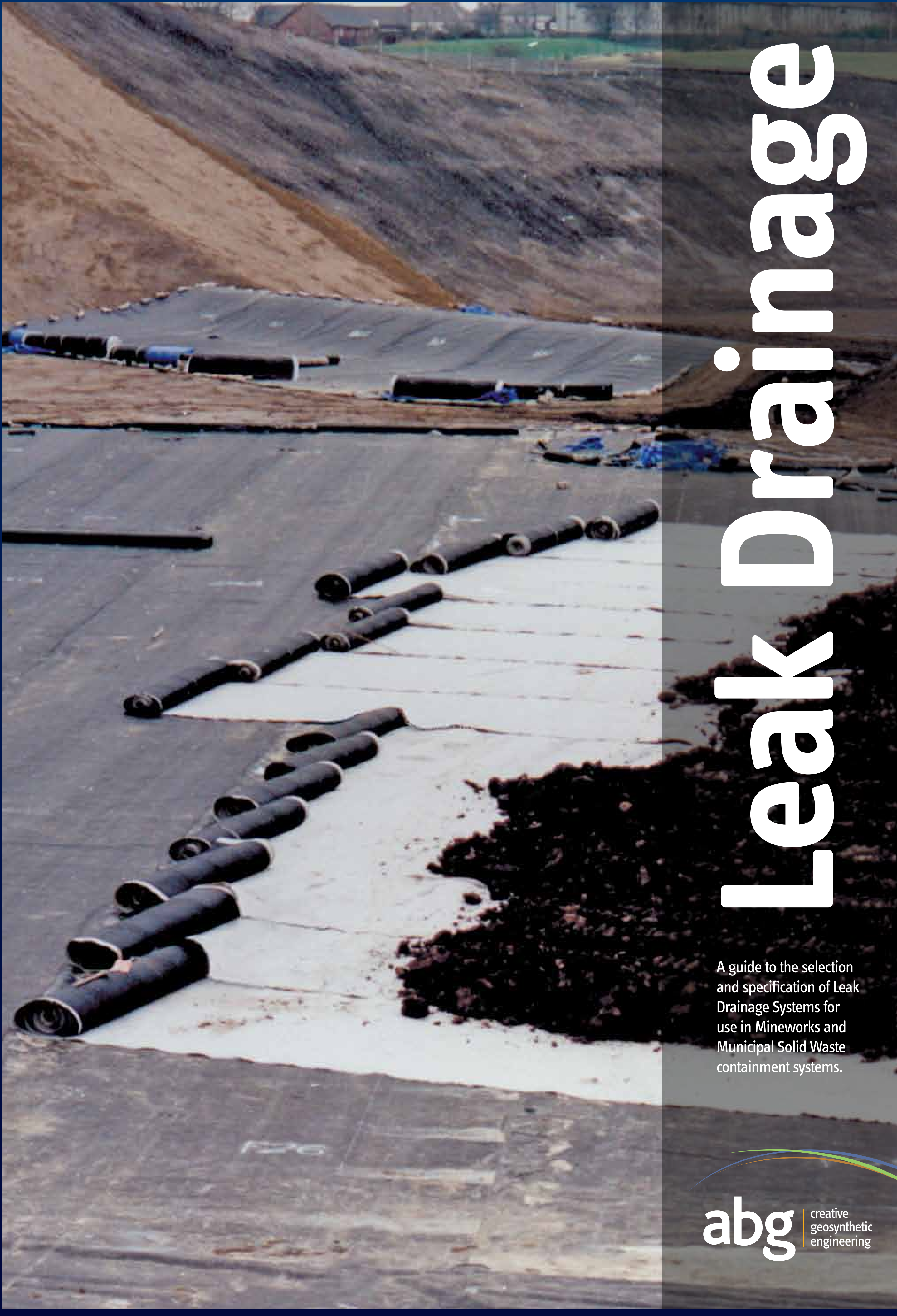
