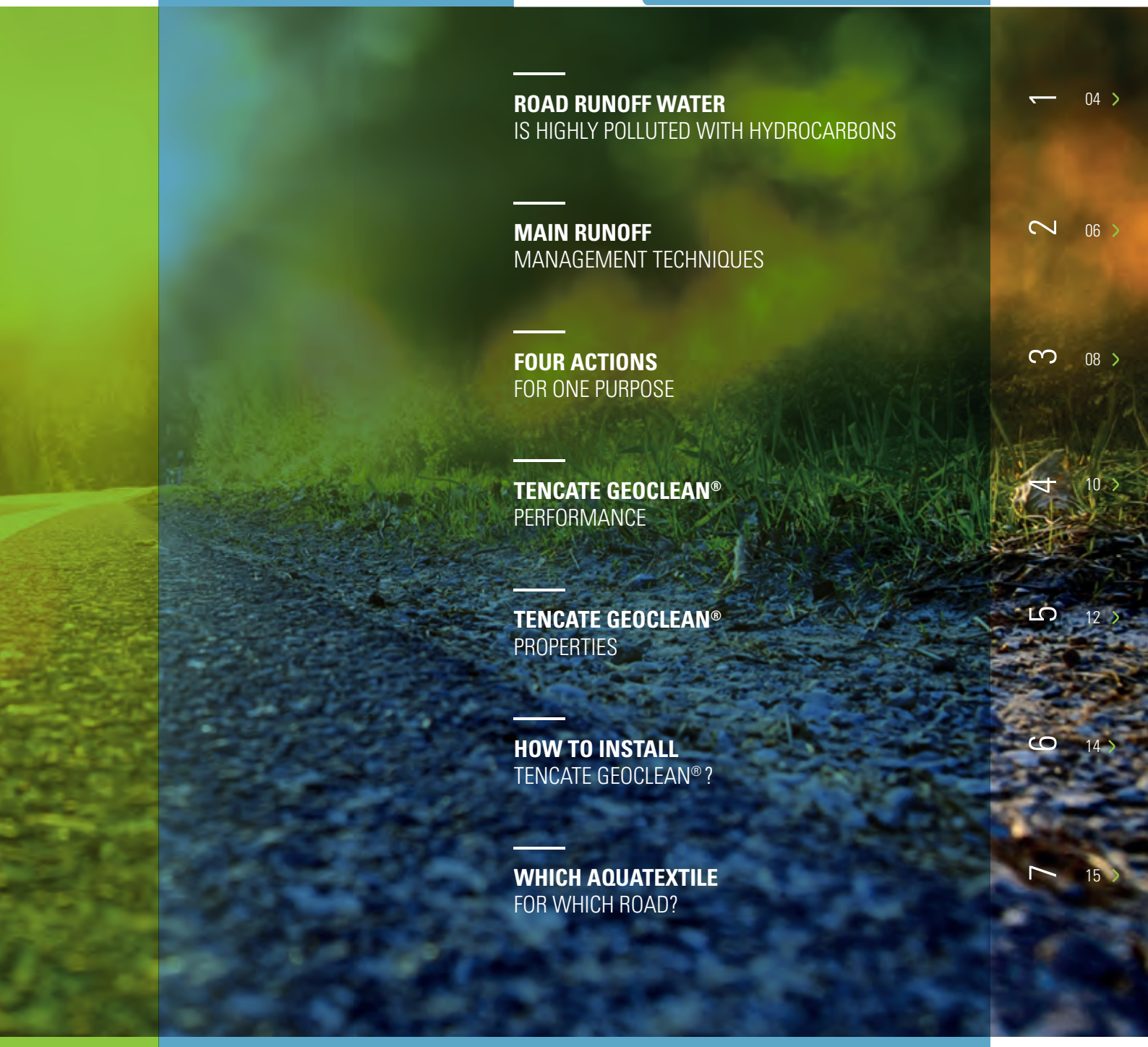
Cleaning runoff water

Naturally!

