Specialists in wastewater percolation systems

January 2016

Publication of the EPA Research on Options for Low Permeability Subsoils in Ireland

I am delighted to announce that the EPA Research report on the assessment of wastewater disposal options in low permeability soils has just been released. This is very satisfying for us in Ash Environmental and we look forward to working with many of you as the use of these technologies becomes more widespread.

The research focussed on three technologies:

1. **Low Pressure Pipe (LPP) pressure distribution**
   - Similar to existing pipe pressure systems in the EPA Code of Practice 2009 (CoP) for sand filter beds and raised mounds except the LPP is a trench arrangement with indigenous soil between the pipes.
2. **Drip Distribution System**
   - High pressure drip irrigation system adapted for wastewater use
3. **Evapotranspiration systems (ET)**
   - Sealed bed zero discharge willow bed systems.

Both the Low Pressure Pipe(LPP) and the Drip Distribution system (referred to as DD in the report) being assessed in the EPA report were designed by this writer Joe Walsh of Ash Environmental and both pressure systems were supplied at each test site by Ash Environmental.

The reported results were excellent for both the LPP and Drip systems on both low permeability sites evaluated. The Drip was the star performer and has been recommended for use in the most impermeable soils with T-values up to 120 combined with a reduction of soil depth to 600 mm of unsaturated soil. The LPP is recommended for T-values up to T-90 and 900 mm unsaturated soil depths. The ET systems performed well but had some overflow issues due to weather conditions.

The full report link is http://www.epa.ie/pubs/reports/research/water/researchreport161.html#.VqDMc2SvlaQ
I have taken some quotes and sections from the report that are particularly relevant to the LPP and Drip technologies and included them in this summary document. I hope this may be of interest to you.

We specialise in pressurised wastewater soil infiltration systems for schools, housing and industrial projects. We work with engineers, architects, site assessors and contractors providing sub-contracting services on rural projects incl. design, supply, installation, project oversight and certification. We are master distributors for the Geoflow drip distribution system successfully tested in this study. Our contact details are below for any enquiry.

Joe Walsh

Report No. 161

epa Research
Climate - Water - Sustainability
Identifying pressures • Informing policy • Developing solutions

Assessment of disposal options for treated waste water from single houses in low permeability subsoils

Authors:
Laurence Gill et al

haol, Pobal agus Rialtas Áitiúil
ment, Community and Local Government

www.epa.ie

Link to the full report…http://www.epa.ie/pubs/reports/research/water/researchreport161.html#.VqDMc2SvlaQ

Executive Summary

The two sites located on low-permeability soil were upgraded by installing alternative pressure-dosed distribution [low-pressure pipe (LPP) and drip dispersal (DD)] systems. This resulted in a decrease in the faecal contamination of groundwater, as well as the prevention of surface ponding of effluent, at both sites.
Furthermore, the field results and calibrated models of the unsaturated zone show that the LPP system could be a solution for sites with T-values of less than 90, and the DD system could be a solution for sites with T-values of less than 120 after secondary treatment.

1. Introduction

It is estimated that the overall proportion of the country with inadequate conditions for DWWTSs, that can arise all year round or intermittently during wet weather conditions, is 39% (EPA, 2013). In particular, areas with (1) inadequate percolation because of low-permeability subsoils and/or (2) insufficient attenuation because of high water tables and shallow subsoils present the greatest challenge in Ireland for dealing with effluent from DWWTSs.
Alternatively, if (1) the permeability of the subsoil is excessive, (2) the effluent loading on the subsoil is too high or (3) there is an insufficient depth of unsaturated subsoil (e.g. a high water table or shallow bedrock), then the groundwater beneath a percolation area is at risk of pollution, in particular from microbiological pathogens and/or nutrients.
To address these problematic areas and allow development, while protecting water resources from the risk of pollution by existing septic tanks in these areas, the so-called legacy sites that are now starting to be assessed under the National Inspection Plan, alternative wastewater treatment and disposal options are needed. Hence, the aims of this project were to (1) assess the performance of and the risk of pollution from existing septic tank soakaway systems in a range of subsoil permeabilities and (2) identify alternative disposal options and investigate their suitability for areas of low-permeability subsoils.