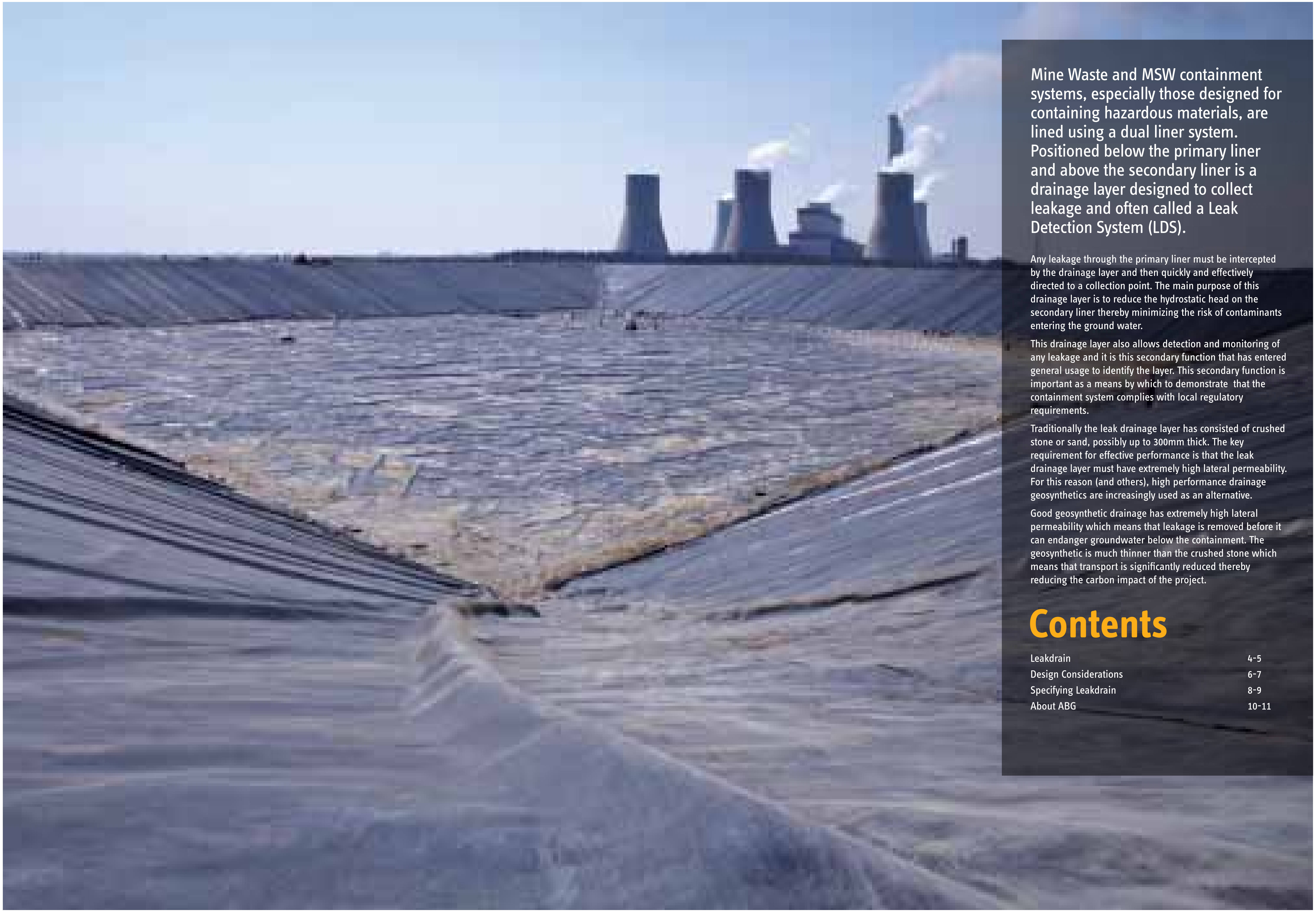


