

# DRAINAGE SYSTEMS WITH GEOCOMPOSITES IN NEW CELLS MSW LANDFILLS

This case study describes the design and use of **TECHDRAIN** and **INTERDRAIN** drainage geocomposites in the construction of new cells for Municipal Solid Waste (MSW) landfills. These drainage geocomposites are composed of a HDPE geonet (drainage) combined with two PP geotextiles (filtration, separation and protection), with excellent mechanical properties and high flow capacity.

Drainage geocomposites are widely used as leachate collection and leak detection layers, as well as for groundwater suppression, instead of the original solution with gravels, due to their advantages in cost, performance, delivery terms and environmental impact. Several examples in Spain, France, Belgium and Ireland are shown and explained in this paper.

## INTRODUCTION

Directive 1999/31/EC of 26 April 1999 on the landfill of waste establishes in its first article, first point, that “... the aim of this Directive is, by way of stringent operational and technical requirements on the waste and landfills, to provide for measures, procedures and guidance to prevent or reduce as far as possible negative effects on the environment, in particular the pollution of surface water, groundwater, soil and air, and on the global environment, including the greenhouse effect, as well as any resulting risk to human health, from landfilling of waste, during the whole life-cycle of the landfill”.

Later on, in Annex 1 “General requirements for all classes of landfills”, general requirements for bottom sealing and leachate drainage are defined. The use of geosynthetics has finally brought the engineered landfills, helping operators to achieve the requested performance by means of easy-to-find industry-manufactured products.

Drainage geocomposites are only one of these products, where we can find as well geomembranes, geocomposite clay liners, reinforcement grids, geotextiles, etc... All these products have shown clear advantages in front of traditional solutions with clay and gravels, especially in those places where the nature does not provide us with such materials.

## OLD SOLUTION WITH GRAVELS

Gravels have been used for decades in the construction of drainage systems for new landfills. There are three main purposes that gravels can be used for, from top to bottom:

- ▶ **Leachate collection.** This is a “must” layer that is installed over the geomembrane in order to collect leachate and convey it out of the landfill. Due to the difficulties in calculating the leachate flow, normally a 50cm thick layer is accepted with minimum slopes of 2-3°. This layer must be separated from the waste by means of a PP nonwoven geotextile, acting as separator and filter to avoid gravels clogging, that would be critical for the installation. In addition, a heavy nonwoven geotextile must be placed directly over the geomembrane in order to avoid damages.
- ▶ **Leak detection.** Depending on several factors, mainly technical and economical, a double geomembrane may be installed. In that case, a drainage layer is placed in between, acting as leak detection. It allows the operator to know if the upper geomembrane has suffered any damage and where it is located. A 30cm thick layer is typically accepted, being the flow requirements very low.
- ▶ **Groundwater suppression.** Water in the subsoil is a main concern, since it could provoke pressure on the installation thus causing bumps and important damages. If water table is expected to be high enough, it must be evacuated by creating a drainage network.

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A standard section for a new landfill using the traditional solution is shown in figure 1.

If we imagine an average 5 Ha landfill, only for the leachate collection layer more than 25.000m<sup>3</sup> of gravels would be needed. For a standard 12m<sup>3</sup> truck, this solution entails around 2.000 trucks to serve the entire amount of gravels. The main concerns are:

- ▶ Where such a big amount of gravels could be found nearby?
- ▶ What is the storage necessity on site for such a volume of gravels?
- ▶ What is the environmental impact of the extraction of 25.000m<sup>3</sup> of gravels from a river or quarry nearby, and what is the environmental impact of 2.000 trucks driving in the surroundings?

In addition to these economic and environmental concerns, the design and geometry of the new landfill depends also on the type of drainage to be used. In the case of gravels, considering they have an internal friction angle of 30-35°, slopes can have a maximum inclination of 20-25° (security factor, installation procedure...) which is a very demanding limit when there's not enough space for the landfill, and additionally the costs increase very much because the landfill will occupy a larger space.

