until permanently secured.

PART 2 – PRODUCTS

2.1 MATERIAL DESCRIPTION

A. Draintube Drainage Geocomposite shall consist of two geotextile layers comprised of short synthetic staple fibers of 100% polypropylene or polyester needle-punched together with perforated corrugated polypropylene pipes regularly spaced inside.

B. The pipes shall be corrugated with two perforations per corrugation at 180° and alternating at 90°.

2.2 DRAINTUBE DRAINAGE GEOCOMPOSITE PROPERTIES

A. The Draintube Drainage Geocomposite specified shall meet or exceed the values provided in the table below.

CHARACTERISTIC	STANDARD	UNIT	MARV
Mini-pipe Properties			
Outside diameter (1)	ASTM D2122	mm (in)	25 (1.0)
Stiffness at 5% deflection	ASTM D2412	kPa (psi)	3000 (435)
Geotextile Properties			
Mass Per Unit Area	ASTM D5261	g/m^2 (oz/yd^2)	100 (3)
Grab Tensile Strength	ASTM D4632	N (lb)	135 (30)
Puncture CBR	ASTM D6241	N (lb)	500 (112)
AOS (2)	ASTM D4751	mm	0.180
Permittivity	ASTM D4491	sec^{-1}	1.8
Geocomposite Properties			
Transmissivity (3)	ASTM D4716 / GRI GC15	m^2/sec	2.0×10^{-3}
Structural Reduction Factor (4)			1.0

(1) Nominal Value.
(2) Maximum Average Value.
(3) Value at a gradient of 0.02 when tested with boundary conditions consisting of sealed sand / geocomposite / geomembrane / sealed sand. The seating time, with a uniformly applied load of 489 kPa (10,000 psf) shall be a minimum of 100 hours.
(4) Structural Reduction Factor (SRF) is a reduction factor that must be applied on the Index Transmissivity to take into account the creep and the intrusion factors. SRF = $RF_{CR} \times RF_{IN}$. For Draintube technology, RF_{CR} = 1.0 and RF_{IN} = 1.0. The SRF value is a product/technology specific value.

PART 3 – EXECUTION

3.1 INSPECTION

A. Prior to deploying any Draintube Drainage Geocomposite, CONTRACTOR shall carefully inspect the surface on which the material will be placed and verify that the material may be placed without adverse impact.

B. CONTRACTOR shall certify in writing that the surface on which the Draintube Drainage Geocomposite will be installed is acceptable. The certificate of acceptance shall be given to ENGINEER prior to commencement of Draintube Drainage Geocomposite installation in the area under consideration.

C. Special care shall be taken to avoid desiccation cracking or freezing of the soil surface. The soil surface shall be maintained in the required condition throughout the course of geocomposite installation.

3.2 MATERIAL STORAGE AND HANDLING

A. Rolls of Draintube Drainage Geocomposite shall be shipped to site in a manner that will not cause damage to the rolls.

B. CONTRACTOR shall be responsible for the handling, storage, and care of the Draintube Drainage Geocomposites from the time of delivery to the site until final acceptance of the completed work by ENGINEER and OWNER. CONTRACTOR shall be liable for all damages to the materials during such time.

C. CONTRACTOR shall comply with ASTM D4873 with respect to storing and handling the Draintube Drainage Geocomposite.

D. The rolls shall be stored flat on a smooth surface protected against dirt, mud, and excessive heat.

E. Draintube Drainage Geocomposite shall not be stockpiled or stored within the work area limits.

3.3 MATERIAL PLACEMENT

A. Draintube Drainage Geocomposite shall not be placed, seamed/joined, or repaired during periods of precipitation, excessively high winds, or in areas of ponded water or excessive moisture.

B. Draintube Drainage Geocomposite shall be installed in accordance with manufacturer’s recommendations, and as shown on the Drawings and specified herein.

C. Draintube Drainage Geocomposite shall be installed in the direction of the slope (if any) and perpendicular to the collector trench or collector pipe, such that the pipe components are oriented with the intended flow direction unless otherwise specified by the ENGINEER.

D. The Draintube Drainage Geocomposite shall be kept clean prior to and during installation.

E. Folds or excessive wrinkling of deployed Draintube Drainage Geocomposite shall be removed to the extent practicable.

F. CONTRACTOR shall exercise care not to entrap stones, excessive dust, or foreign objects in the material.

G. Draintube Drainage Geocomposite shall be adequately weighted, using sand bags or equivalent until the subsequent soil, concrete or geosynthetic layer is placed. In the presence of wind, the sandbags or the equivalent shall be placed along the leading edge and removed once cover material is placed.

H. Overlaps shall be singled in the direction that backfilling will occur.

3.4 SEAMING AND JOINING

A. Adjacent sheets of Draintube Drainage Geocomposite shall be overlapped as described below.

1. Connections at along the side of the Draintube Drainage Geocomposite roll shall be overlapped 100 mm (4 inches) and shall be secured using sewn seams, additional overlap, or welds (hot air or flame).
2. Connection at the leading or terminating edge of the Draintube Drainage Geocomposite shall be overlapped such that the upper geotextile layer can be rolled back 150 mm (6 inches) and the end of the next roll inserted into the opening. Pipes shall be connected either using a snap coupler fitting supplied by the geocomposite manufacturer or by overlapping the pipes by 250 mm (10 inches) minimum.