Building more sustainable roads

TENCATE GeoClean®

TENCATE GeoClean®



ROAD RUNOFF WATER IS HIGHLY POLLUTED WITH HYDROCARBONS

Today's challenges

- Dense urban areas comprise more than 70% impermeable artificial surfaces on average.
- Impermeable surfaces in Europe have increased by 38% in the last 25 years.
- Roads, car parks, and railways are polluted by oil and grease leaks.

Did you know?

Large amounts of hydrocarbons are released on road surfaces every day

Around **1 to 5 kg[1] of hydrocarbons are released each day on every kilometre** of heavily trafficked road.

Up to **5kg** of hydrocarbons per km and per day

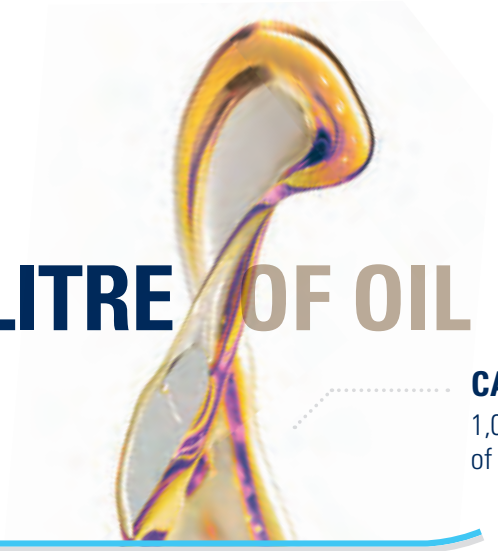
Estimates for the daily oil pollution in several European countries is provided in the following table[2]:

	MOTORWAY	
	Length (km)	Diffuse oil (kg/day)
EU28	77 365	232 095
Spain	16 583	49 749
Germany	12 917	38 751
France	11 882	35 646
United Kingdom	3 764	11 292
Netherlands	2 808	8 424

(1) Service d'Etudes sur les TRansports et leurs Aménagements (now Cerema). Heavy traffic road: 10.000 veh./day

(2) Calculation made from an average diffuse load of 3 kg/km/day on a high-traffic road

A SINGLE LITRE OF OIL



CAN CONTAMINATE
1,000,000 litres
of natural water

CAN COVER
1,000,000 m²
of water surface
(100 hectares)

The rate is about 0.2 g/m²/week
on car parks

For example, oil leaks reach up to about **200 litres oil /year** on a 20,000 m² car park with 400 spaces.

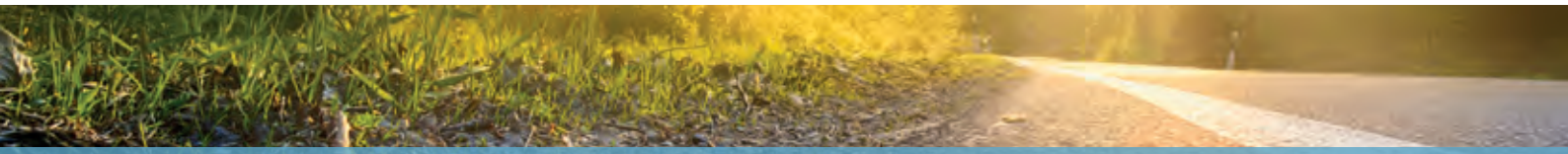
Thus up to
4 Litres
per week

A large proportion of these hydrocarbons may infiltrate

While around 30% of these hydrocarbons degrades outdoors, **70% may be carried off by runoff, infiltrating** the soil and polluting the subsurface and aquifers.

To protect aquifers,
it is essential to design infrastructure
that promotes local infiltration of rainfall
and cleans polluted runoff
water prior to infiltration

2 MAIN RUNOFF MANAGEMENT TECHNIQUES



WATER MANAGEMENT ON ROADS

Quantity

Road safety requires rainwater to be removed from the roadway as quickly as possible.

Quality

Regardless of the technique used, up to 50% of the road pollution is released onto the sides of the road by runoff or projections.

