



# **BENTOMAT**

Geosynthetic Clay Liners



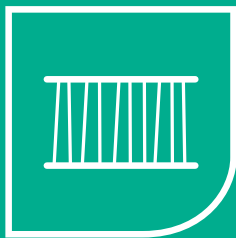
# KEY ADVANTAGES

## at a glance

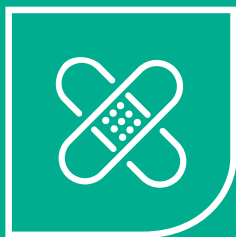
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→ Excellent sealing



→ Full-coverage needle-punching



→ Self-repairing effect



→ Cost-effective sealing system

# BENTOMAT

## Geosynthetic Clay Liners



Geosynthetic clay liners, also known as bentonite mats, are geosynthetic materials that have been in use for many years as a successful natural method for sealing against liquids and gases in a wide variety of applications. The spectrum ranges from landfill sites and road construction through to water engineering structures and the construction of storage and rainwater retention basins. In contrast to the construction method that uses mineral sealing materials such as clay, bentonite mats provide consistently high product quality and clear economic benefits.



# PRODUCT DETAILS

## and properties

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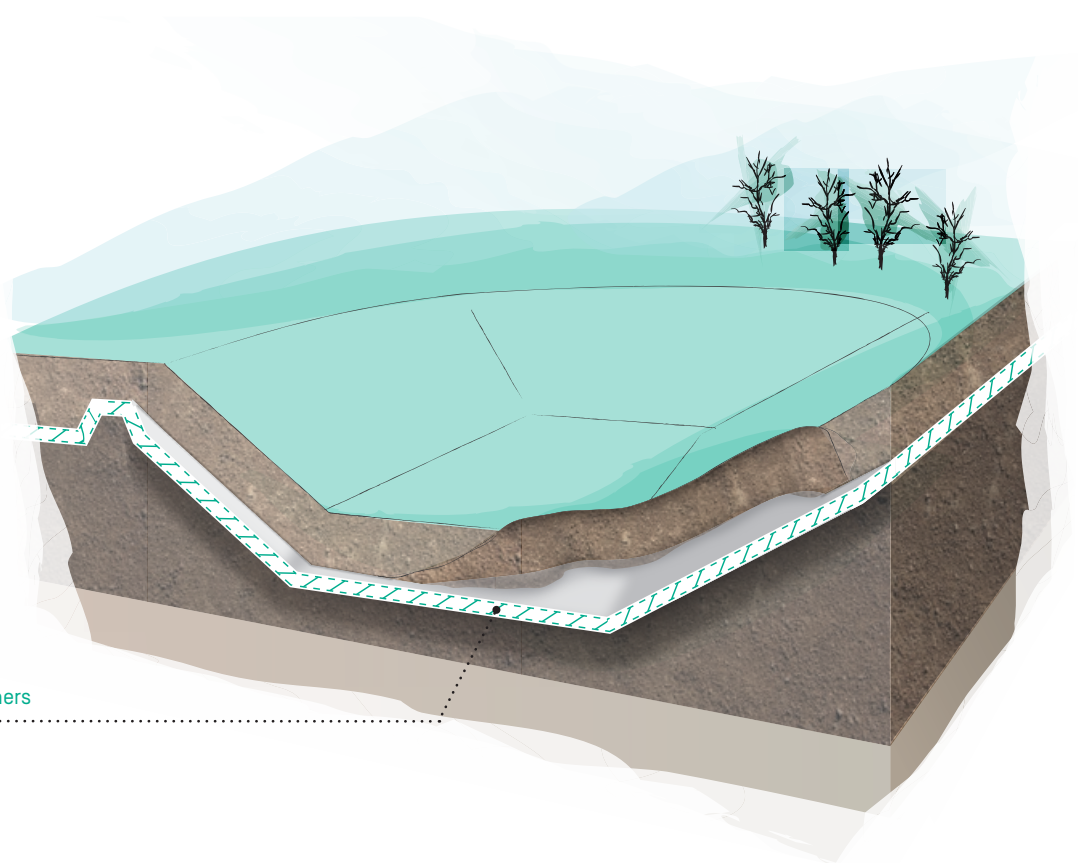
BENTOMAT Geosynthetic Clay Liners normally consist of three components:  
The geotextile top layer, the bentonite granules and the geotextile base layer.

As a rule, the geotextiles consist of a mechanically-bonded, non-woven fabric on one side and a woven geotextile on the other side. All the components of the layers are mechanically bonded by needle-punching over their entire area and are filled uniformly with bentonite granules.

This ensures that the bentonite is optimally embedded and prevents material loss and rearrangement during transport and installation. The use of bentonite granules instead of the conventional bentonite powder avoids the problem of dust production.







BENTOMAT Geosynthetic Clay Liners



The main component of BENTOMAT is the mineral sodium bentonite, which is 90 % montmorillonite. Bentonite is a volcanic clay mineral that formed naturally during the course of 200 million years under the influence of water and pressure.

