

Science for Environment Policy

Volume of leachate and environmental impact from landfills reduced – but legacy effects remain

Landfill leachate is the liquid that seeps through or out of waste deposits in landfill sites. EU regulations, such as the Landfill Directive¹, have significantly reduced the volume of leachate produced, a study on leachate management in Ireland has found. Leachate, mainly from younger landfills in Ireland is, however, stronger since implementation of the legislation, and the researchers say the future treatment of leachate under stricter environmental protection regulations will continue to be a long-term concern for landfill operators and regulators.

As rainwater infiltrates through landfill waste, it becomes contaminated with dissolved and suspended matter originating from the decomposing waste. The composition of the resulting leachate varies according to the nature of the landfill material, which may include biodegradable/non-biodegradable, organic/inorganic and toxic/non-toxic waste.

Leachate that escapes from a landfill can contaminate groundwater, surface waters and soil, potentially polluting the environment and harming human health. In the EU, leachate is typically collected from landfills and sent to be treated in wastewater treatment plants (WWTPs) before being discharged to the environment as part of the WWTP effluent. Some countries, however, treat the leachate at the landfill. France, for example, treats 79% of leachate on site before discharging it to the environment. Landfills can continue to produce leachate for several hundred years after they have ceased to operate, making the sustainable management of leachate a long-term problem for landfill operators and regulators.

In the EU, four major pieces of legislation govern landfilling and leachate management: the [Landfill Directive](#) places strict operational and technical requirements on waste management and landfills to prevent or reduce harmful effects on the environment and human health during the whole lifecycle of the landfill; the [Waste Framework Directive](#)² requires Member States to prioritise prevention and reduction of waste, with the disposal of waste in landfills as the last resort; the [Water Framework Directive](#)³ and lastly, the [Urban Wastewater Treatment Directive](#)⁴ (UWWTD), which aims to protect the environment in the EU from the effects of insufficiently treated urban domestic wastewater, have established standards on the treated wastewater discharged from urban waste water treatment plants (UWWTPs) into receiving waters⁵.

Using Ireland as a case study, this paper investigated how EU legislation has affected landfill management in an EU Member State. The researchers collected leachate-management data from all 48 Irish landfill sites that send landfill leachate to WWTPs. Twenty-two of the sites were classified as 'young' (still operating or closed for less than five years), 10 as 'intermediate' (closed for more than five years but less than 10 years) and 16 as 'old' (closed for more than ten years). The researchers analysed the data to determine the amount of leachate collected for treatment, where the leachate was sent and the composition of the leachate.

They also collected data from the 33 receiving WWTPs to determine the amount and chemical make-up of leachate the plants received annually, as well as the composition of wastewater received from other sources, in order to assess how much of the total annual concentration of certain pollutants came from leachate. They looked at three indicators of pollution, which are typically used to monitor wastewaters: COD (chemical oxygen demand) and BOD (biochemical oxygen demand), both of which are laboratory tests used to indirectly measure the organic content of wastewater; and ammonium ion (NH₄-N) concentrations. There are strict NH₄-N emission limits from WWTPs because of its toxic effect on aquatic organisms.

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1. [Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste](#)

2. [Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives](#)

3. [Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy](#)

4. [Council Directive 91/271/EEC of 21 May 1991 concerning urban wastewater treatment](#)

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5. Leachate from landfills is not equivalent to 'domestic wastewater', the main target of the UWWTD. Leachate, if treated in a UWWTP, would fall in the category of industrial wastewater under this Directive, and would be regulated by Article 11: its treatment would be subject to regulation and/or prior authorisation by the MS' competent authorities, which should satisfy the requirements of [Annex IC of the Directive](#).

6. See above reference to the UWWTD, also applicable here

Between 2010 and 2015, 30% fewer WWTPs treated landfill leachate in Ireland. The researchers say increasingly stricter WWTP effluent limits could make the co-treatment of leachate with municipal wastewater unsustainable. They highlight the same potential problem for other EU countries, including Hungary, Latvia and Portugal, all of which landfill over 70% of their waste.

The researchers found that since 1995, EU legislation has had a significant impact on the number of landfills in Ireland and the way in which they are managed. Between 1995 and 1997, there were around 200 operational landfill sites. In 2009 there were only 30, reflecting both the reduced volume of waste that is being sent to landfills and the closure of smaller landfills, which are increasingly unable to meet expensive licencing costs.

The operating landfills that remained were typically larger. It is the change from a large number of smaller landfills to fewer, larger landfills, as well as better leachate management, (better control of leachate and diversion storm water using caps, covers and liners), driven by the Landfill Directive and Waste Framework Directive, that has resulted in smaller volumes of leachate being produced per unit of waste landfilled. However, the leachate was stronger, which will likely affect the way leachate is treated in the future, as more advanced technologies are needed for effective treatment. Although young landfills produced over half of all the leachate in 2013, they contributed 70% to the total annual concentration of leachate COD, and around 80% of the annual concentration of all leachate BOD and NH₄-N from all types of landfills.

While the contributions of leachate BOD and COD from all classifications of landfill site to total influent BOD and COD in WWTPs were each less than 4%, leachate NH₄-N accounted for up to 33% of total nitrogen influent in some WWTPs. Many WWTPs are not able to process such high nitrogen loads, and their effluents would exceed the regulatory emission limits for NH₄-N and total nitrogen.

In addition, the researchers found that in young landfills that have not been capped, seasonal rainfall increased the volume of leachate. Unless the leachate could be stored on site, the researchers say the WWTPs could potentially be overloaded during extreme rainfall events and become non-compliant with discharge limits set by the Urban Waste Water Treatment Directive⁶.

The researchers say their study has implications for leachate management in the EU. In 2012, 26 megatonnes (Mt – 10⁶ tonnes) of waste was landfilled in the EU. The waste could produce 49 to 246 Mt of leachate (assuming 0.2–1.0 m³ of leachate is produced for each cubic metre of waste landfilled), which will have to be managed for a long time under increasingly stricter water-discharge regulations for WWTPs. Increasing costs might also reduce the ability of landfill operators to finance treatment facilities. The researchers say that future research should concentrate on sustainable methods of treating high-strength leachate, and information sharing across the EU will help those making decisions on landfill policies.