The two main options to manage

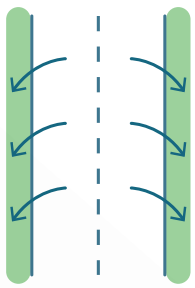
runoff water from impermeable roads are:

TECHNIQUE 1

› Centralised collection, possibly sent to a treatment plant

RWTP: Runoff Water Treatment Plant

TECHNIQUE 2



› Distributed lateral infiltration

TenCate GeoClean® benefits

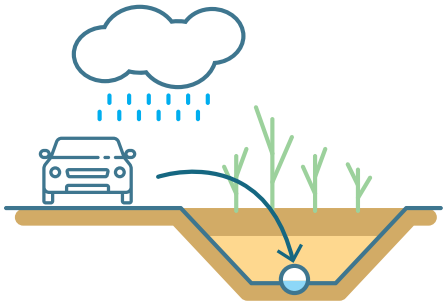
- Local infiltration of runoff water
- Protection of the subsurface and aquifers
- Very effective elimination of hydrocarbons in the water (< 1 ppm) upon installation
- Ecological: natural and systematic biodegradation using the local microbiota
- Autonomous and self-regulating system based on inputs
- Buffer storage in case of accidents
- Durable and maintenance-free
- Economical upon installation and over the long term
- A range adapted to different needs

1 LATERAL INFILTRATION

This is better than central* collection, because:

- It reduces the distance water travels;
- Infiltration is localised;
- The lateral surface is already polluted by projections;
- Reduced maintenance;
- Low cost;

The runoff must come in contact with a layer that can treat its pollution.

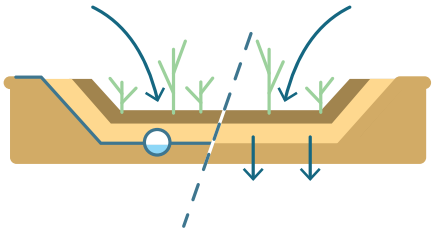


2 CENTRALISED COLLECTION

This technique is widely used, mainly for water management. It requires pipes and gutters laid along roads to collect and transport runoff water to a centralised retention pond and treatment plant. It is a complex design, dividing the network into basic watersheds based on road topography.

Planted treatment ponds may be installed at the end of the collecting network to treat and infiltrate polluted water, but:

- Infiltration is slow and requires large areas;
- Appropriate soils are not always available;
- It takes time to grow the plants and establish roots;
- There is a risk of cracks and preferential flow through the soil.



* Swiss Federal Office for Roads – ASTRA 18005

3 FOUR ACTIONS FOR ONE PURPOSE

TenCate GeoClean® is an **eco-friendly and sustainable** solution for **cleaning oil-polluted runoff water.**

It is a bicolour two-layer aquatextile with a unique structure that naturally traps and biodegrades oil from runoff water, to protect aquifers and ensure that only clean water infiltrates the natural soil.

To do this, TenCate GeoClean® has four simultaneous actions

1 CLEANS OIL OUT OF RUNOFF WATER

TenCate GeoClean® cleans water by **fixing oil** in its **oleophilic top blue layer.**

When oil-polluted water percolates through TenCate GeoClean®'s unique porous structure, the **oil immediately adheres to the surface of the many thin oleophilic continuous filaments**, while clean water flows out.

2 PROVIDES HIGH WATER INFILTRATION CAPACITY

TenCate GeoClean® is **highly permeable,** with or without oil trapped into its structure. It offers a high **margin of safety** to instantly **infiltrate all types of rain,** even during the strongest storms.