Only high quality bentonite in granular form is used for the manufacture of BENTOMAT Geosynthetic Clay Liners. The excellent swelling capacity of bentonite when it comes into contact with moisture is responsible for the quick and reliable sealing effect of the BENTOMAT.

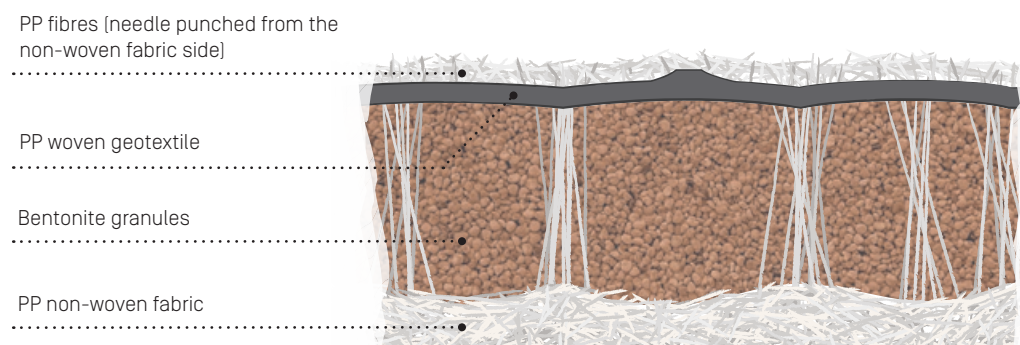
This special property of bentonite allows the sealing layer to repair itself securely if it becomes mechanically damaged during installation or later use.

When dimensioned correctly, BENTOMAT Geosynthetic Clay Liners can also be laid on slopes. The mechanical needle-punching of the components across the entire area of the liner creates a firm bond and a high internal shear angle.

# BENTOMAT / BENTOMAT GDA CL

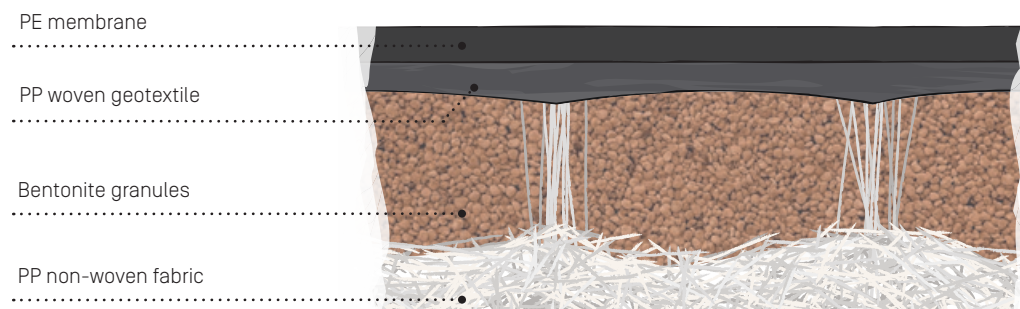
BENTOMAT Geosynthetic Clay Liners are normally made up of three components: The geotextile top layer, the bentonite granules and the geotextile base layer.

## BENTOMAT cross-section



BENTOMAT GDA CL has been specially developed for applications with particularly stringent requirements in terms of sealing performance. This innovative product incorporates an PE membrane that is bonded across the whole area of the bentonite mat to create a multi-layer product. The bonded membrane provides additional protection against unwanted drying out and against root penetration.

## BENTOMAT GDA CL cross-section





BENTOMAT GDA CL is the perfect solution when it comes to greater depths of standing water, because the flow through geosynthetic clay liners increases at higher hydraulic gradients. By adding an PE membrane, this effect is significantly impeded without having to forgo the benefits of a bentonite mat.

BENTOMAT GDA CL is the ideal solution for applications where the hydraulic performance of traditional geosynthetic clay liners is inadequate and a conventional combination sealing system would be uneconomical. The PE membrane used as standard is 1.50 mm thick and has a textured surface. Membranes with a thickness of 0.20 mm up to 1.50 mm are also available.

For thicknesses greater than 1.50 mm, the membranes can also be welded together by a professional installer in order to achieve the best possible seal.

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As a composite made of mineral sealing material with a sealing geomembrane bonded to it, BENTOMAT GDA CL is a multi-layer product that offers the highest level of reliability.



# FUNCTIONS

## BENTOMAT Geosynthetic Clay Liners

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### Sealing

As a sealing element, BENTOMAT Geosynthetic Clay Liners protect the environment, structures and people from the harmful effects of liquids and gases. This is particularly true in the case of landfill sites and road, tunnel and water engineering construction.

The sealing properties of BENTOMAT Geosynthetic Clay Liners are largely determined by the quality of the bentonite used. The excellent sealing effect achieved by BENTOMAT is due to the limitation of the natural swelling behaviour of the bentonite as it absorbs water.