Leak Drainage

A guide to the selection and specification of Leak Drainage Systems for use in Mineworks and Municipal Solid Waste containment systems.

abg creative geosynthetic engineering



Mine Waste and MSW containment systems, especially those designed for containing hazardous materials, are lined using a dual liner system. Positioned below the primary liner and above the secondary liner is a drainage layer designed to collect leakage and often called a Leak Detection System (LDS).

Any leakage through the primary liner must be intercepted by the drainage layer and then quickly and effectively directed to a collection point. The main purpose of this drainage layer is to reduce the hydrostatic head on the secondary liner thereby minimizing the risk of contaminants entering the ground water.

This drainage layer also allows detection and monitoring of any leakage and it is this secondary function that has entered general usage to identify the layer. This secondary function is important as a means by which to demonstrate that the containment system complies with local regulatory requirements.

Traditionally the leak drainage layer has consisted of crushed stone or sand, possibly up to 300mm thick. The key requirement for effective performance is that the leak drainage layer must have extremely high lateral permeability. For this reason (and others), high performance drainage geosynthetics are increasingly used as an alternative.

Good geosynthetic drainage has extremely high lateral permeability which means that leakage is removed before it can endanger groundwater below the containment. The geosynthetic is much thinner than the crushed stone which means that transport is significantly reduced thereby reducing the carbon impact of the project.

Contents

Leakdrain

Leakdrain is designed specifically as a drainage layer between primary and secondary barriers in containment systems and is widely used in the construction of landfill cells, mine waste storage facilities and lagoons.

It comprises a single cuspated core with very high long-term compressive strength and high in-plane multi-directional flow capacity. Should a leak occur in the primary liner then these characteristics allow the safe removal of leachate and other particle laden liquids without risk of clogging, even under the high loads associated with these applications.

Pozidrain comprises the same cuspated core as Leakdrain and so offers all the benefits of strength, creep resistance and flow but offers the additional benefit of an integral filter geotextile bonded to the cuspates. This geotextile allows fluids to freely enter the drainage core but prevents intrusion when used beneath a CCL or GCL barrier. Leakdrain, placed cuspates down, can also be used in this application. Pozidrain can also be used when additional stability is required on steep slopes. Both Leakdrain and Pozidrain have extremely high lateral permeability as required for effective leak drainage systems.

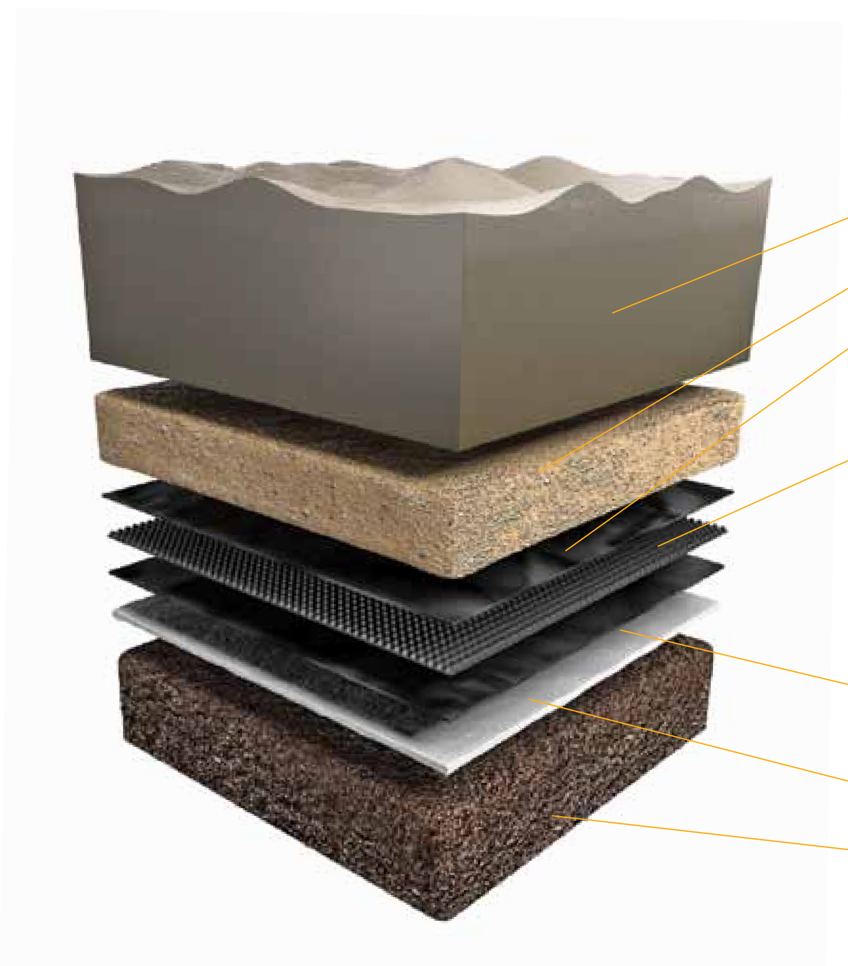
Both Leakdrain and Pozidrain can be installed quickly and easily without specialist equipment and with simple training for the installation team.