TENCATE GeoClean®

TenCate GeoClean®
houses a natural ecosystem

Aquatextile
A textile for managing
water quality in the soil

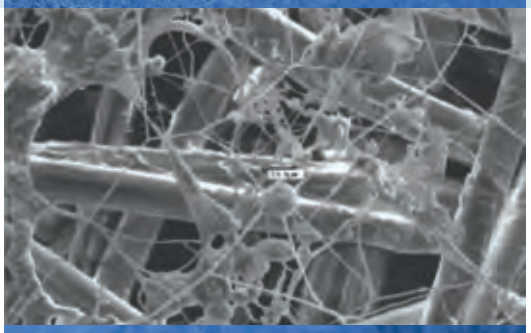
3 CLEANS CAPTURED OIL

TenCate GeoClean® **naturally biodegrades** the oil trapped in its filamentous structure because it houses a **sustainable cleaning ecosystem** in its blue layer.
To prevent any risk of the aquatextile becoming saturated with the trapped oil under normal operating conditions in the event of diffuse and regular oil leaks, TenCate GeoClean® **activates a natural biodegradation of the oil by the site's microorganisms.**

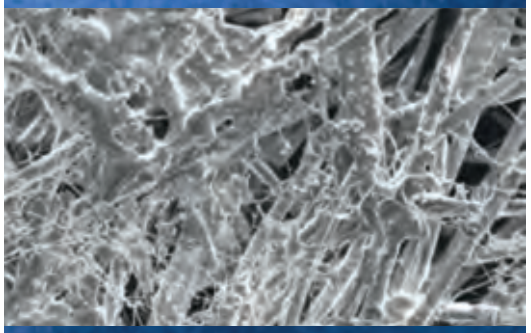
It offers **optimal living conditions** to attract oil-degrading bacteria and fungi:

- A 3D **porous filamentous structure** supports this **microbiota** and maintains **sufficient oxygen;**
- The gentle **release of a natural growth activator boosts** oil biodegradation, which occurs several weeks after the oil is trapped;
- TenCate GeoClean® **stores water** in its white bottom layer to **maintain the moisture** needed for microbial life;

It is a **sustainable, maintenance-free** water cleaning process.



Microscopic fungi and mycelium on the filaments



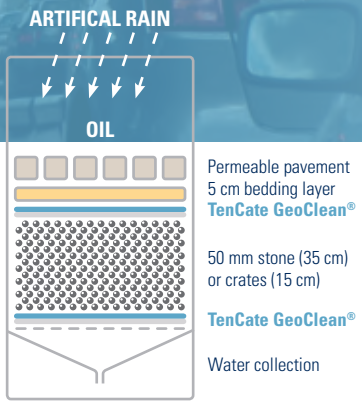
Oil degrading biofilm on the filaments

4 ENSURES SAFETY IN CASE OF AN ACCIDENTAL OIL SPILL

In case of **accidental and localised spill,** TenCate GeoClean® offers **additional oil storage capacity** in its white filamentous layer.

4 TENCATE GEOCLEAN® PERFORMANCE

WATER CLEANING AND OIL RETENTION



REGULAR AND DIFFUSE OIL LOAD

Laboratory trials have been carried out to assess the oil retention for a high diffuse load (18 g/m²/week, about **3 to 18 times more than the average diffuse oil load from heavily trafficked roads**(1)) with **heavy rain** of 13 mm/hr (Return period T=6 months in Western Europe).

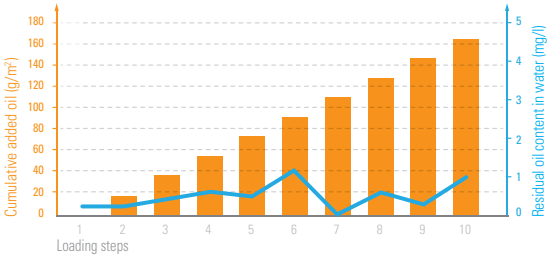
The road tested was a permeable structure with two TenCate GeoClean® layers on both sides of a drainage layer between the surface course and the foundation.

Results show that when runoff infiltrates through this pavement system, the **maximum residual hydrocarbon content** in the percolating water is **less than 1 mg/l(2),** which is **better than Class 1 oil separators** (5 mg/l) according to EN858-1:2002.