The BENTOMAT liner is uniformly strengthened by the filaments of the non-woven geotextile base layer as a result of the needle-punching across the entire area of the liner, and this in combination with the permanent load of the suitable covering material keeps the natural swelling action within strict limits. Since the bentonite cannot swell freely under these conditions, the resulting swelling pressure compresses the layer structures of the clay and creates a sealing effect.

### Self-repairing effect

A side effect of the swelling capacity of bentonite is that if minor mechanical damage is caused to the liner, a so-called "self-repairing effect" comes into play, whereby the leaking area seals itself automatically. The swelling pressure "repairs" damaged areas up to 6 mm in diameter.

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As is also the case with purely mineral liners, geosynthetic clay liners are not completely watertight and gas-tight. However, they can achieve the same sealing effect with a significantly thinner liner.



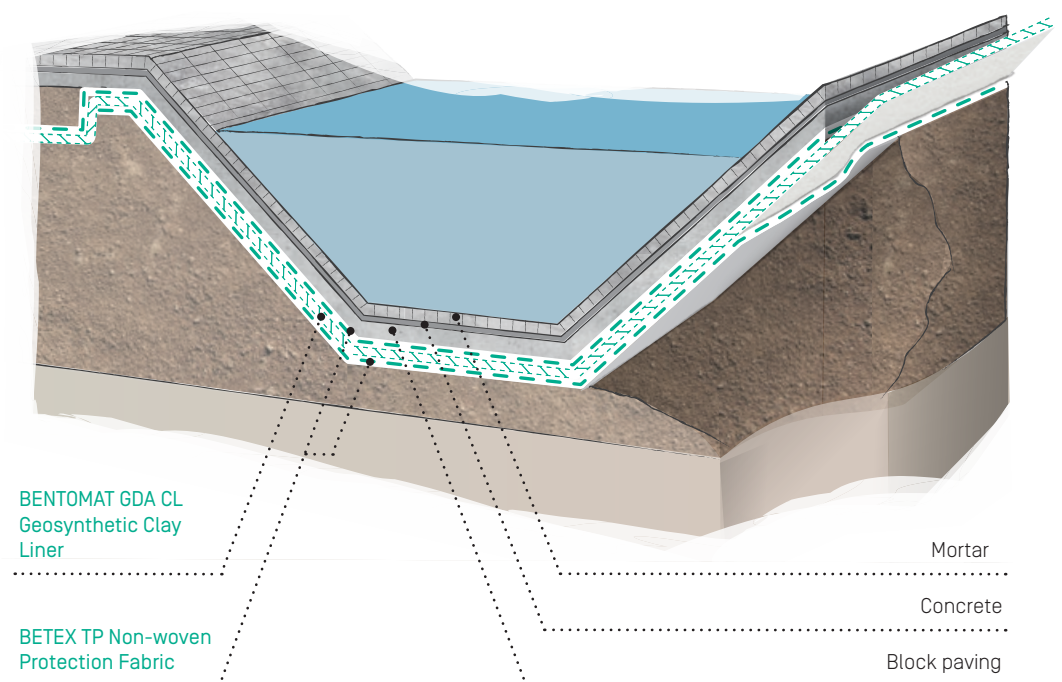
# APPLICATIONS

## BENTOMAT Geosynthetic Clay Liners

### Dykes and water engineering structures

One of the classical fields of application for geosynthetic clay liners is in dykes and water engineering structures. Here, bentonite mats are used to prevent water losses, to separate ground water from surface water and to ensure durability and erosion stability and thus the static stability of structures. Water engineering structures that require sealing include for example storage basins, ponds, dams, dykes and canals. The selection of a geosynthetic clay liner for use as a sealing element in water engineering structures is made in accordance with the project-specific requirements.