2.2 Performance of pressurised effluent distribution systems

2.2.1 Site construction and instrumentation

Low-permeability Sites A and B in Kilkenny and Monaghan were upgraded with pressurised distribution systems and packaged secondary treatment plants. On each site, the effluent was split into two, with half being diverted to a low-pressure pipe (LPP) system and the other half to a drip dispersal (DD) system. The DD systems were designed to have a nominal loading rate of 3 l/m_2 per day and used 12.7-mm diameter tubing (Geoflow, Corte Madera, CA) with the drippers 600 mm apart. The pipes were installed by hand at a shallow depth, of approximately 150 mm, in the root zone (see Figure 2.15). The pumping into the DD system was on a timed basis at four doses per day under normal conditions. The LPP system had 9-m-long trenches that were 300 mm wide at a depth of 400 mm and were filled with washed pea gravel and designed to have a loading rate of 3 l/m_2 per day. Their spacing and layout is shown in Figure 2.17. In the LPP system, the effluent was pumped through 25-mm diameter pipes on a volumetric basis, at

LPP lateral spacing was 2.3m.

approximately 90 l per pumping event discharging through 5.0-mm diameter holes, spaced at 0.95-m intervals. Site A had an extended aeration activated sludge plant installed, but effluent from the septic tank was first dosed onto the DD and LPP systems, from August 2012, before changing over to the packaged plant on 1 October 2013. At Site B, a coconut husk media filter was added and the secondary treated effluent was divided equally and sent to the pressurised DD and LPP distribution systems from the time of start up (September 2012) (Figure 2.16). The percolation areas were instrumented with (1) tensiometers and soil moisture probes to establish the temporal soil moisture conditions; (2) suction lysimeters for soil moisture samples for chemical and microbiological analysis; (3) full weather stations to determine effective rainfall at each site; (4) shallow groundwater monitoring boreholes upstream and downstream of the percolation areas; and (5) flow measuring devices to measure the effluent loading (Figure 2.17). ***2.2.2 Soil moisture results*** The mean hydraulic loadings to the DD and LPP systems across the monitoring periods on both sites are given in Table 2.4. Mean effluent production on the sites equated to 129.0 l per capita (l/c) per day on Site A and 104.1 l/c per day on Site B, both of which are lower than the EPA Code of Practice design figure of 150 l/c per day (EPA, 2009), but in line with several other detailed on-site studies of effluent production in Ireland (Dubber and Gill, 2014). The soil moisture conditions beneath the different distribution systems at Site B over the monitoring period are shown in Figures 2.18 and 2.19, which reveal clear differences between the LPP and DD systems. Beneath the LPP trenches, there is a significant increase in soil moisture below the 400-mm-deep infiltration plane, whilst more uniform (and more unsaturated) soil moisture conditions were found beneath the DD systems, as corroborated by the modelling described later (in Section 2.2.4). The lower soil moisture levels beneath the DD systems were particularly evident in summer periods because of the higher ET losses from the shallow level into which the effluent is introduced. It should be noted that these same trends were also evident between the LPP and DD systems at Site A. No surface water ponding was evident on either site above either distribution system throughout the monitoring period; however, the soil moisture results did show that the subsoil did become saturated at times in winter, particularly after heavy rainfall events. At both sites, overloading trials were carried out whereby, for 6-week periods, all of the effluent was diverted to either the DD system or the LPP system in order to effectively double the hydraulic loading. Although a mild effect was picked up by the soil moisture monitoring, the subsoil conditions were similar to the results under normal loading conditions and were more related to the meteorological conditions at that time of year. ***2.2.3 Chemical and microbiological analysis*** The analysis of chloride, as a tracer, in the soil moisture lysimeter samples from both sites	(Holes were 4mm) i.e. double the loading rate showed no adverse problems