Oil retention rate > 99.9%*

Residual oil content into water percolating through the permeable pavement system with 2 layers of TenCate GeoClean® Crystal

Diffuse oil load: 18g/m²/week - Rain: 13 mm/hr/week



Residual hydrocarbon content in the water (blue curve) after 9 diffuse oil loadings (orange bars)

ACCIDENTAL HIGH OIL LOADS

TenCate GeoClean® offers **additional safety** in case of an **accidental localised oil spill.**

The same pavement system was subject to **spot loads of 0.6 l/m²** (corresponding to one large 6 litres car engine emptying over a 10 m² parking space) combined with an **extreme rainstorm** of 65 mm/hr (Return period T=100 years in Western Europe).

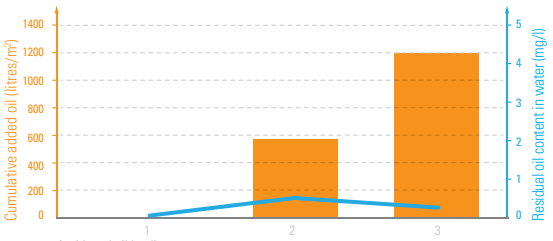
Despite these severe conditions, the structure with the TenCate GeoClean® aquatextile performed the same as with a diffuse load, with **maximum residual hydrocarbon content** into the percolating water of **less than 1 mg/l.**

The two TenCate GeoClean® products, Crystal and Pure, have even higher retention capacities, able to retain **two or more accidental spills** in exactly the same place (low occurrence).

Residual hydrocarbon content in the water > 1mg/l*

Residual oil content into water percolating through the permeable pavement system with 2 layers of TenCate GeoClean® Crystal

Spot oil load: 0.6 l/m² - Rain: 65 mm/hr



Residual hydrocarbon content in the water (blue) after 2 large oil loadings (orange)

(1) The diffuse oil load on a heavily trafficked road is 1 to 5 kg/m²/day, or 1 to 6 g/m²/week for half-road runoff infiltrating into a 3 m wide roadside ditch.

(2) 1 mg/l or 1 ppm - Data from the KTP project in collaboration with the University of Coventry and SEL Environmental, UK.

* : Performance of the described pavement system.

Maximum oil retention
of TenCate GeoClean® Crystal
is more than 1 litre/m²

2 WATER PERMEABILITY

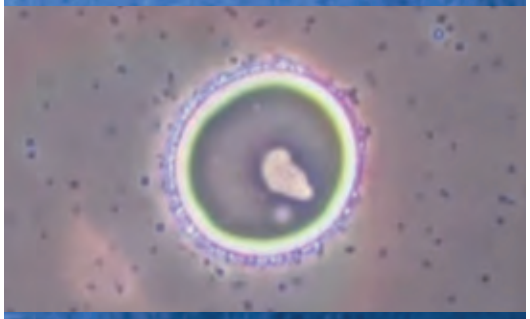
The very open 3D structure of the TenCate GeoClean® aquatextile offers very high water permeability, much higher than the **permeability of the surrounding soils,** even sandy soils. This excellent performance allows for **instantaneous infiltration of a 100 year rainfall** (65 mm/hr) or even stronger, without water retention at the surface, even when the aquatextile has reached its maximum retention capacity (when the residual content of hydrocarbons in the percolation water exceeds 1 mg/l).

3 OIL CLEANING

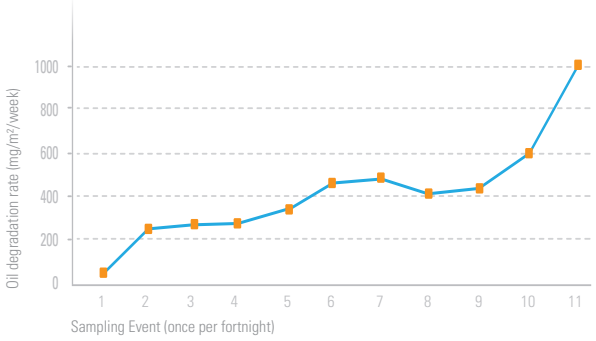
TenCate GeoClean® is an aquatextile that offers an optimum environment for the development of an ecosystem that effectively degrades hydrocarbons.

In an experiment, the **biodegradation** speed of a diffuse oil load trapped in the oleophilic filaments quickly reached **1 g/m²/week** just 22 weeks after reaching optimum biodegradation conditions. This rate increased to around **2 g/m²/week about 1 year after** the experiment started, which is about **5 times the average diffuse oil load** from car parks.