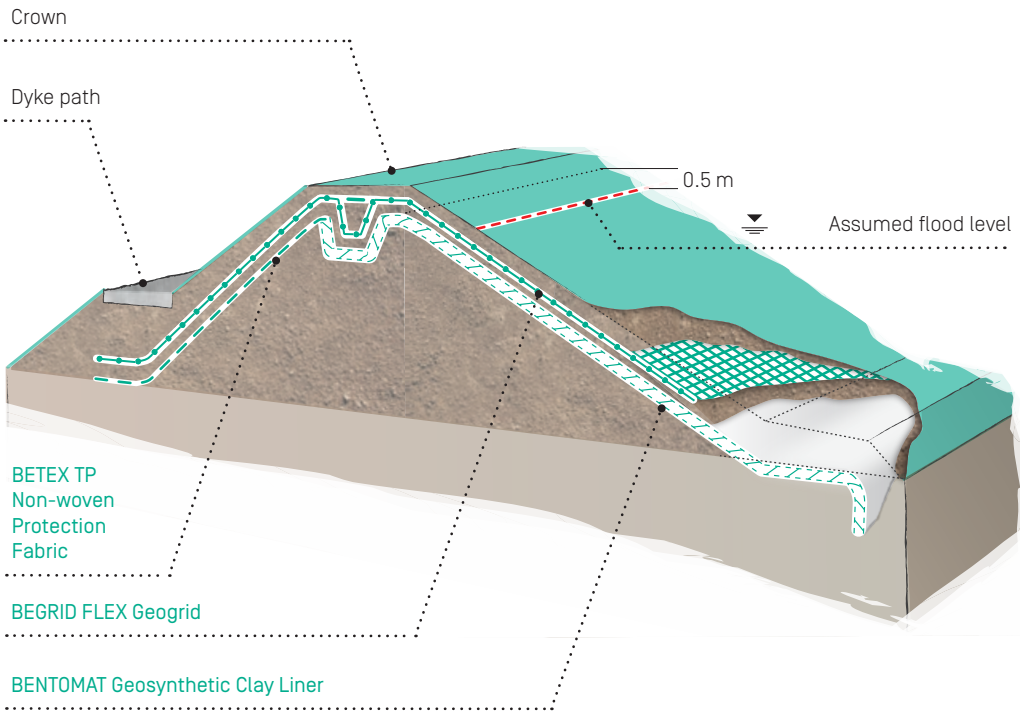
Fire water pond  
or reservoir



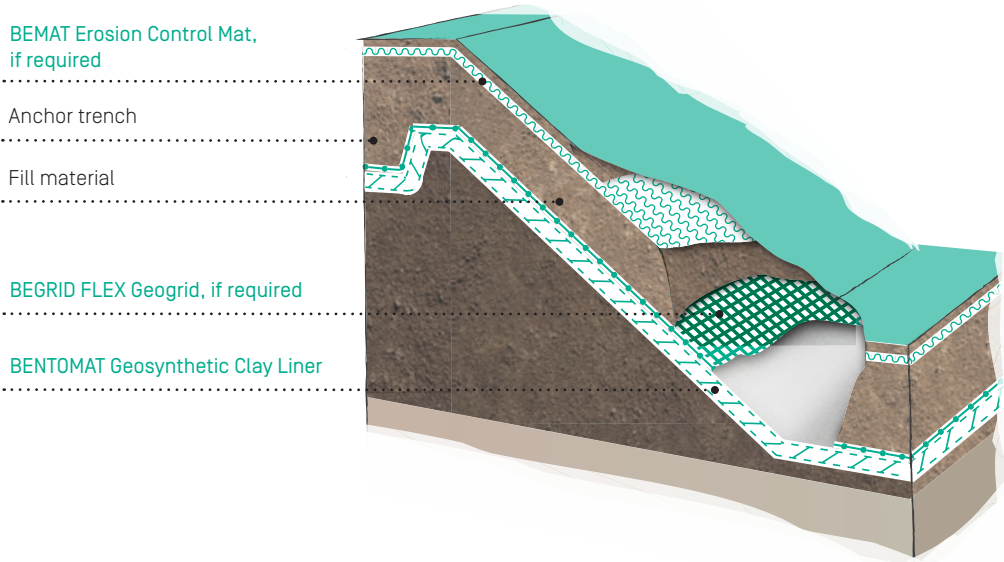




Dyke sealing



Rainwater retention  
basin

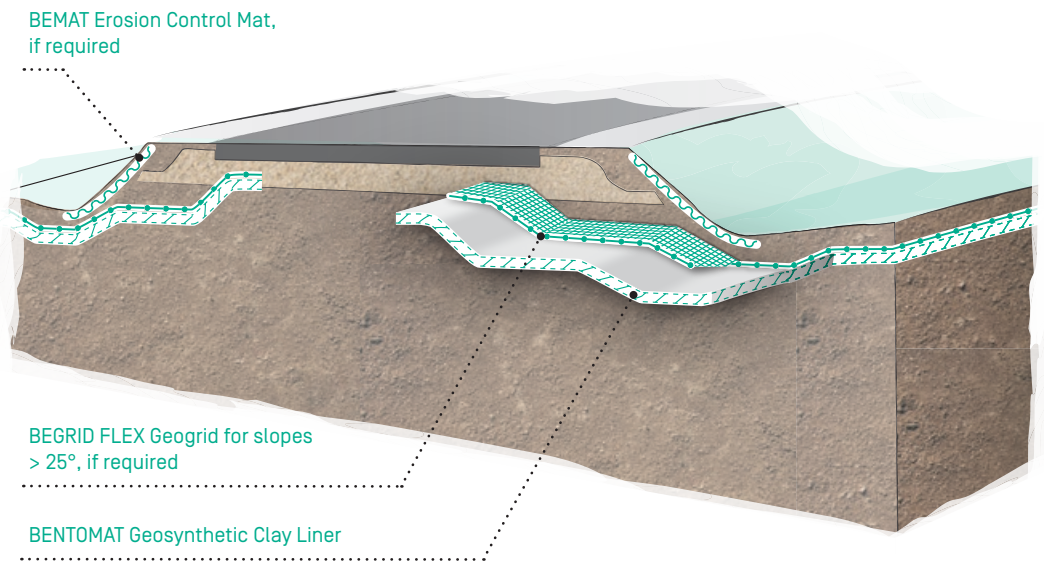


## Infrastructure projects

The types of application for geosynthetic clay liners in road and traffic route construction are far ranging. They are used for the protection of groundwater in and around traffic areas to prevent the harmful effects caused by the ingress of substances that are hazardous to water.