Finally, for the deployment of such a layer of gravels, one single team could achieve a maximum performance of 15 to 20 trucks per day, which means around 480m<sup>2</sup>/day, very far from the performance that can be achieved with geosynthetics components, as we will see in the next point.

## NEW SOLUTION WITH DRAINAGE GEOCOMPOSITES

In order to overcome all the pitfalls that can appear by using the traditional solution, drainage composites came in the market a few years ago, being the first known use in 1.984 as a leak detection layer in the United States. There are several types, but the most adequate one for new landfills is the geonet-based composite, due to its resistance and good performance under high compressive loads and low gradients.

This new solution expanded very quickly worldwide. In the case of Europe, it is needed to accomplish with the current legislation, both the **European Directive 1999/31/CE** and the local national regulations in each case. Therefore, the flow capacity of the new geosynthetic layer should be equivalent to a 50cm layer of gravels, in general.

As shown in figure 2, the new solution allows as well the reduction of the lining height, thus giving more capacity to the installation.

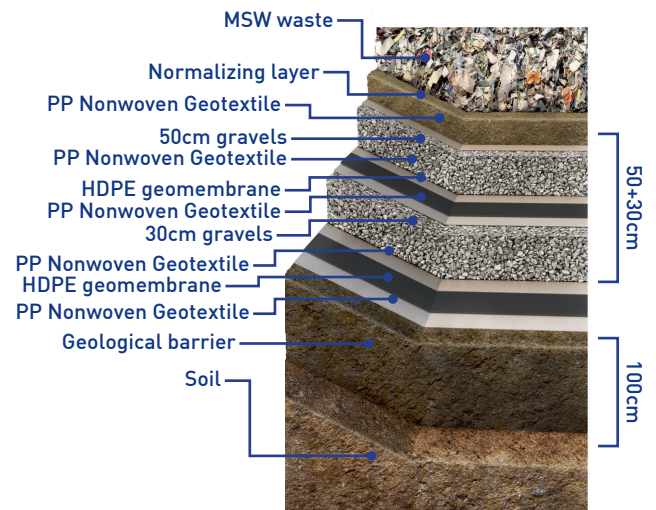


Fig. 1. Traditional lining section for a new cell in a MSW landfill

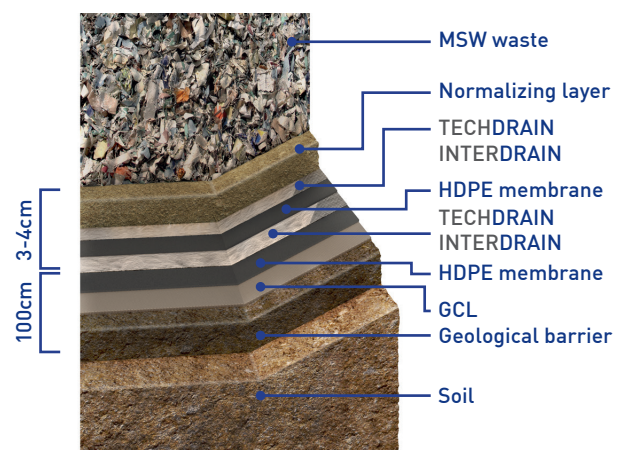


Fig. 2. New lining section with drainage composites

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The main advantages of composites can be shortlisted as follows:

- ▶ Cost savings 40 to 60%.
- ▶ Environmental friendly solution:
  - Innocuous.
  - Not polluting.
  - 100% recyclable.
- ▶ Reduction of storage and transport costs. One truck of composite equivalent to 400 trucks of gravels.
- ▶ Easier and faster installation.
- ▶ One product with four functions:
  - Drainage.
  - Protection.
  - Separation.
  - Filter.
- ▶ Larger landfill capacities.
- ▶ Chemically and biologically resistant to leachate in Municipal Solid Waste and also in chemical waste and coal ash ponds.