TenCate GeoClean® is an **autonomous and self-regulating system** whose **biodegradation rate adjusts** to the amount of diffuse oil.
It is therefore **maintenance free.**



Oil drop (at the centre) surrounded by oil degrading bacteria (purple dots)



5 TENCATE GEOCLEAN® PROPERTIES

1 STRUCTURE

TenCate GeoClean® oil biodegrading aquatextiles:

- are made of **continuous oleophilic filaments;**
- have a **two-layer bicolour structure.**

The **top blue layer,** made of **active filaments:**

- **Cleans water** by **fixing diffuse oil**
- **Activates** the growth of an **oil biodegrading ecosystem**

The **bottom white layer** is:

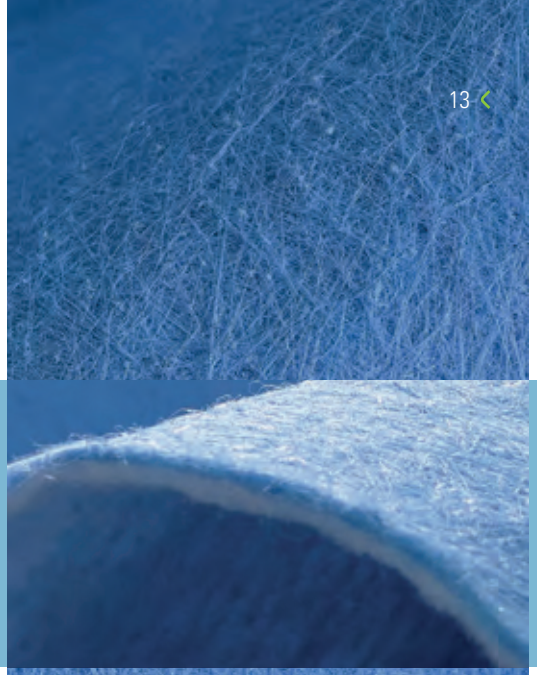
- a **water reserve** to provide **moisture to microorganisms;**
- A space for **additional oil retention** in the event of a large local spill, which will be gradually biodegraded.

2 A SPECIFIC RANGE DESIGNED TO MEET DIFFERENT NEEDS

The TenCate GeoClean® range includes the following aquatextiles:

- Origin
- Crystal
- Pure

with increasing retention and treatment capacities.



UNDER NORMAL OPERATING CONDITIONS:
DIFFUSE AND REGULAR OIL SUPPLY

for example: average oil leakage in a car park is about 10 g HC/m²/year

TenCate GeoClean®		Origin	Crystal	Pure
Maximal oil retention capacity (1)		> 500 g/m²	> 1000 g/m²	> 1700 g/m²
Water treatment efficiency (2)	Maximum residual HC content into water after percolating through the structure with TenCate GeoClean®	**<1 mg/l**		
	Oil retention rate	**> 99,9%**		
Biodegradation speed of the trapped oil (3)		**100 g/m²/year**		
Degradation rate compared to diffuse oil input on the car park		**x 10**		

IN THE EVENT OF A TRAFFIC ACCIDENT:
LARGE AND LOCALIZED OIL SPILL

for example: engine oil volume of 6 litres spread on a car park of 10 m²

TenCate GeoClean®		Origin	Crystal	Pure
Maximal oil retention capacity (1)		> 0,6 l/m²	> 1,2 l/m²	> 2 l/m²
Water treatment efficiency (4)	Maximum residual HC content into water after percolating through the structure with TenCate GeoClean®	**<1 mg/l**		
	Oil retention rate	**> 99,9%**		
Biodegradation: maximum rate (3)		+	++	++++

(1) The system tested had a 50 cm thick stone layer, a TenCate GeoClean® layer on the top and bottom sides, and was covered with a concrete permeable structure;
(2) Supply of 18g of oil/m²/hr with a heavy rains of 13 mm/hr, for an average incoming concentration of 1.4 g/l;
(3) Estimate from laboratory measurements calculated for an identical oil input and optimal biodegradation conditions. The quantity of oil degraded depends on the maximal oil retention capacity of each product;
(4) Supply of 0.2 litres of oil/m²/ hr during a 100 year rain of 65 mm/hr, for an average incoming concentration of 2.8 g/l.