Retention basins are constructed for the purpose of delaying the discharge of surface water and protecting the groundwater. Here, BENTOMAT Geosynthetic Clay Liners can replace mineral sealing materials.

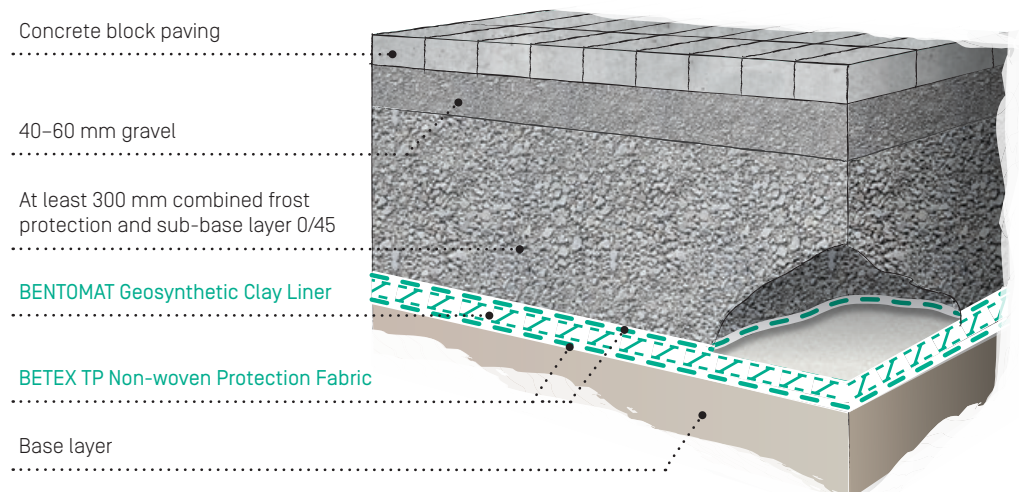
### Groundwater protection in traffic areas



## RiStWag

When bentonite mats are used for groundwater protection purposes, they require certification in accordance with the German (RiStWag) guidelines for construction engineering measures in water abstraction areas.

### Multi-storey and underground car parks





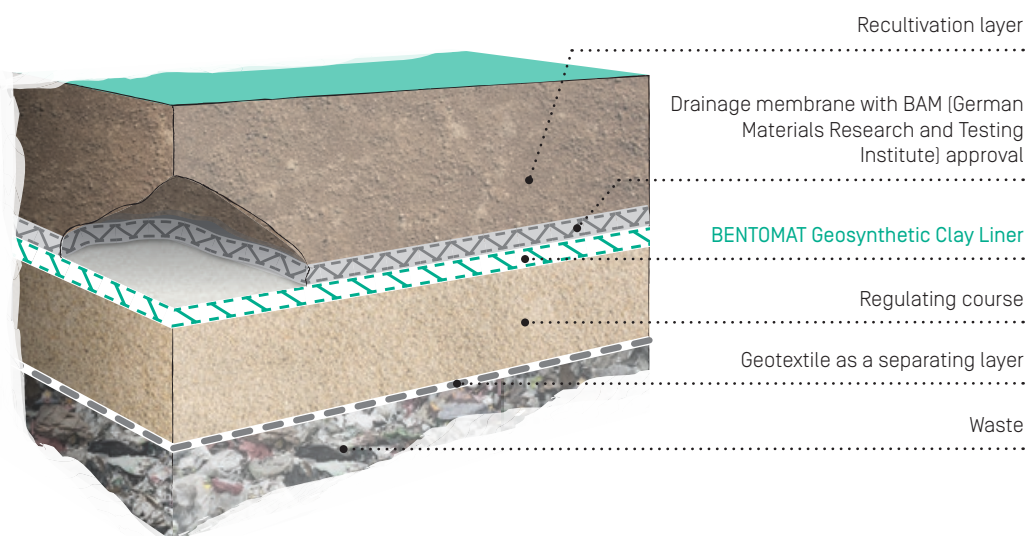
# Landfill sites

The BENTOMAT LAGA Geosynthetic Clay Liner has been issued with a LAGA suitability approval for the construction of mineral sealing layers in surface sealing systems for landfill classes 1 and 2.