## INTERMAS DRAINAGE COMPOSITES. TECHDRAIN & INTERDRAIN

### ▶ INTERDRAIN

**INTERDRAIN** is formed by continuous extrusion of two intersecting high density polyethylene (HDPE) strands to form a high profile biaxial net structure. The evenly spaced ribs, which intersect at 60°, keep flow channels open with a high capacity for water evacuation.

**INTERDRAIN** is resistant to chemical and biological agents normally present in the soil and wastes; also stabilized with carbon black for resistance against UV degradation.

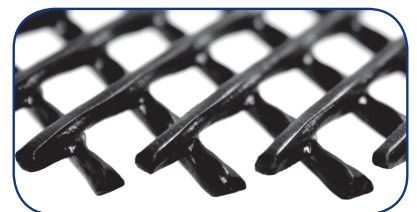
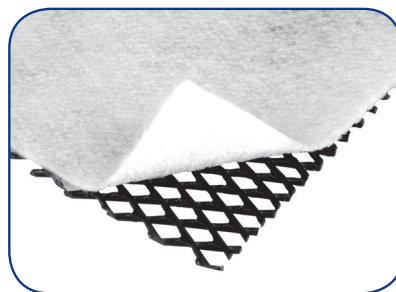


Fig. 3. INTERDRAIN drainage geocomposite

### ▶ TECHDRAIN

**TECHDRAIN** is a high-density polyethylene (HDPE) TRIPLANAR geonet. The geonet is made with 3 strands, whose geometry create channels with a high flow capacity, also under pressure and at very low gradients. It's also resistant to chemical and biological agents, and stabilized with carbon black for resistance against UV degradation.

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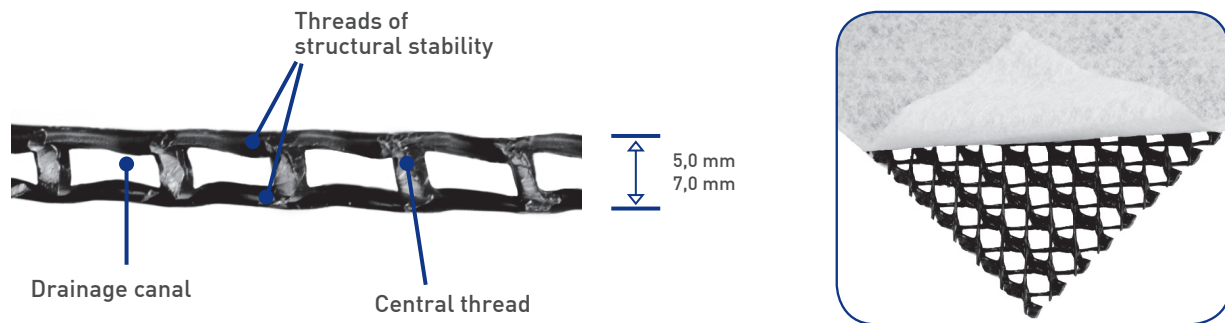


Fig. 4. TECHDRAIN drainage geocomposite

The main difference with INTERDRAIN is the higher flow capacity and the better compressive behavior. The election of one or another will depend on the real necessity of the Project, according to the height of waste, geometry of the landfill, rainfall intensity (therefore the creation of leachate), etc... The designer's criterion is also important, depending on the Security Factor that wants to be applied in the Project.