Comments

These data are from the KTP project in collaboration with the University of Coventry and SEL Environmental (UK).

Biological degradation involves microorganisms, a variety of living organisms whose activity depends on food availability and living conditions. No matter the conditions, the high oil storage capacity of the TenCate GeoClean® aquatextile buffers the variations in biodegradation.

This process takes time. However, the natural growth activator that gently diffuses out of the TenCate GeoClean® filaments speeds up oil biodegradation and self-regulates according to the quantity of hydrocarbons.

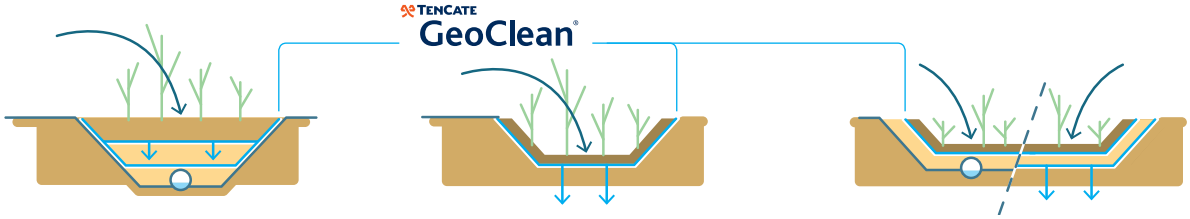
This prevents the structure from becoming saturated with oil.

HOW TO INSTALL TENCATE GEOCLEAN® ?

TenCate GeoClean® is light, easy to transport, and is installed by simply unrolling it at the soil surface.

It is therefore a very economical solution to clean runoff water polluted by hydrocarbons from roads.
The best places to install TenCate GeoClean® are infiltration areas, such as:

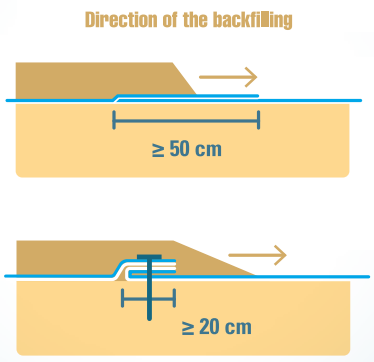
- **Infiltration ditches** on both sides of the road for distributed lateral infiltration.
- **Infiltration ponds** or drainage ditches in case of centralised collection.



Drained infiltration ditch | Infiltration ditch | Infiltration basin

TenCate GeoClean® is installed just below the top of the soil surface, in one or preferably two layers depending on the structure, in the aerobic unsaturated zone where the oil-polluted water infiltrates. When water passes through TenCate GeoClean®, the oil load adheres to the aquatextile filaments while clean water percolates through to the groundwater.

When several rolls are installed side-by-side, they should overlap by at least 50 cm to ensure that oil-polluted runoff flows through TenCate GeoClean® everywhere. The overlap should be placed in the direction of the topsoil backfilling. When such overlap is not possible, an alternative is a butterfly fold of the 2 adjacent rolls, also in the direction of the backfilling, preferably held with a pin.



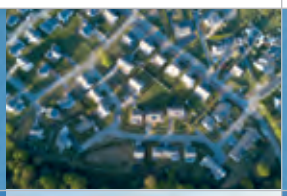
The TenCate GeoClean® aquatextile ensures safe protection of the underground aquifer thanks to:

- The homogeneity of its properties across the entire surface,
- Constant performance regardless of soil variability (cracks, micro-ducts),
- Characteristics that are quantified and tested in the lab,
- A fast and systematic start to oil biodegradation due to optimum living conditions for the biotope.

WHICH AQUATEXTILE FOR WHICH ROAD?