Leakdrain inbetween a geomembrane and a CCL/GCL

When Leakdrain is positioned beneath a CCL or GCL it is laid cuspates down to prevent the void being compromised by the liner above. As an alternative, Pozidrain may also be used in this situation laid with the geotextile faced up. In this instance the filter geotextile prevents material encroachment into the void space.

Leakdrain between two geomembranes

Leakdrain can be placed between two geomembranes to form the LDS. In this situation Leakdrain is laid with the cuspates upwards.



Selecting the Drainage Layer

The key performance is the in-plane flow capacity (l/m·s) under long-term load and with minimal hydrostatic head. Optimisation of these criteria implies that the leak drainage layer is relatively thin, with extremely high in-plane permeability (m/s) and excellent resistance to creep at design load.

The in-plane flow capacity of the leak detection layer must be a factor of safety greater than the expected leakage rate so that the flow remains unconfined.

Several design methods have been published but the definitive reference paper is the research of Giroud et al* which indicates, amongst many other things, that sand is a very poor leak drainage layer and that gravel and geocomposite drainage perform well. This conclusion is based on the high in-plane permeability of gravel and high performance geocomposites (typically >0.24m/s).

Compressive Strength and Flow Capacity

Geocomposite compressive strength and in-plane flow capacity are inextricably linked. When subjected to compressive load the geocomposite will compress, the flow channels will reduce in height and therefore the in-plane flow capacity will reduce. This reduction in flow is minimised with a high performance geocomposite such as Leakdrain, as indicated by the performance figures in the comparative chart on Page 8. Specification of compressive strength without an associated flow capacity is meaningless.

The design compressive load is the product of the density and depth of the waste. Over the design life of the facility this compressive load will result in an on-going reduction in thickness and hence flow capacity of the geocomposite, this is called creep.

The in-plane flow capacity of a leak drainage layer is proportional to the hydraulic gradient. The base of a waste storage facility will typically be at a gradient of around 3%.
The convention is to show comparative performance figures at a gradient of 1 (corresponding to vertical flow). An approximation to the in-plane flow at 3% gradient can be obtained by taking 3% of the HG1 performance. Leakdrain actually performs better at low gradients than this approximation suggests. Leakdrain flow charts at all gradients are available from ABG.

The in-plane flow capacity of Leakdrain is determined and tested to EN ISO 12958 and ASTM D4716. For Leakdrain testing is undertaken between two hard platens to simulate an installation between two HDPE geomembranes. For Pozidrain testing is undertaken between a hard and a soft platen, the soft platen being positioned over the bonded geotextile to simulate a CCL or GCL which will apply pressure onto the geotextile and not just the core.

Chemical Resistance

All materials used in the lining system must able to withstand prolonged contact with any pollutants contained. Leakdrain is manufactured from HDPE which is used extensively in forming lining systems and is capable of withstanding long-term exposure to a wide range of chemical compounds.

ABG can provide advice for specific chemicals and will manufacture Leakdrain in grades with enhanced performance when required.

Leakage

A single geomembrane or GCL will leak as a result of it's permeability and as a result of holes. The liner permeability will be specified as 1x10-11m/s, which is very small but will result in a leakage of 10 -10,000 litres/hectare/day. Despite the best CQA the geomembrane will have holes after construction. A 1cm^2 hole will leak at a rate of 30 - 10,000 litres/hectare/day and there could be 15 holes per hectare. Both of these leakage rates are influenced greatly by the depth of liquid above the geomembrane or GCL barrier.

A single geomembrane is not sufficient to achieve a secure containment. A composite system comprising an HDPE geomembrane and a GCL or clay barrier together will reduce the leakage rate by a factor of 10 but that still results in significant loss of contaminants into the ground below. The most secure system is to provide a competent leak drainage layer between the two barriers. This will reduce the leakage rate by a factor of 100.