B. Connections to an interceptor drain and/or vacuum pipe shall conform to the Drawings and be at the direction of ENGINEER.

3.5 MATERIAL PROTECTION

A. Draintube Drainage Geocomposite shall be covered by soil, concrete or another geosynthetic so that the material is not exposed to ultraviolet rays for more than 14 days before being covered.

B. No construction equipment shall drive directly across the Draintube Drainage Geocomposite without permission from ENGINEER.

C. The cover layer shall be placed on the Draintube Drainage Geocomposite in a manner that prevents damage to the Draintube Drainage Geocomposite. Placement of the cover layer shall proceed immediately following the placement and inspection of the Draintube Drainage Geocomposite.

D. Cover soil or concrete shall be free of matter that could damage the Draintube Drainage Geocomposite.

E. Cover soil or concrete shall not be dropped directly onto the Draintube Drainage Geocomposite from a height greater than 1 meter (3 feet). Cover shall be pushed over the Draintube Drainage Geocomposite in an upward tumbling motion that prevents wrinkles in the Draintube Drainage Geocomposite.

F. The initial loose lift thickness of soil shall be 300 mm (12 inches) or less using adapted construction methods. Compaction shall consist of a minimum of 2 passes over all areas. The loose lift thickness of each subsequent list shall be no greater than 300 mm (12 inches). Normal soil placement shall be allowed on areas after the second loose lift of fill has been placed and compacted.

G. In case of a concrete slab directly poured on the geocomposite, the reinforcing steel shall be placed with the rebar supports on the geocomposite.

3.6 REPAIR

A. Prior to covering the deployed Draintube Drainage Geocomposite, each roll shall be inspected for damage.

B. Any rips, tears or damaged areas on the geocomposite shall be removed and patched.

1. If a section of pipe is damaged during installation, add a piece of undamaged pipe of the same diameter next to the damaged pipe, extending a minimum of 150 mm (6 inches) beyond each end of the damaged section of pipe or use snap coupler fittings.
2. If the geotextile is ripped or torn, install an undamaged piece of the same material under the hole that extends a minimum of 150 mm (6 inches) beyond the hole in all directions to insure that protection of the geomembrane is maintained.
3. If the area to be repaired is more than 50 percent of the width of the panel, then the damaged area shall be cut out and replaced with undamaged material. Damaged geotextile shall be replaced by the same type of geotextile.

[END OF SECTION]

Appendix 3: Installation guideline of Draintube®

INSTALLATION GUIDELINE

DRAINTUBE® geocomposite

Liquid drainage and/or Gas collection under building

DRAINTUBE *is manucfatured by*
AFITEX-TEXEL Geosynthetics Inc.
1300 2e rue, Parc Industriel
Sainte-Marie de Beauce (Québec) Canada G6E 1G8

DATE: 01/06/2022

Synopsis

General Description

The product consists of geotextile layers comprised of short synthetic fibers of 100% polypropylene or polyester, which are needle punched together. Corrugated polypropylene pipes with two perforations per valley at 180-degree spacing and rotated 90 degrees per valley are inserted longitudinally between the geotextile layers during the manufacturing process at uniform intervals. DRAINTUBE® is manufactured in Canada.

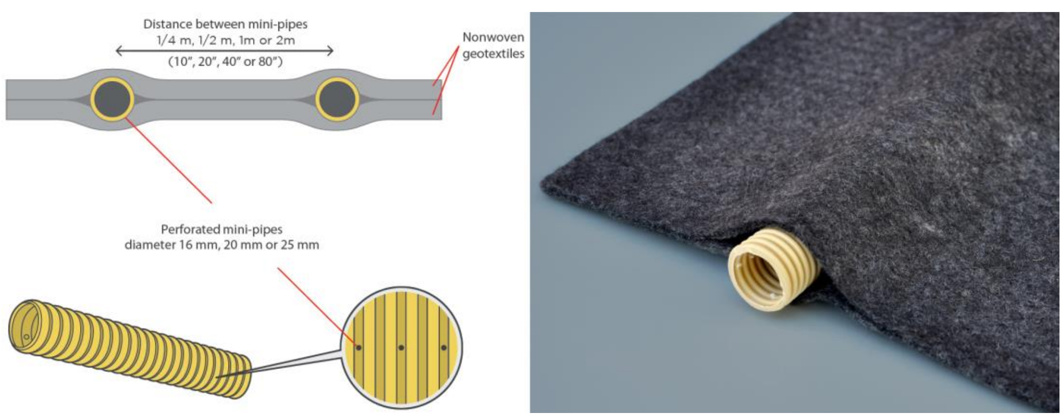
1 HANDLIND AND STORAGE

Rolls of DRAINTUBE® geocomposite shall be shipped to the job site in a manner that will not cause damage to the rolls. The rolls shall be stored flat on a smooth surface (no wooden pallets) away from dirt, mud and excessive heat. For more detailed handling and storage information, please refer to ASTM D4873. The contractor shall handle the rolls so that they are not damaged in any way.