1 POTENTIAL RISK

This table below is a guide to help you choose the most appropriate TenCate GeoClean® aquatextile according to the application and its environment. It crosses the extent of the oil pollution (volume of oil released) with the impact of this pollution on the environment (the site's sensitivity to pollution [1])

	OIL POLLUTION		ENVIRONMENTAL IMPACT	
LOW	Low-density peri-urban areas ▫ Houses and small buildings ▫ Sport areas ▫ Secondary access roads ▫ Small car parks (< 50 u.)		URBAN AREAS	
MEDIUM	Dense peri-urban areas ▫ Small towns centre ▫ Artisanal areas ▫ Large car park ▫ Secondary roads with light vehicles		COUNTRYSIDE	
HIGH	▫ Highways ▫ Motorways ▫ Town rings ▫ High trafficked roads ▫ Logistics areas ▫ Truck parks ▫ Airports ▫ Railway stations ▫ Petrol stations		PROTECTED AREAS, DRINKING WATER STORAGE	

2 PRODUCT SELECTION

TenCate GeoClean®	LEVEL OF DIFFUSE OIL POLLUTION		
ENVIRONMENTAL IMPACT	LOW Secondary roads	MEDIUM Main roads	HIGH High trafficked roads / Motorways
LOW urban areas	**Origin**	**Origin**	**Crystal**
MEDIUM countryside, natural area	**Origin**	**Crystal**	**Pure**
HIGH protected area	**Origin**	**Pure**	**Pure**

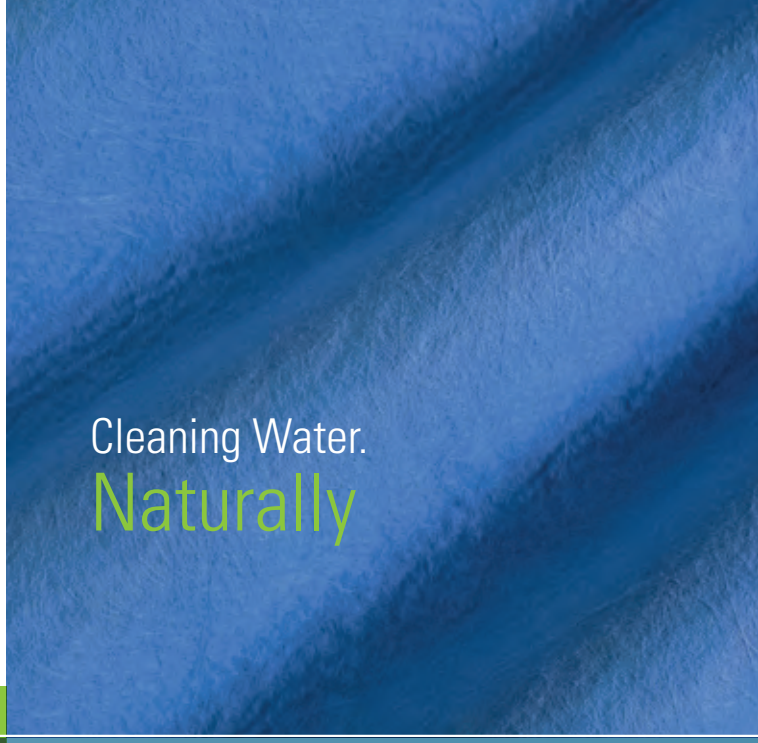
Detailed product safety information can be obtained upon request. This information is based on the best data available to us. These are only suggestions for your own experimentation. They are not intended to replace tests you may have to perform to determine for yourself how well our products suit your needs. This information can be modified as you acquire new knowledge or experiences. In the absence of control over the particular conditions in which our products are used, TenCate Geosynthetics gives no guarantee and declines any responsibility for the use of this information.

This publication shall in no way be considered as authorising the use or recommending the infringement of existing patent rights.

(1) Inspired from a methodology developed by the Grand Lyon Metropole Water Directorate

TENCATE
GeoClean®

For more information on projects, installation of the aquatextile and the savings, please contact us:



Cleaning Water. Naturally

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