The leakage from the leak drainage layer is collected by pipes and pumped back into the storage facility. This allows the leak drainage layer to perform it's second function which is to provide monitoring of the actual leakage through the primary barrier. Regulations will stipulate that within the permit for the facility will be an action leakage rate (ALR) which will be project specific. If the detected leakage exceeds the ALR then by a predetermined response plan, operational changes will be made until the leakage falls below the ALR. As an indication the following values have been proposed in the literature

Action Leakage Rates (litres per hectare per day)	
Composite Liner (CCL)	200
Single layer (Geomembrane)	2000

Installation

Compared to other materials traditionally used in the construction of leak detection layers, Leakdrain offers a lightweight solution. This means a much greater area can be covered per load arriving on site, resulting in a reduction of the haulage required, and improving the CO2 balance of the site.

Leakdrain arrives on site in large rolls that allows installation to be completed quickly and easily without the need for heavy equipment trafficking the liner below and reducing the chance of damage occurring.

Leakdrain installation instructions are available from the ABG website.

Design Considerations

A leak drainage and detection layer is an essential feature of a secure containment for hazardous wastes. The risk of groundwater pollution is minimised by means of a primary barrier, a leak drainage layer and a secondary barrier.

The primary barrier will be specified, selected and constructed to have minimal permeability but even so it will not be totally impermeable. The contained waste liquid will escape through the primary barrier by advection and diffusion as well as escaping through imperfections. The rate of escape of waste liquid through a barrier is governed by the liquid head acting upon it. Reduce the head, reduce the leakage.

The primary function of the leak drainage layer is to reduce the hydrostatic head on the secondary barrier. The leak drainage layer achieves this as a result of it's extremely high lateral permeability. This means that any leakage through the primary barrier is removed as soon as it arrives. Consequently, the hydrostatic head on the secondary barrier is reduced to a minimum and therefore the escape of contaminants through the secondary barrier is minimised. In this way, the primary barrier, leak drainage layer and secondary barrier are significantly more effective than a simple combination of two barriers alone.

The required in-plane flow capacity of the leak drainage layer will be determined by the Action Leakage Rate (ALR) which itself will be governed by local regulations. Factors to be considered are the confining pressure, the gradient and length of slope to the collection pipe, the permeability and defect rate of the primary barrier, temperature, chemical composition of the waste and the design life of the project.

ABG can provide project specific design guidance upon request.

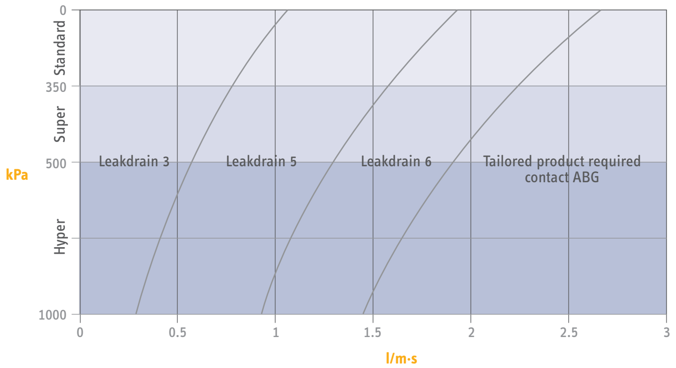
* J.P. Giroud, B.A. Gross, R. Bonaparte and J.A. McKelvey - Leachate Flow in Leachate Collection Layers Due to Defects in Geomembrane Liners, Geosynthetics International, 1997 Vol 4, Nos. 3-4

Comparative Performance

Leakdrain is available in three core thickness grades 3mm, 5mm and 6mm and in three strength grades Standard, Super and Hyper for long-term loadings up to 250kPa, 500kPa and 1000kPa respectively. The chart shows indicative performance plotting flow rate in the machine (MD) and cross-machine direction (CMD) against long-term load for 100 years duration.

Flow in MD and CMD directions allows Leakdrain to be used on gradients in multiple directions.

