Development of sustainable rural housing in the Scottish Highlands and Islands

There has been much publicity recently about the shortage of affordable housing in the UK. This problem is keenly felt within rural communities in the Scottish Highlands. **Mike Bassett MCIAT**, lecturer in Architectural Technology at University of the Highlands and Islands, Inverness Campus explores.

Much of the cost incurred in developing sites for new homes is attributable to the infrastructure required to provide basic services, such as water, drainage, electricity and broadband internet.

The building services infrastructure in the Highlands is generally unsuited to expansion of rural residential development as it has restricted capacity and must connect geographically dispersed communities. However, the fundamental service requirements for modern housing can be achieved without connection to national networks, and new technology is making this more achievable and cost effective.

The Inverness College, University of the Highlands and Islands has initiated a research project to investigate how rural housing development in the region could utilise new technologies to enhance the provision of sustainable housing in remote communities.

Local architectural practice, Square Peg Architecture are developing a site at Cawdor near Inverness to build a single rural dwelling which will encompass 'off-grid' systems such as private fresh water supply and wastewater drainage, electricity microgeneration with battery storage, and satellite communications for telephone and broadband which will provide data for the research project.

As one strand of the project, an innovative system to provide sustainable and reliable private wastewater treatment is being trialled at this development in collaboration with Ash Environmental Technologies of County Wicklow, Ireland, which undertook research[1] in 2015 with the Environmental Protection Agency, Trinity College Dublin and the National University of Ireland to investigate foul wastewater drainage systems in low permeability soils. This research compared the effectiveness of three different systems at sites where existing installation of traditional drainage systems had led to localised concentrations of groundwater pollution. It concluded that the 'Drip Distribution' system was a suitable drainage method where poor subsoil permeability prevented the treated effluent from infiltrating downwards into the groundwater.

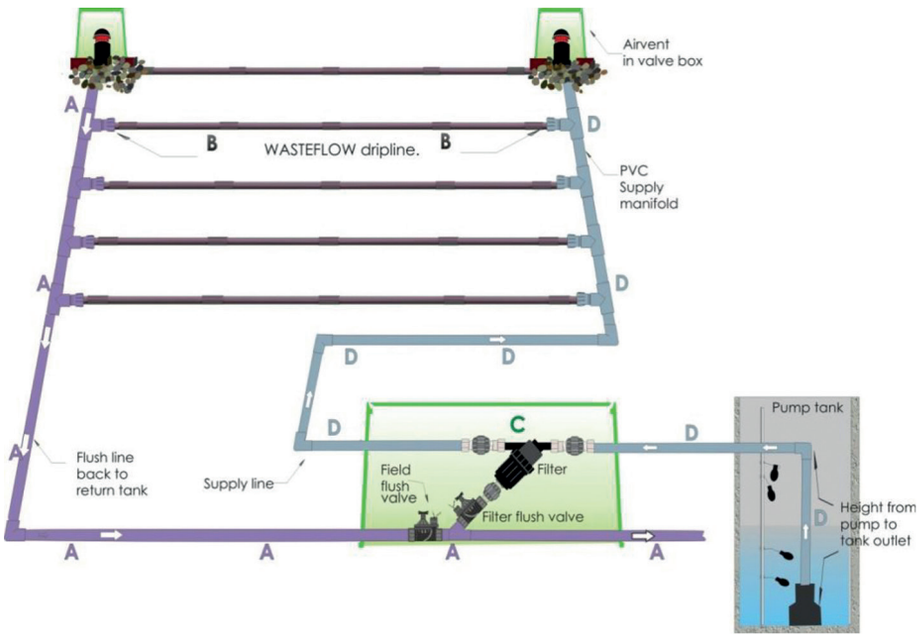
The Drip Distribution system utilises the biologically active root zone in the topsoil to provide tertiary treatment of effluent. Dispersal of the outflow from a standard package treatment plant and pumping chamber is achieved through small bore flexible tubing with drip emitters at 600mm intervals. These emitters operate at a given pressure to release small but regular doses of the treated effluent into the soil. Typically for a three bedroomed dwelling, a 300m^2 drainage field is required to achieve satisfactory dispersal and infiltration. The drip tubing is installed in the ground using a mole plough which causes minimal disturbance of the topsoil, and a manifold system ensures that the doses of effluent are distributed throughout the complete network at consistent pressure.

This system enables sites with high water tables, impermeable soils, shallow bedrock or existing trees and buildings to be used successfully for dispersal of wastewater with minimal disruption and damage to the ground. It is also applicable where there is limited access for construction vehicles as the plant required is minimal, and no aggregate needs to be imported.

From site surveys and percolation tests conducted at the Cawdor site, JIG Environmental Engineers Ltd, Glasgow, proposed a 'Drip Distribution' drainage solution. Scottish Building Warrant approval was gained by Square Peg Architecture in September 2016 for the use of Drip Distribution drainage to disperse treated foul wastewater effluent as subsoil permeability at the site precluded the use of traditional soakaway systems.

Drip Distribution drainage has been used extensively in the United States for many years and has been adopted in the Republic of Ireland, but this is the first application of the technology in the UK. Regulatory approval was therefore achieved through consultation with Local Authority Building Standards Scotland (LABSS) which provides national guidance in Scotland

[1] EPA Research Report, 2010 https://www.epa.ie/pubs/reports/research/water/161_webversion.pdf



Schematic of Drip Distribution system (courtesy of Geoflow Inc. and Ash Environmental Technologies).

on matters where Building Regulations compliance cannot be decided at a local level. This guidance[2] will now enable Drip Distribution to be considered as an alternative to other drainage systems by designers, engineers and verifiers for suitable projects throughout Scotland.

Installation of the system at the Cawdor site was completed in March 2017. Ash Environmental Technologies were employed to oversee installation and commissioning of the system which was undertaken by M&J Designworks and Square Peg Architecture.

The research project at Inverness College will analyse the cost, timescale and regulatory compliance required to design, approve and install the system, and will monitor the effectiveness and reliability of the system at the Cawdor site over long term usage. It is also proposed that the following aspects will be investigated:

- Further collaboration with Building Standards Scotland and other stakeholders to identify pathways which can achieve third party accreditation of Drip Distribution drainage systems.
- Analysis of alternative percolation test methods which would provide more accurate test results where soil permeability is significantly affected by stratification.
- The potential application of Drip Distribution systems to provide drainage for decentralised rural 'cluster' developments in Scotland.
- Application of Drip Distribution drainage to remediate sites in Scotland where traditional drainage systems have been unsuccessfully installed.
- Further monitoring of installed Drip Distribution systems to identify levels of faecal contamination in groundwater.

1. PVC Supply Manifold (refs A and D).
2. 'Wasteflow' dripline (ref B) being installed by mole plough.
3. Mole plough ready to install drip tubing downstream from filter (ref C).
4. Parallel drip lines installed at 600mm centres across the infiltration field.

[2] LABSS Information Sheet, September 2016 https://www.labss.org/sites/default/files/content/LABSS%20INFORMATION%20PAPER%20INFOP14%20Infiltration%20Systems%20for%20Wastewater%20Treatment%20-%20Version%203%20-%20090916_2.pdf