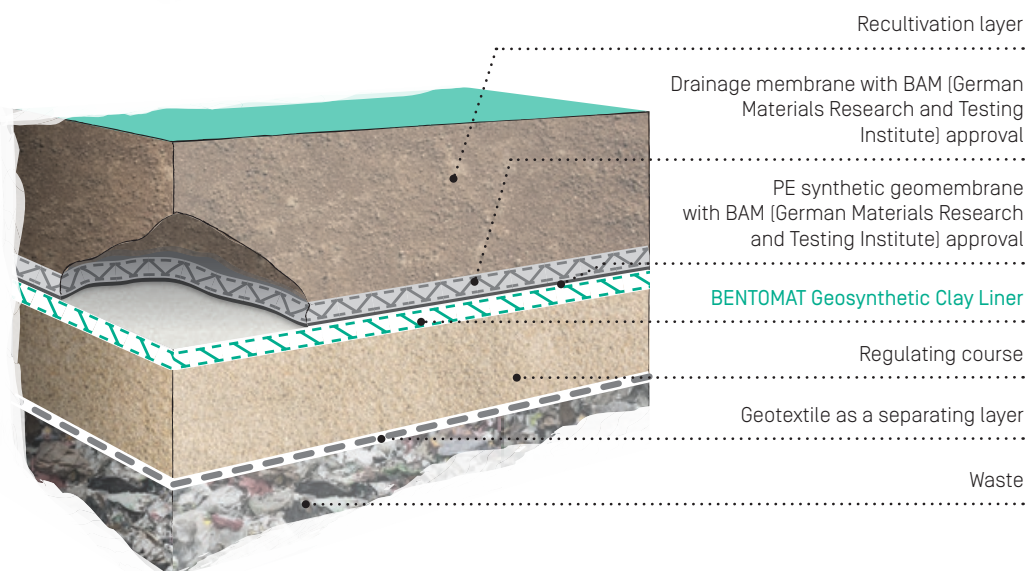
In order to avoid the risk of environmental hazards, waste material in landfill sites and waste disposal facilities must be stored permanently and safely. The relevant technical regulations specify suitable systems for sealing the base and upper surface of landfill sites. Geosynthetic clay liners are used in surface sealing systems, in the technical barrier, and in intermediate and temporary sealing layers.

The selection of a geosynthetic clay liner for use as a sealing element in a landfill site is made in accordance with the project-specific suitability assessment made by the relevant waste management authority. This certification of suitability is important because the clay liner forms an essential component in a coordinated sealing system. The certification of suitability is deemed to have been successfully completed if a nationally recognised suitability approval has been issued by the German states (LAGA Ad-hoc-AG "Deponietechnik") for a sealing component or a sealing system.

## Landfill class 1



## Landfill class 2





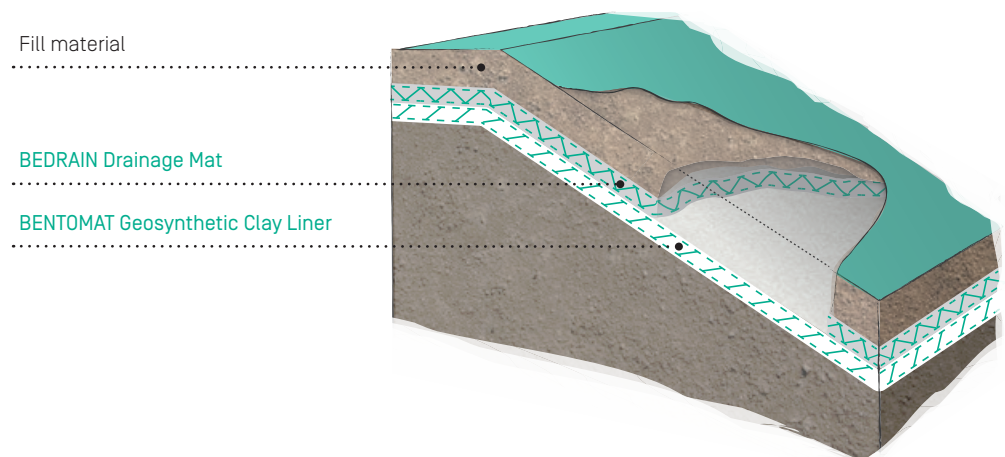
## Contaminated sites

The remediation of contaminated sites involves the construction of technical systems that are suitable for protecting the soil, groundwater and bodies of water in the long term.