2 INSTALLATION

2.1 *DRAINTUBE® description*

DRAINTUBE® geocomposite is supplied on rolls 3.98 m (13 ft.) wide and 75 m (246 ft.) long (figures 1 & 2).



Figures 1: DRAINTUBE® structure

Figure 2: DRAINTUBE® packaging

2.2 *Putting into place*

DRAINTUBE® is unrolled on a base which has been graded and compacted to the required elevation (figure 3). Ensure that the product is properly oriented.

Figure 3: DRAINTUBE® installation

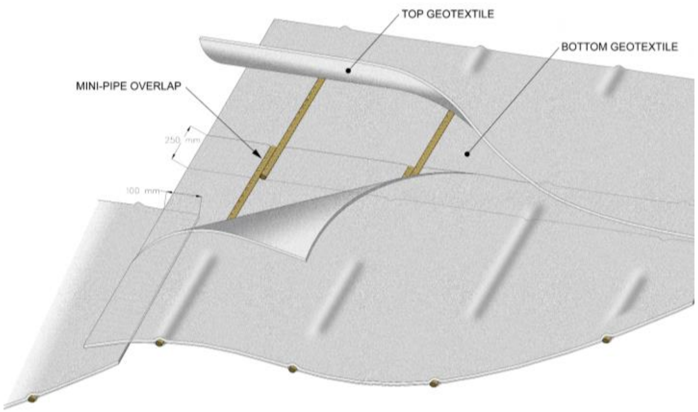
Protect underlying layers from damage during placement of the geocomposite. Use sandbags or equal to weigh down the geocomposites prior to backfilling to prevent displacement by the wind.

2.3 *Transverse Connections (at the end of a roll)*

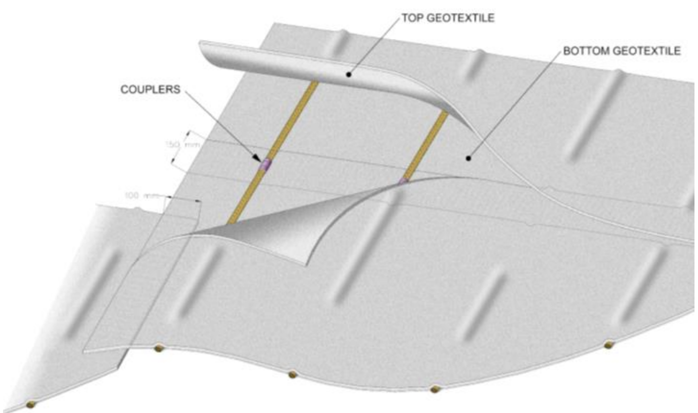
Connection at the leading or terminating edge of the DRAINTUBE® shall be overlapped such that the upper geotextile layer can be rolled back 150 mm (6 in.) minimum and the end of the next roll inserted into the opening. Mini-pipes may be either overlaped by 250 mm (10 in.) minimum (figures 4) or connected using snap coupler fittings supplied by the geocomposite manufacturer (figures 5). Connection method requirements shall be at the engineers' discretion. Mechanical connections are recommended under high compressive loads.

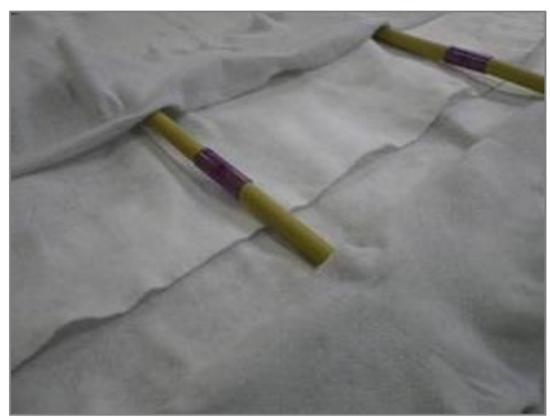
Overlapped geotextiles shall be secured using sewn seams, welds (hot air or flame) or additional overlap.

The mini-pipes of the geocomposite must always be maintained between the geotextile layers to prevent contamination by soil particles.