The main technical properties of both products that must be highlighted when it comes to new landfills are:

- ▶ **Transmissivity.** This is the main purpose of the composite. Short-term flow capacity is measured at INTERMAS accredited laboratory in accordance with ISO 12958 and ASTM D4716. Long-term flow capacity is calculated following GRI-GC8 "Determination of the Allowable Flow Rate of a Drainage Geocomposite".  
**Note:** INTERMAS provides detailed calculations to show the performance of our composites when compared to the traditional layer of gravels.
- ▶ **Compressive resistance,** in accordance with ASTM D1621 and ISO 25619. The minimum resistance is for the 4mm INTERDRAIN geonet with 500kPa, reaching up to 2.400kPa with the 7mm TECHDRAIN geonet.
- ▶ **Creep behavior,** in accordance with ASTM D7361 "Accelerated Compressive Creep of Geosynthetic Materials Based on time-temperature superposition using the Stepped Isothermal Method", and GRI-GC8. Both geonets give results from 1,05 to 1,30 in the worst scenario (high loads and 1.000.000 hours).
- ▶ **Long-term protection efficiency,** in accordance with EN ISO 13719:2002 "Determination of the long-term protection efficiency of geotextiles in contact with geosynthetic barriers", where it is demonstrated that INTERMAS composites are able to offer a similar geomembrane protection to the one that is provided by the typical thick geotextiles used for this application.
- ▶ **Chemical and biological clogging.** The geonet is heat laminated with two PP geotextiles. The geotextile above works as a protection, separation and filter layer. The main concern in this case is the geotextile clogging, that could be assessed by means of the gradient ratio test (ASTM D5101), the long-term flow test, or the hydraulic conductivity ratio (ASTM D5084).

However this, it's not possible to apply these tests to municipal waste, due to its lack of homogeneity. This is the reason why most designers accept the use of a 120-270gr/m nonwoven needle-punched PP geotextile on top of the geonet, as a filter and separation for the leachate, and with the following properties:

- Apparent opening size (AOS) – ISO 12956 = 70-100µm
- Normal permeability – ISO 11058 = 60-90l/m2s

In addition, a 20-30cm thick normalizing layer (sand and/or thin gravels) can be applied over the composite, helping to eliminate the risk of clogging in the upper geotextile (see figure 2), and also needed for the operation of the landfill.

**Note:** this normalizing layer is also applied over the gravels, since the risk of clogging exists for the traditional solution as well (see figure 1).

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► **UV protection.** New cells need time to be finally filled with waste. During this operational time lapse, the upper side may be exposed to UV radiation. INTERMAS can advise on this issue giving a customized solution to each case and necessity.

## NEW MSW LANDFILLS IN EUROPE WITH INTERMAS DRAINAGE COMPOSITES

### Balleally landfill in Fingal County - Ireland

Balleally landfill has collected for years all the MSW disposals from the area of Fingal county, in the outskirts of Dublin. This landfill, operated directly by the Fingal County Council, was in operation since 1.971, finally closed on May 15th 2012.

During year 2.006 INTERMAS supplied 200.000m<sup>2</sup> of INTERDRAIN GMG512 for the construction of a new cell in Balleally landfill. Additionally also 200.000m<sup>2</sup> of INTERDRAIN GMG412 were supplied for the capping of an old cell.

GMG512 was used for leachate collection in the bottom and slopes of the landfill. See next pictures for details.



Fig. 5. General overview of Balleally landfill under operation. The waste is disposed when the new cell is still being constructed. Normalizing layer is clearly seen above the drainage composite for leachate collection.

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## Indaver landfill - Belgium

Indaver NV is a European leader in the operation of landfills, among other activities. In 2011 they had the necessity to create a new cell for one of their landfills in the surroundings of Amberes. With a total height of 44 m of waste, and a specific weight of 16 kN/m<sup>3</sup>, they required a drainage geocomposite for leachate collection with a compressive resistance around 700 kPa.

A 5mm high crush resistance triplanar HDPE geonet with two 120 g/m<sup>2</sup> polypropylene geotextiles heat-bonded to it was selected by the designers. The product was **TECHDRAIN GTG512**.

40.000 m<sup>2</sup> of product were installed with the purpose of collecting leachate in the slopes and also in the base of new cell of the landfill, where at maximum loadings the product was installed with a 2% inclination ensuring an adequate performance.