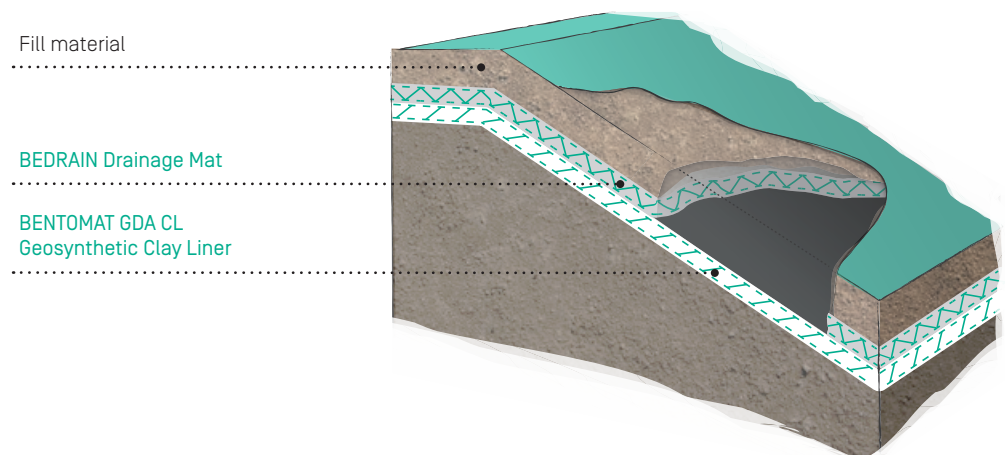
Contaminated areas are permanently and safely encapsulated with sealing systems comprising various coordinated components. This dispenses with the need for costly treatment or decontamination measures.

The aim is to achieve emission-free storage of soils and building materials that contain environmentally harmful substances. The ingress of rainwater is reduced and leaching from these soils and building materials is prevented.

**Construction method  
with weather-sensitive  
sealing element and  
no seepage layer**



**Construction method  
with weather-sensitive  
sealing element and a  
seepage layer**



# Applications matrix at a glance

We are happy to supply current data sheets, specifications, certificates and technical verifications on request.

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Properties	GDA	LAGA	300/200	GDA CL*
Product type	All-over needle-punched clay liner			All-over needle-punched clay liner with additional sealing membrane
Raw material	Non-woven: PP. Inlay: Bentonite. Woven: PP			Non-woven: PP. Inlay: Bentonite. Woven: PP. Membrane: PE
RiStWag Sealings	yes	yes	yes	yes
LAGA appraisal of aptitude		yes		
Fields of application				
Landfill construction		●		
Contaminated sites	○	●	○	●
Dike and hydraulic structures	○	●	○	●
Retention basins	○	●	●	●
Reservoirs**	○	○	○	●
Road and traffic areas	●	●	●	○
Canal structures	●	●	●	○
Ponds**	○	○	○	●
Underground / multi-storey car parks	○	●	●	○

\*0.2 – 1.5 mm. Available with or without structure

● suitable ○ partly suitable (project-related assessment necessary)

\*\* Depending on the product-specific water permeability, overflow height, physical soil and climatic conditions, a controlled water supply may be necessary.

# APPLICATION

## in practice

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### Constructing a sealed area for rubble storage

Construction period: September 2016  
Site location: Kieswerk Hardt GmbH & Co. KG  
System: BEGRID TG 30 30 S, BETEX TP 50,  
BENTOMAT LAGA  
Quantity: Approx. 3,000 m<sup>2</sup>  
Note: Geosynthetics as a cost-effective  
alternative to concrete slab  
Contractor: Hildebrand OHG,  
78351 Bodman-Ludwigshafen

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Top: A completed section of the storage area.  
Bottom left: BENTOMAT LAGA Geosynthetic Clay Liner  
laid as a sealing layer.  
Bottom right: Covering the sealing layer with fill.







## Construction of a sealed storage area for the temporary storage of concrete rubble and building rubble.

### Advantages of BENTOMAT:

- Evens out any settlement
- Reliable long-term sealing
- No costly and extensive concreting necessary
- Very safe and proven construction method
- High design reliability for the project participants
- Inexpensive and economical system solution
- Ecologically sustainable construction method



**BBO (Bodenseekreis Bauschuttauflbereitung GmbH & Co. KG) operates a collection point on the premises of the Hardt GmbH & Co. KG gravel plant. The mineral rubble that is stored here temporarily is used to produce recycled construction materials. The storage and operating area needed to be constructed in such a way that surface water could be discharged and soaked away in a controlled manner. The original design envisaged the construction of a waterproof concrete slab.**

### The requirements

The area was originally a gravel extraction site, which was later filled with excavated earth. The soil investigation for the proposed slab construction indicated a fill layer thickness of approximately 7 m and showed that the soil mechanics properties of the fill material vary locally. This meant that the proposed concrete slab would require a sub-base layer that would even out these differences.

Thus, in addition to the considerable costs for the slab itself, there would have been additional costs for excavation, for the removal of the excavated soil, and for the installation of the sub-base material.