Figures 4: Transverse connections without couplers





Figures 5: Transverse connections with couplers

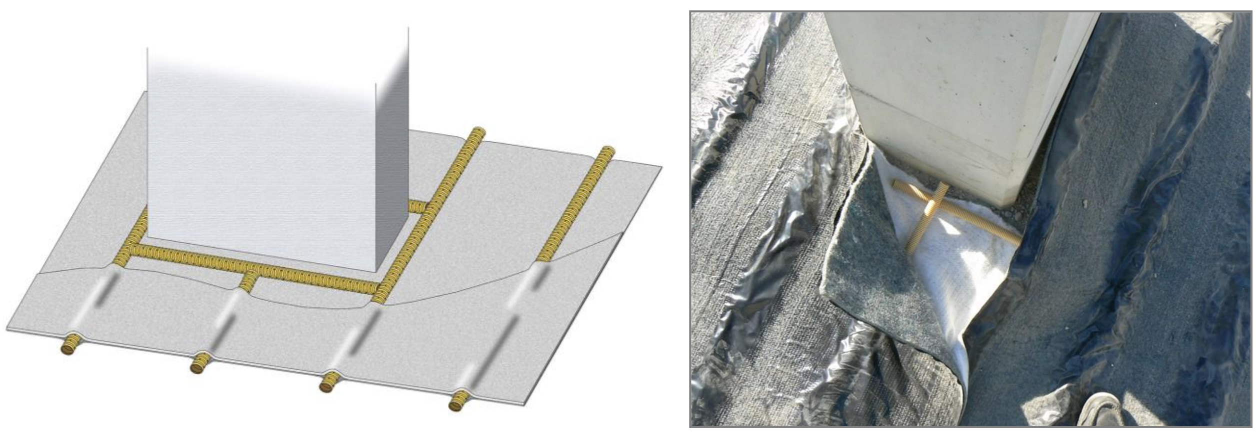
2.4 *Side by Side Connections*

Connections along the side of the DRAINTUBE® roll shall be overlapped 100 mm (4 in.) minimum and shall be secured using sewn seams, additional overlap, or welds (figure 6). Connection method requirements shall be at the direction of the engineer.

Figure 6: Side by side connections

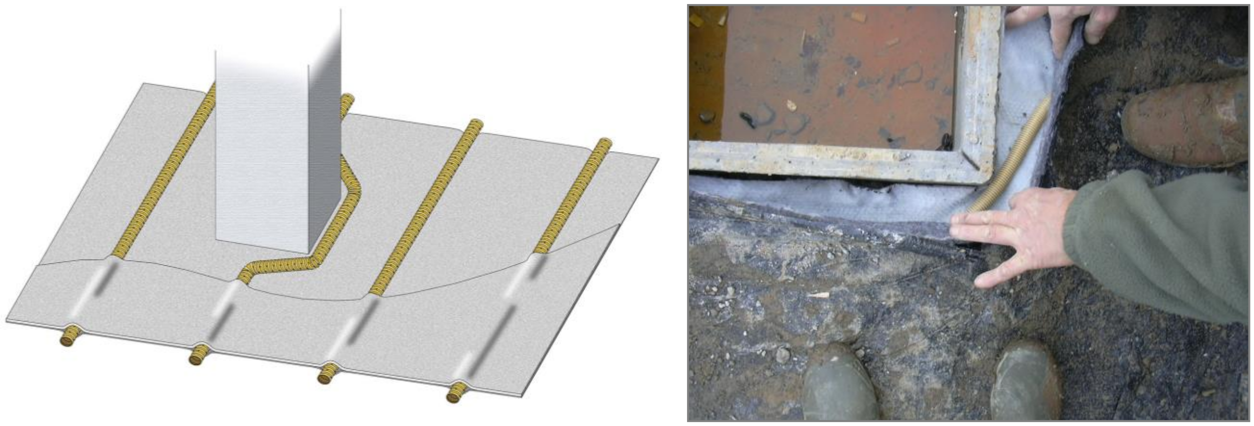
2.5 *Specific points*

In case of wide posts, DRAINTUBE® is cut next to the post. The mini-pipe(s) interrupted by the post are cut off about 100 mm (4 in.) upstream of the post. A mini-pipe is then positioned at 90° angle between the drainage layer and the filter layer so as to link the closest two mini-pipes (figures 7).



Figures 7: Side by side connections

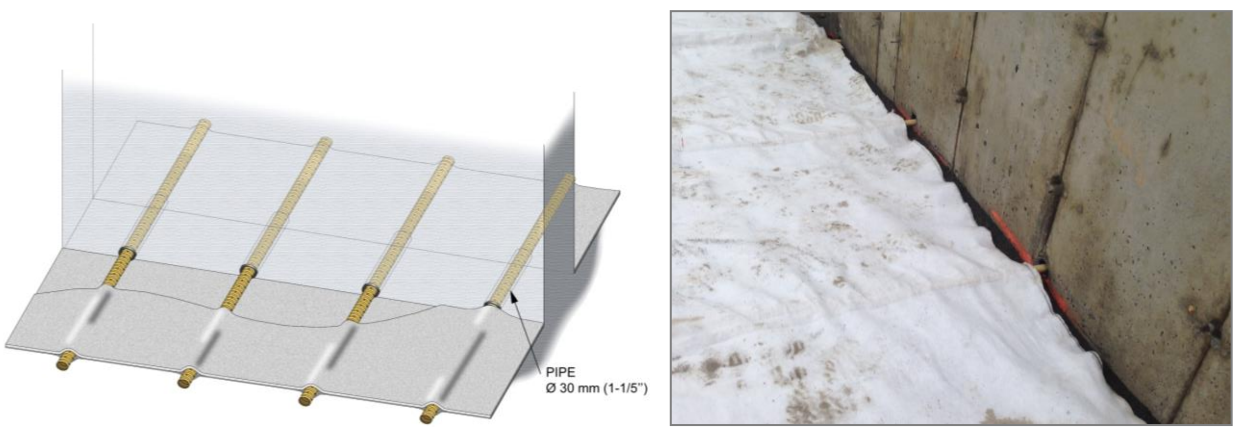
In case of a narrow post less or equal to 300 mm (12 in.) width, the mini-pipe is then derived along the side of the post (figures 8).