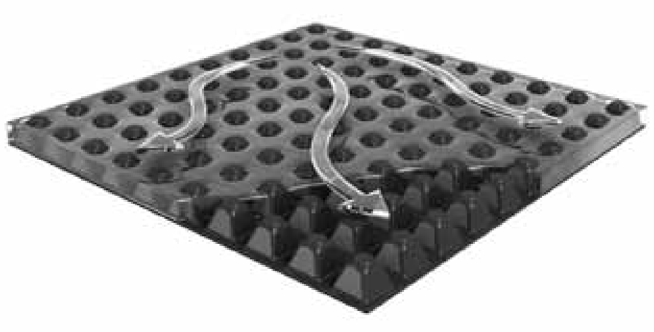
This chart is intended as a quick indicator of flow capacity at a range of pressures. The chart includes a reduction to allow for the effects of creep. The chart indicates comparative flow performance at HG=1 (Vertical) and 20°C to EN ISO 12958 hard platens.



It should not be considered a guide for design and must not be used so. Advice on the exact product specification for your application is available without obligation by contacting the ABG Technical Team on +44 1484 852250 or by email to technical@abgltd.com.

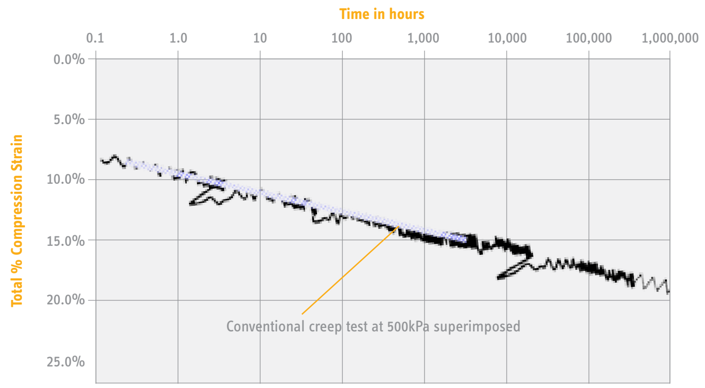
Multi-directional flow

Crushed stone drainage has equal flow in all directions. For true equivalency, the geosynthetic drainage layer must also have multi-directional flow because containment bases often have multi-directional gradients. Multi-directional flow means that in the event of a blockage the liquid simply flows around the affected area. Leakdrain has true multi-directional flow, many other geosynthetics including geonets and random fibres do not.

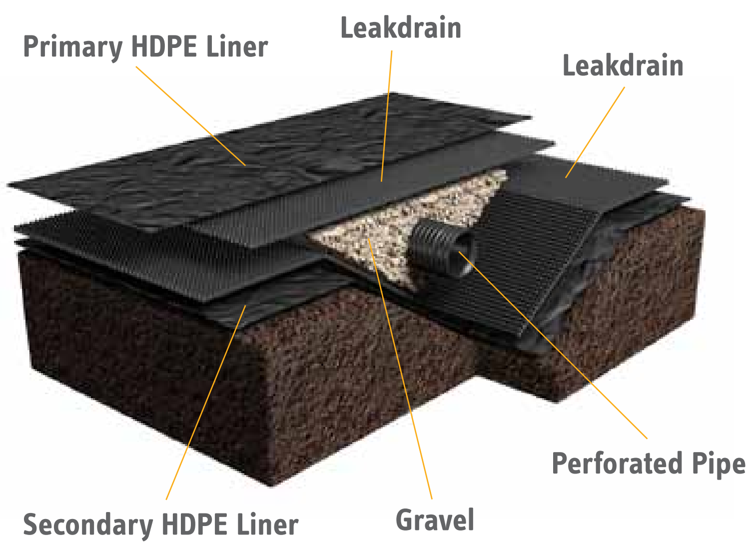


Long-term creep

Creep is the time dependent change in the thickness under constant load. Creep affects all materials but is noticeable with long-term loads on plastics. The Stepped Isothermal Method (SIM) to ASTM D7361 allows the magnitude of the creep at any particular load for 100 years or more to be determined accurately in just a few days. Leakdrain had been extensively SIM tested and as a result Leakdrain can be used confidently at high loads for more than 100 years.



Leakdrain Collector Pipe Detail



Leakdrain creates extra capacity and reduces hydrostatic head

Leakdrain allows a maximum hydrostatic head of 6mm compared to crushed stone which may support a significantly higher hydrostatic head.