The design life of the cell is 20 years, which indicates the need of a good creep behavior, such as the one offered by a triplanar geonet, in order to ensure an optimum long-term performance.

One particularity of the project is that this new cell was not dug into the ground, but built above it as an “artificial mountain”.



Fig. 6. Indaver landfill. The drainage composite is deployed directly over the geomembrane.

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## New landfill in Tourville - France

Tourville-la-Rivière is a commune in the Seine-Maritime department in the Normandy region in northern France. INTERMAS was assigned the supply of a drainage composite for the construction of new cells during 2011 and 2016.

In the first phase, 55.000m<sup>2</sup> of a special composite INTERDRAIN AM5 with high UV protection were supplied, required for the installation on slopes. The necessity of such a composite was due to the long-term exposure of the slopes to the UV radiation, since the new landfill was designed to be filled at a very low rate.

In the other hand, for the new expansion phase during 2016, 20.000m<sup>2</sup> of TECHDRAIN GTG512 were supplied. This composite was deployed in the bottom of the landfill.



Fig. 7. In Tourville landfill, gravels were used as a normalizing layer over the drainage composite. The use of a drainage composite reduced 3 times the need of gravels.



Fig. 8. Detail of AM5 composite installed on slopes. No normalizing layer is generally needed on slopes.

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## New landfill in Meruelo - Spain

Meruelo's landfill is located in the north of Spain and managed by the public company MARE. It serves to more than 500.000 people in the County of Cantabria, very close to the Cantabrian Sea. Its total capacity is around 5 million Tn, having an average annual waste inlet of around 120.000 Tn.

In 2.010 a new cell was constructed, and INTERMAS supplied the drainage composite for leachate collection. The total quantity was 210.000m<sup>2</sup> installed in both the bottom and the slopes of the landfill. INTERMAS had participated in the design phase of the Project, where the Contracting Authority had chosen to use TECHDRAIN GT512.



Fig. 9. General overview of Meruelo new cell under construction.



Fig. 10. Normalizing layer of gravels in the bottom of the landfill.

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## New landfill in Serín - Spain

The public company Cogersa manages this landfill since 1.983. It is located in the province of Asturias, and it has received close to 9 million Tn until 2.016. A new extension is forecasted for 2.017, while it is expected to be finally closed in 2.020.

Cogersa undertook one of the extensions during 2.010. INTERMAS supplied 120.000m<sup>2</sup> of TECHDRAIN GTG512 for the bottom and slopes, for leachate collection.



Fig. 11. General overview of Serín new cell.



Fig. 12. General overview of Serín new cell under operation.

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## Madrid landfill - Spain

Located in Valdemingómez town, Madrid landfill is very probably the largest landfill in Spain. It was settled in 1.978 and it occupies currently more than 210Ha, where more than 110Ha are already capped and recovered. At the same time, after several investments during the last years, it has become a very important technological hub for renewable energies around waste management.

The daily inlet rate of waste is 4.000Tn, since this landfill is giving service to 4,8 million people. INTERMAS has participated in this Project for many years, but the most important extension was undertaken in 2.000, where 500.000m<sup>2</sup> of INTERDRAIN GMG512 were supplied.



Fig. 13. Valdemingómez landfill under operation.

## CONCLUSIONS

The use of geosynthetics in environmental applications requires a very wide approach, taking into consideration all factors that affect the installation. For high compressive loads in new cells, only the geonet is able to guarantee the long-term performance, when drainage capacity, compressive resistance and creep behavior are taken into account.

INTERMAS has many references worldwide for such applications (also for Civil Works and Mining), that enable both TECHDRAIN and INTERDRAIN as a reliable solution:

- ▶ High flow capacity, also with very low gradients.
- ▶ Very high compressive resistance.
- ▶ Excellent creep behavior.
- ▶ Quick and easy installation.
- ▶ Environmentally friendly.
- ▶ Cost-effective alternative in front of traditional solution.
- ▶ Whole life-cycle durability ensured.