Figures 8: Passing of a narrow post

Cross walls which interrupt mini-pipes must be passed as follows (figures 9):

- formation of mounds of highly permeable granular material (in case of grounwater),
- separation of these mounds from the form base by a geotextile filter on either side of the cross wall (in case of groundwater),
- linking of the two mounds by drainage channels at least 30 mm (1-1/5'') diameter.

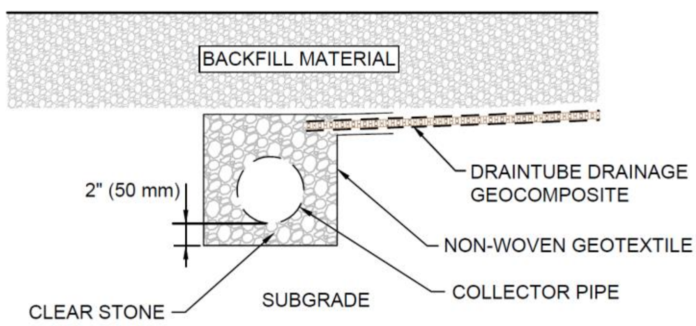


Figures 9: Passing of a cross wall

3 TERMINATION

3.1 *Connection to a collector trench*

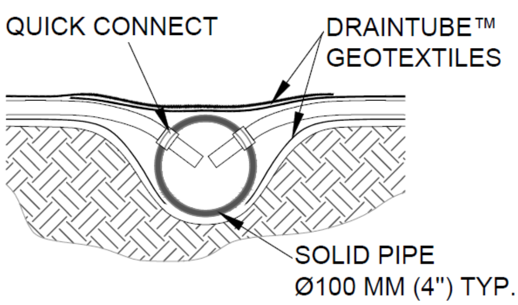
Connection to a collector trench requires an overlap of a minimum of 200 mm (8 in.) and a geotextile cover (figures 10).

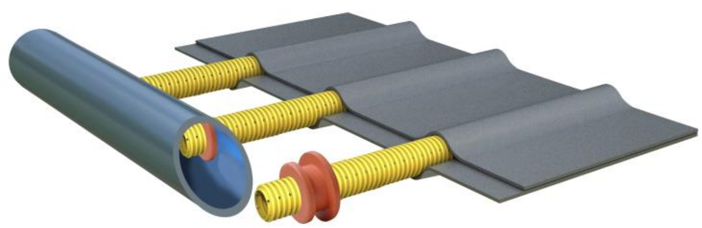


Figures 10: Connection to a collector trench

3.2 *Quick Connect system*

DRAINTUBE® can be connected directly to a collector drain using the Quick Connect system (figures 11 & 12). For vacuum applications, this allows a positive connection of the mini-pipes to the collector drain.





Figures 11: Quick Connect system

Figure 12: Connection to a plain drain with Quick Connect

4 Repair

Prior to covering the deployed DRAINTUBE® drainage geocomposite, each roll shall be inspected for damage. Any rips, tears or damaged areas on the geocomposite shall be repaired.

If a section of pipe is damaged during installation, add a piece of undamaged pipe of the same diameter next to the damaged pipe, extending a minimum of 150 mm (6 in.) beyond each end of the damaged section of pipe.

If the geotextile is ripped or torn, install an undamaged piece of the same material under the hole that extends a minimum of 150 mm (6 in.) beyond the hole in all directions to ensure that protection of the geomembrane is maintained.

If the area to be repaired is more than 50 percent of the width of the panel, then the damaged area shall be cut out and replaced with undamaged material. Damaged geotextile shall be replaced by the same type of geotextile.

5 Upper layers installation

5.1 *Geosynthetic installation*

DRAINTUBE® shall not stay uncovered for more than 14 days after deployment.

Low ground pressure All-Terrain Vehicle (ATV) that exerts a maximum load of 6 psi may be used on DRAINTUBE®. It shall be operated to avoid abrupt stops, starts, and/or turns. ATV tires shall be clean, and no passengers are allowed on the ATV. No other equipment shall be operated on the top surface of the geocomposite drainage layer without permission from the Engineer.
Geosynthetic (geomembrane, geogrid, etc.) is to be installed without displacing the DRAINTUBE® (figures 13).

Figures 13: Upper geosynthetic layer placement

5.2 *Backfill placement*

The geocomposite drainage layer shall be covered with the specified material within 14 days of deployment. The backfill shall be free of foreign matter which could damage the geocomposite drainage layer. Backfill may usually be placed directly on DRAINTUBE® (figure 14). Care should be taken to avoid displacement of the geocomposite.