Specifying Leakdrain

Leakdrain is available in a range of standard thicknesses and core strengths making it suitable for many leak drainage layer applications, even when high flow is required under high load. Tailored products are produced for extreme performance in specific applications.

Standard specification clauses for specific grades of Leakdrain are available by contacting the Technical department or the following text can be used in conjunction with the relevant product datasheet to form a clause for use in specification documents.

1. The manufacturer of the geosynthetic leak drainage layer shall be certified to ISO9001 and maintain current independent test reports verifying performance data.

2. The leak drainage layer shall comprise a cuspated HDPE (High Density Polyethylene) geosynthetic. Drainage nets and random fibre geosynthetics shall not be permitted.

3. The geosynthetic drainage layer shall be permeable one side and be supplied in rolls with a minimum width of 2.2m.

4. The rolls shall be laid into position such that the sheets overlap laterally by a minimum of 100mm. All fixing and cutting details shall be in accordance with the manufacturer's instructions.

5. The geosynthetic drainage layer shall have a mean MD & CMD in-plane flow capacity when tested to EN ISO 12958 (hard platens) at hydraulic gradient 1 and confining pressure of XXkPa of at least XX l/m·s.

6. The geosynthetic drainage layer shall have less than 20% creep in 100 years at the confining pressure of XX kPa when tested to ASTM D7361.

7. A suitable geosynthetic leak drainage layer meeting specification is Leakdrain [Insert full product code] as manufactured by ABG.

Groundwater Drainage

Site investigations frequently reveal the presence of groundwater within the development area. Even small amounts of groundwater can create difficult conditions for construction of the containment facility. Groundwater may also create damaging buoyancy forces on the containment barrier layer.

Pozidrain is an effective groundwater drainage layer that intercepts and transmits groundwater flow safely to collector pipes.

Veneer Soil Stability

Geomembranes are often protected by a thin veneer of cover soil placed directly over the top. The poor friction interface between the soil and the geomembrane can lead to instability and possible erosion occurrences in the soil layer.

Erosaweb is a flexible polymer geocell that provides long-term stability to hold the cover soil in place. It works by containing the soil within its cellular matrix. When used over a geomembrane the Erosaweb is often laid over and tied to a Trigrid geogrid

Pozidrain laid as groundwater control.

Veneer reinforcement using Erosaweb.

Gas Venting Below Lagoons

Liquid storage lagoons with geomembrane or GCL liners are vulnerable to gases rising from the ground.

Small volumes of naturally occurring ground gas can give rise to huge forces that create 'whales' in the geomembrane and render the facility unserviceable.

Fildrain geocomposite laid in a lattice on the formation beneath the geomembrane will vent gases away safely and ensure that the full storage capacity of the facility is achieved.

Other Systems

ABG manufacture a wide range of geosynthetic materials.

Webwall - Retaining wall system with vegetated face and use of site fill that offers a cost effective alternative to gabions.

Deckdrain - Geocomposite for water pressure relief behind retaining walls.

Erosamat - A range of natural and synthetic erosion control mats.

Abweb - Three-dimensional cellular matrix for the formation of site access roads.

Pozidrain - Geocomposite drainage layer for capping, restoration and the drainage of basal side slopes.

Problems arising from no gas venting.

Pozidrain installation as part of landfill lining system.

About ABG

ABG is a market leader in the design, development, manufacture and technical support of high performance geosynthetic systems for use in a wide range of waste management and environmental containment applications.

Formed in 1988, based in the UK in Meltham, close to Manchester, ABG has attained an excellent reputation for developing quality products and delivering outstanding service. The ability for rapid product development ensures that the most innovative, up to date and cost effective solution can be found for many engineering challenges including basal lining systems, capping systems, reinforced earth applications and high performance drainage.

ABG's involvement in lining systems goes back over twenty five years and we have a complete range of products developed specifically for use in these technically demanding applications. During this period we have supplied projects globally in excess of 50 million square metres.

Technical support is provided by our trained and experienced staff, many of whom are Chartered Civil Engineers. This extensive support extends to full design, design validation, feasibility studies, cost advice and advice on meeting regulatory requirements.

ABG is active on UK and international technical committees to develop guidance and best practice to increase knowledge of geosynthetics and provide effective codes and regulations.

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