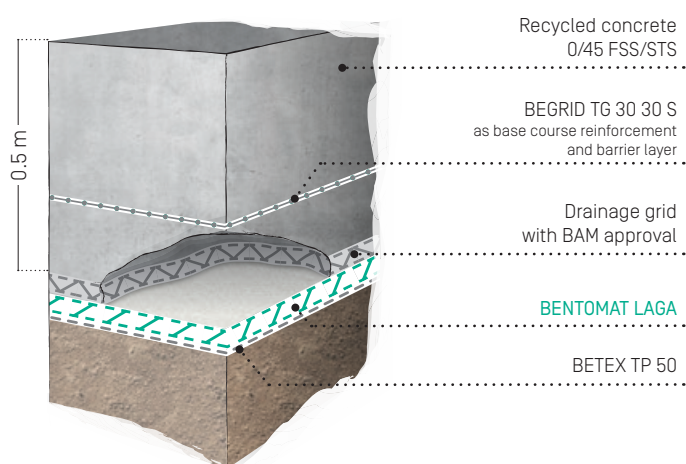




### The solution

Since the proposed slab was a very high-cost solution, BECO BERMÜLLER worked with geologist Tobias Hoelz, of Geoteam A2 GmbH, Argenbühl, to develop a new proposal that would significantly minimise the amount of excavation and provide a technically equivalent solution using geosynthetics.

The following structure was proposed and presented to the approval authority:



The authorities accepted the proposed pavement design.

### The result

As a result of the chosen configuration and layer structure, in addition to the effective prevention of uncontrolled surface water seepage into the subsoil, further disadvantages of a concrete slab were avoided.

The geosynthetics based layer structure can absorb settlement of the subsoil without incurring any damage. With a concrete slab, on the other hand, differences in the settlement of the subsoil could result in cracks forming on the surface of the slab. Water could then penetrate through these cracks or even permeate the entire slab. The water in the cracks would destroy the slab in the long term due to freeze/thaw cycles and, in combination with mechanical stress, would cause it to become permeable.

By using geosynthetics as reinforcing and sealing elements, the construction costs of the project were significantly reduced. And if the structure ever needs to be dismantled in the future, this will involve considerably less effort than the removal of a concrete slab.



# POTENTIAL SAVINGS

## thanks to BENTOMAT Geosynthetic Clay Liners

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With mineral clay sealing layers, layer thicknesses of up to 100 cm are required. BENTOMAT achieves a comparable or superior sealing effect with a thickness of just 1 cm.

As well as conserving natural raw materials and reducing excavation, the thinner BENTOMAT Geosynthetic Clay Liners also allow comparatively larger volumes of waste to be deposited in landfill sites.

The use of bentonite mats is therefore more environmentally friendly and more cost-effective than the conventional method of construction.

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Because BENTOMAT is industrially manufactured and is therefore subject to continuous quality monitoring, it guarantees a sealing layer that has constant and uniform properties.

# INSTALLATION

## instructions

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BENTOMAT Geosynthetic Clay Liners are quick and easy to install. BENTOMAT is supplied in rolls and laid with an overlap, requiring no expensive welding work. The required overlap width of 30 cm is marked on the mat during manufacture.

In order to achieve the same sealing effect in the overlap area as in the rest of the liner, a layer of loose bentonite granules is strewn, on site, in the marked overlap area. In order to maximise the sealing performance, bentonite mats require permanent loading with a suitable fill material laid in a layer at least 30 cm thick.



# INSTALLATION

## BENTOMAT

### Geosynthetic Clay Liners

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### To be considered:

1. Lifting equipment that has a cross beam and is suitable for lifting loads of at least 1,300 kg is required for unloading and laying the liners. The rolls, even if still packaged, must be stored in dry and weatherproof conditions.
2. The material may be laid only by qualified personnel.
3. It must always be laid in dry weather.
4. The subgrade must be flat, even and free of foreign bodies, surface water, rubble, roots, and pointed or sharp edged stones.
5. The liners must always be laid without creasing and in the direction of incline.
6. The overlap areas must be installed neatly and with particular care.
7. The bentonite granules must be distributed evenly in the overlap areas.
8. For reasons of stability, it may be necessary to secure the bentonite mat at the top edge of the incline.
9. Extra care must be taken in the area of pipe penetrations and connections.
10. To prevent the material from swelling before the overburden is applied, it must be covered with suitable fill material immediately after laying.
11. The covering material must be "end tipped" onto the liner.
12. Vehicles must not drive directly on the liner.
13. In order to achieve the required overburden, the entire surface of the BENTOMAT liner must be covered with fill material.

Our detailed installation and laying instructions for BENTOMAT Geosynthetic Clay Liners must also be observed.



# ADVANTAGES

## BENTOMAT

### Geosynthetic Clay Liners

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- Excellent sealing performance
- Self-repairing effect
- Full-coverage needle-punching
- Consistent product characteristics
- Many areas of application
- Very little dust generation during installation
- Conservation of natural resources
- Cost-effective sealing system
- Cost-effective installation
- Low transport costs

#### **Additional advantages of the BENTOMAT GDA CL Geosynthetic Clay Liners:**

- Redundant sealing system to meet the highest safety and reliability requirements
- Superior sealing performance compared to conventional clay liners
- Root-proof sealing
- Drying out is effectively prevented





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