Figure 14: Backfilling

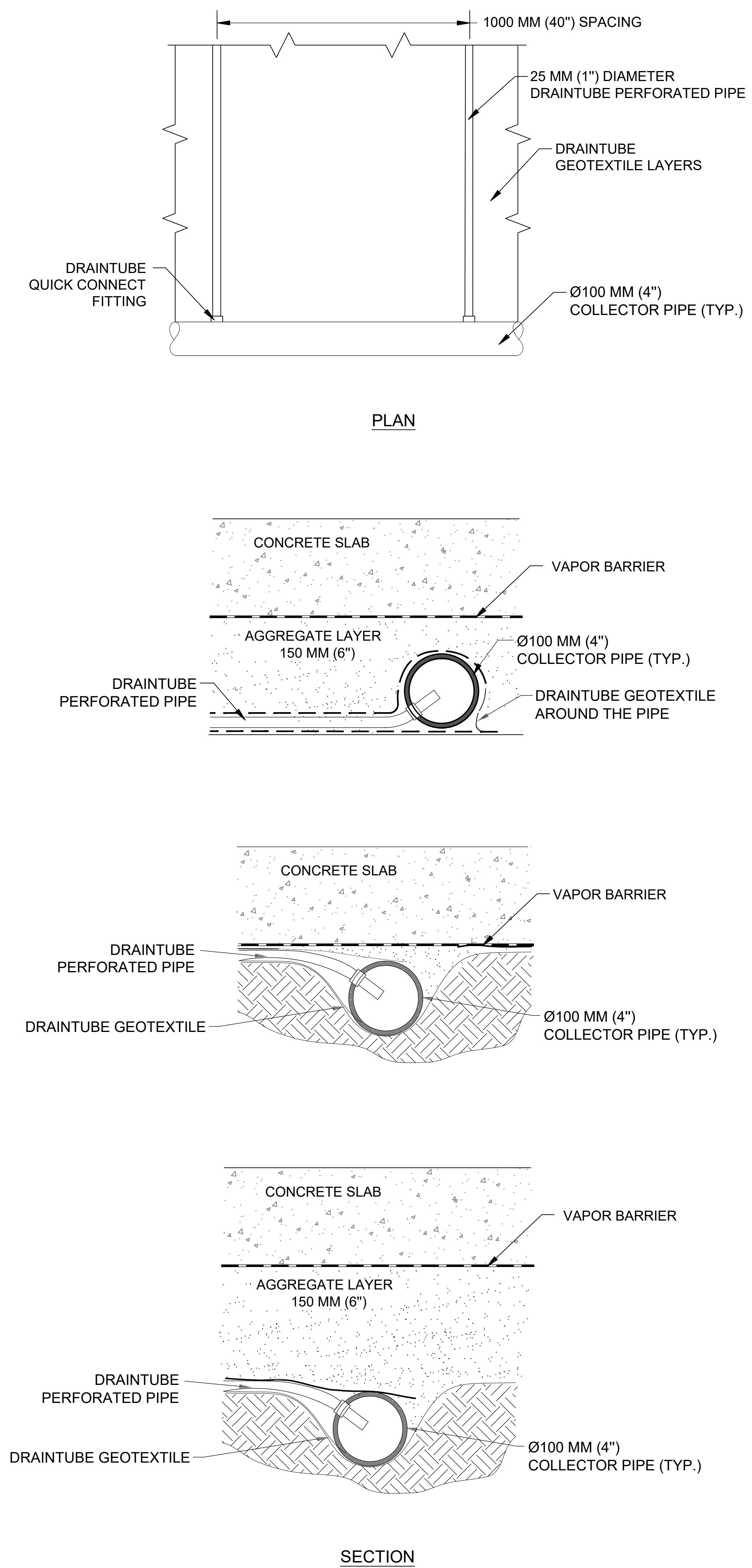
The backfill shall not be dropped directly onto the drainage geocomposite from a height greater than 1 meter (3 ft.). The backfill shall be pushed over the geocomposite drainage layer in an upward tumbling motion that prevents wrinkles in the drainage layer.

Low ground pressure All-Terrain Vehicle (ATV) that exerts a maximum load of 6 psi may be used on DRAINTUBE®. It shall be operated to avoid abrupt stops, starts, and/or turns. ATV tires shall be clean and no passengers are allowed on the ATV. No other equipment shall be operated on the top surface of the geocomposite drainage layer without permission from the Engineer.

The contractor must maintain a minimum of 300 mm (12 in.) of backfill between DRAINTUBE® and the backfill equipment or use adapted lightweight equipment. Heavy equipment like dumpers shall operate on access roads with a minimum thickness of 1 m (3 ft.) above the DRAINTUBE®.