revealed that the effluent under all four systems was fairly evenly distributed, as would be expected with such pressurised systems. In general, the effluent quality below a 1-m depth of subsoil was very good beneath all systems. The N coming from both packaged treatment plants was almost totally nitrified when going into the soil and remained in nitrate form down through the subsoil with very little attenuation. In contrast, the soil moisture results at Site A when STE was being dosed did show nitrification and then some subsequent N removal (attributed to denitrification). This difference between the fate of secondary treated and STE in the subsoil concurred with previous results from gravity flow distribution systems on other sites in Ireland (Gill et al., 2009). Detection and quantification of the *nosZ* gene was carried out on soil sample extracts taken from underneath the distribution lines of the LPP and DD systems at Site B. This aimed to determine whether or not denitrifying bacteria, which could potentially reduce nitrate to N gas, were present. The abundance of the *nosZ* gene was then correlated with nitrate concentrations retrieved from the soil moisture lysimeter samples; an inverse correlation was observed for the DD system (Figure 2.20), but not for the LPP system. Both the LPP and DD systems in Site B had, on average, a similar level of *nosZ* abundance [$3.81 \times 10_6$ gene copies (GC)/g for the LPP system and $4.60 \times 10_6$ GC/g for the DD system] (Figures 2.21a and b) indicating a similar potential for denitrification in each, when conditions are appropriate. Nitrate concentration gradients (Figures 2.21c and d) (and the correlation analysis), however, suggest that the DD system provided more favourable environmental conditions for actual denitrification to occur, and thus reduced nitrate losses to groundwater more effectively than the LPP system. Hence, in areas of particular nutrient concern, the DD system would be a preferable treatment solution than the LPP distribution system. The lysimeter sample results from overloading trials, whereby all the effluent was diverted to either the LPP or the DD for a period in order to effectively double the effluent hydraulic loading, revealed very little difference from the percolating effluent quality down through the subsoils under more normal effluent loading conditions. It should be noted that, although the effluent quality at depth in the subsoil was very good when STE was being discharged, the DD system did need significant maintenance every 2 months to clear blocked filters, which was not the case once it had been switched to secondary treated effluent.	Good for us to know the systems were designed properly to distribute the effluent evenly. This highlights the ability of drip to aid denitrification in soils. The STE was unscreened i.e. no effluent filter. A filter would have helped but STE does require more maintenance.
2.2.4 Modelling The model simulations show that the subsoil conditions directly beneath the LPP trenches were much more saturated than below the drip irrigation pipes, as indicated from the field results particularly in summer conditions (Figure 2.23). However, as mentioned previously, there did not seem to be any significant difference with respect to treatment at depth. Once satisfactorily calibrated, the models were rerun with reduced hydraulic conductivity values to try to establish minimum soil permeability values at which the systems would still be able to take the hydraulic loading without ponding at the surface or excessive saturation occurring.	Due to hundreds of drip emitters releasing controlled drips of water in dose and rest cycles.

Nevertheless, from modelling both systems at both sites, it was concluded that DD systems could be used in subsoils with T-values of up to 120 using secondary treated effluent (but not STE) and designed to have an areal loading rate of 2.8 l/m2/d with the required depth of unsaturated subsoil being a minimum of 600 mm. For LPP systems, the conclusion is that STE (from septic tanks with effluent filters) can be used with subsoils with T-values of less than 75 and then secondary treated effluent can be used for soils with T-values of less than 90, based on a trench loading rate of 18 l/m2/d but requiring 900 mm of unsaturated subsoil. For both designs, an average effluent production of 120 l/c per day should be used and, to ensure this hydraulic loading, the house should be fitted with water-saving devices such as dual flush toilets (which are now a mandatory part of Building Regulations), as discussed in detail in Dubber and Gill (2013).	Drip is recommended up to T-120 with 600 mm unsaturated soil. LPP up to T-90 with 900mm unsaturated soil. 120L/c design flow?
3 Strategic assessments ***3.1 Advanced treatment with consented surface water discharge*** For sites experiencing significant problems with low-permeability subsoils, the consented discharge of biologically treated on-site wastewater to suitable water courses needs to be reconsidered. In particular, in areas of relatively dense settlement which may have been identified by the National Inspection Plan as having significant issues for many on-site systems, it could be economically feasible to connect single houses via a small bore sewer system and treat the wastewater at a decentralised plant before discharge to a nearby watercourse. This would have the advantage [particularly from a local authority's (LA's) perspective] of having only a single consent, covering several houses, to manage. However, it should be noted that the financing, management and other socio-economic logistics of setting up such a decentralised clustered system will need considerable motivation and careful planning between many different actors in the field if such systems are to be successful in the future.	Ash Environmental can assist with this concept with direct experience of similar US installations.
In higher permeability soils, the effluent from soakaway systems is more likely to percolate downwards and cause a risk of localised groundwater pollution if the water table is shallow.	Drip can be used as a polishing technology to maximise soil treatment in shallow soils and high permeability soils.

Joe Walsh
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