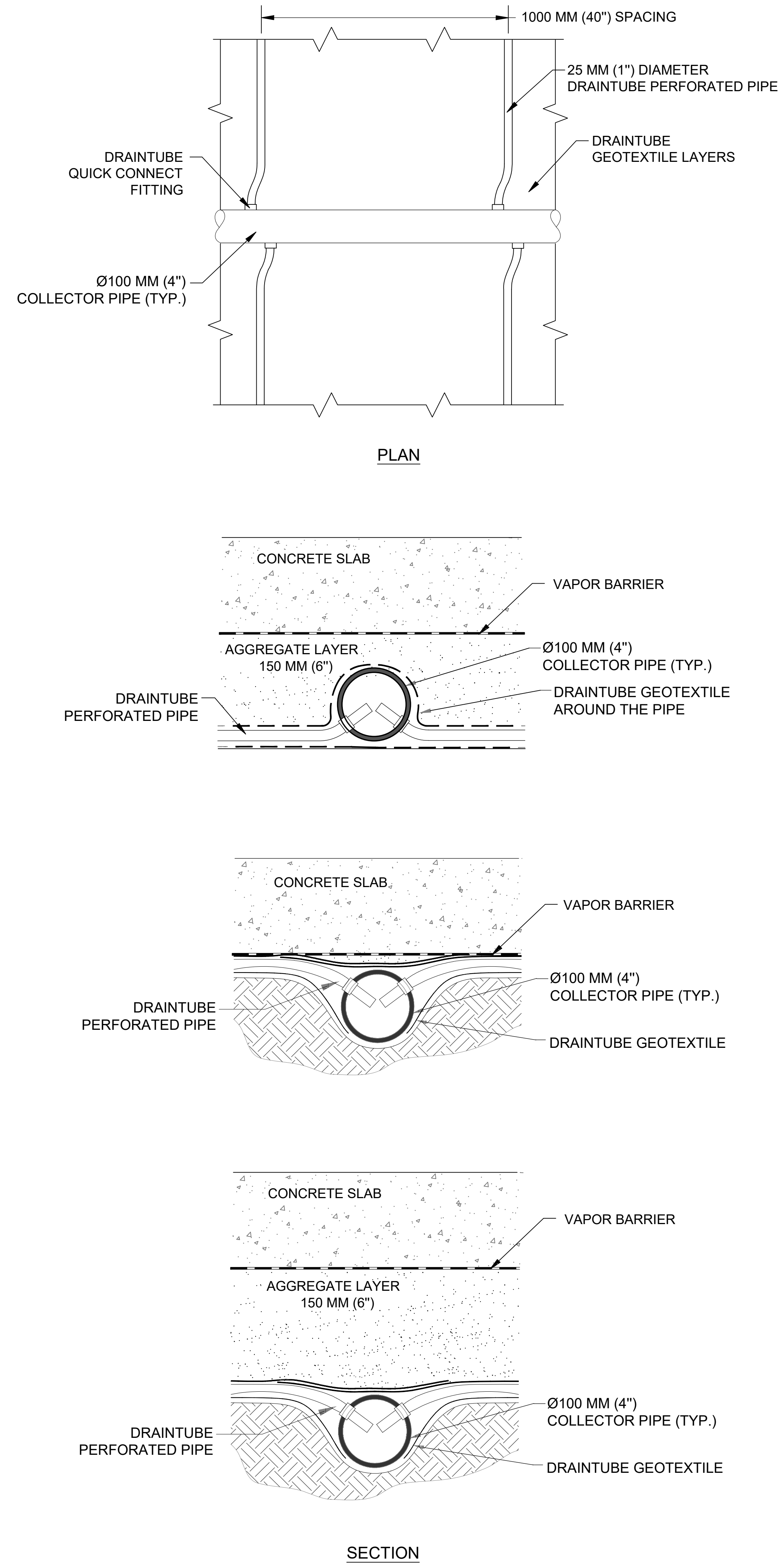
Table of figures

Appendix 4: Typical details for Draintube®



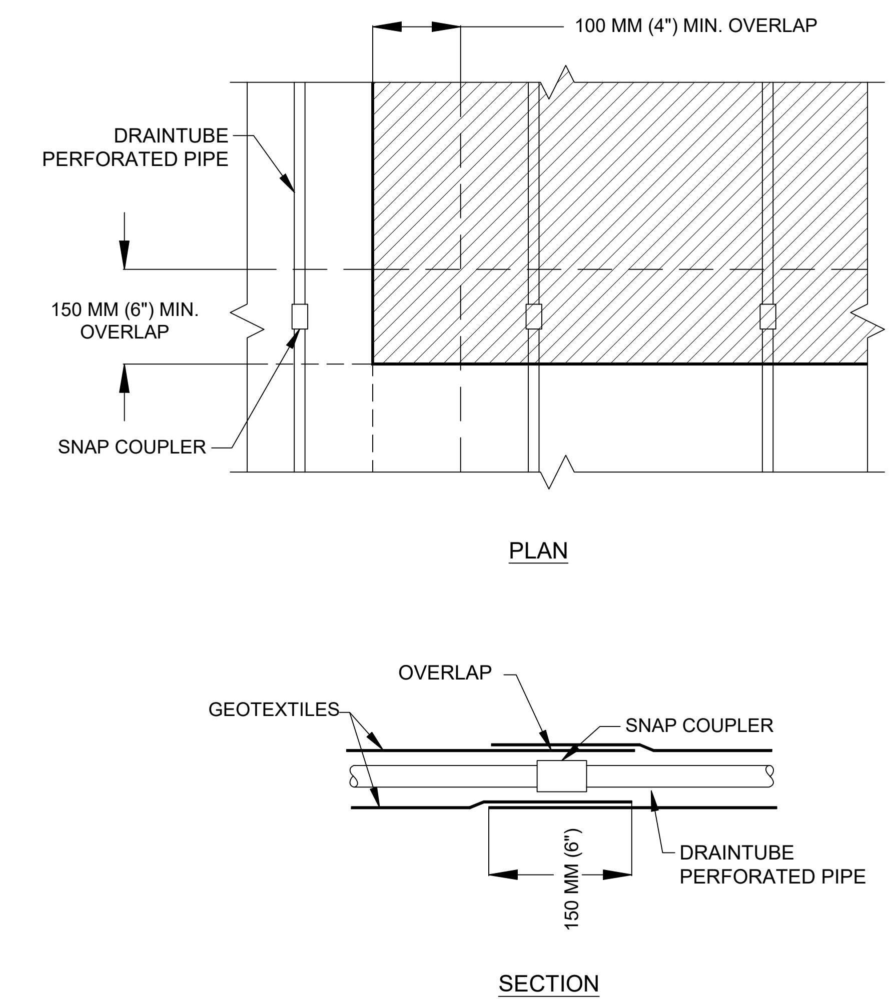
1 CONNECTION TO THE PIPE

NOT TO SCALE



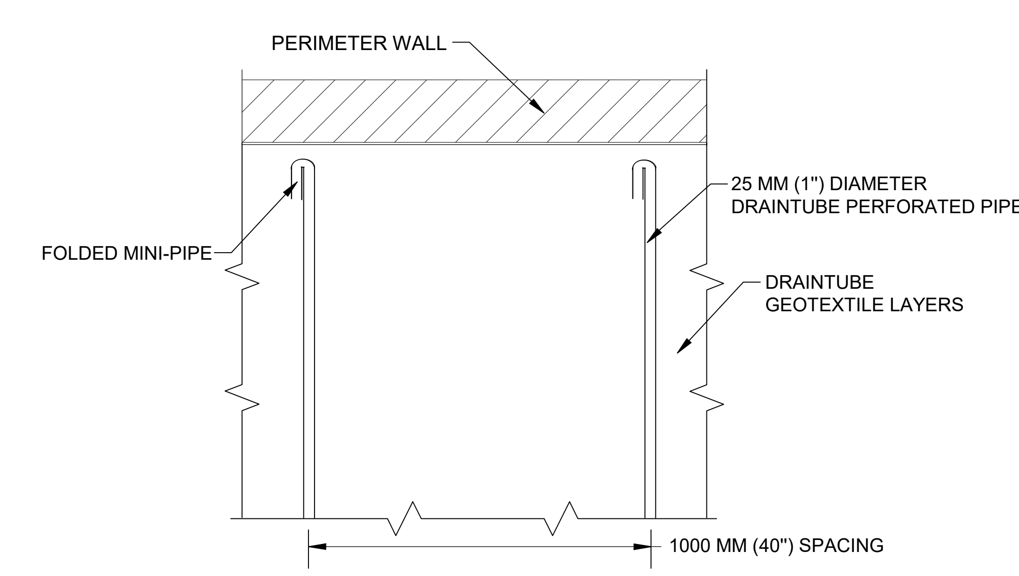
2 DOUBLE CONNECTION TO THE PIPE

NOT TO SCALE



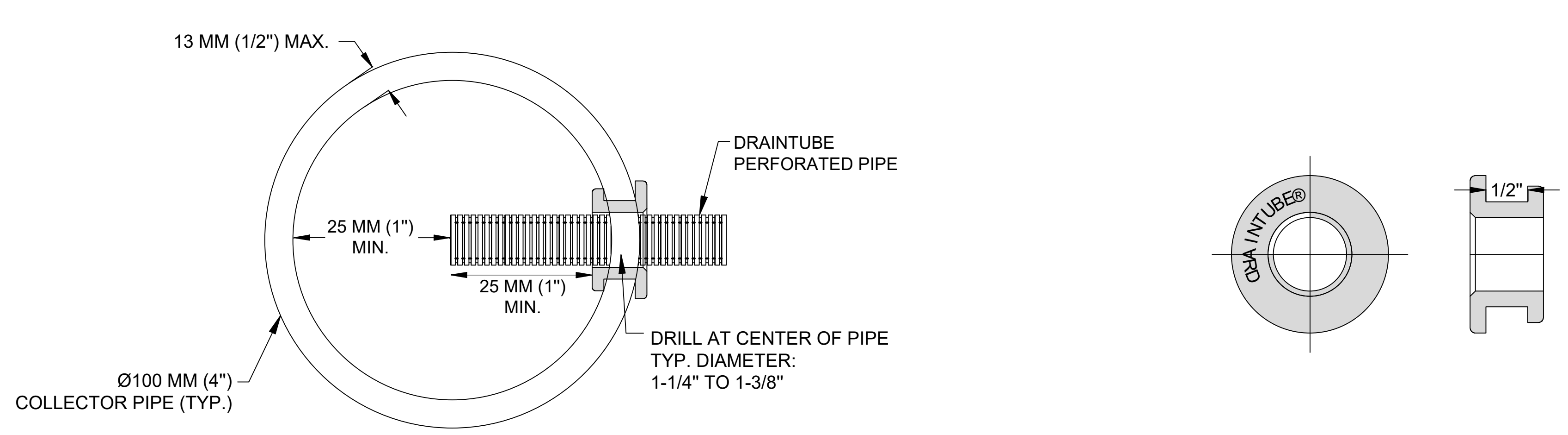
4 PANEL JOINING

NOT TO SCALE



5 DRAINTUBE TERMINATION

NOT TO SCALE



3 QUICK CONNECT FITTING

NOT TO SCALE

SUBSLAB DEPRESSURIZATION

TYPICAL CONNNECTION DETAILS

DRAINTUBE GAS

Afitex-Texel Geosynthetiques Inc.