Clay Soil

Green Infrastructure: Opportunities for Pittsburgh Fact Sheet Series

The roofs, roads, and parking lots in our urban areas prevent rainfall from soaking into the ground, overwhelming sewers and leading to flooding and polluted rivers. Green infrastructure helps solve flooding and prevent water pollution by using soil, vegetation, and natural processes to restore natural drainage patterns in our communities. Green infrastructure can also clean our air, revitalize our neighborhoods, create jobs, save our communities money, and provide many other lasting community benefits.

The Challenge

The Pittsburgh region's clay soil is sometimes perceived as a challenge to green infrastructure practices. Clay soil is often thought to allow little to no infiltration of water to the groundwater table.

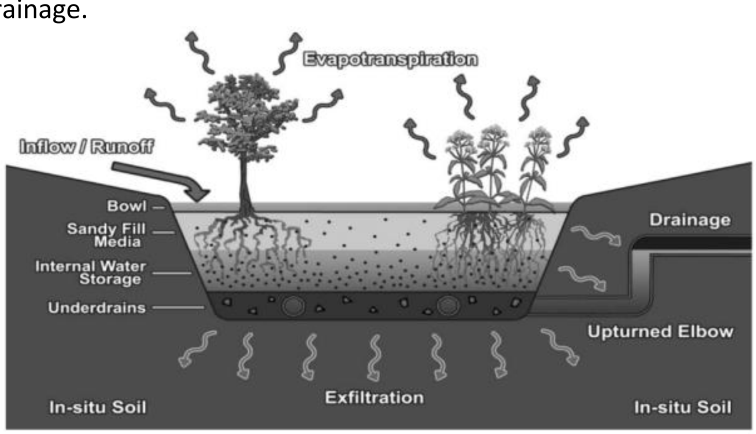
In actuality, undisturbed clay soil can infiltrate water quite well. The real challenge is when soil has been disturbed and compacted by construction. Compacted soil often results in very little infiltration and ponding is often observed.

While the design of green infrastructure practices for sites with clay soils may require greater care, the right green infrastructure practices can work well in Pittsburgh's clay soil.

Opportunities

Green Infrastructure practices such as rain gardens, permeable pavement, and bioretention are all practices that are successful in clay soils.

- Rain Gardens capture stormwater draining from roofs. Even in clay soils, infiltration can be expected if the soil is protected from compaction or restored through deep plowing.
- Permeable pavement is used for sidewalks, parking lots, and roads. It allows water to drain through it to a stone storage layer. Underdrains can be laid in the storage layer to help the practice drain in clay soils.
- Bioretention is similar to a rain garden but is typically more engineered. In clay soil, an underdrain is generally installed to ensure drainage.



This diagram shows a bioretention system. Underdrains drain the system in clay soils.
Source: Brown, R., Hunt, W. and Kennedy, S. 2009. Urban Waterways: Designing Bioretention with an Internal Water Storage Layer. NC Coop. Ext.

Green Infrastructure Practices that Work with Clay Soils

This rain garden collects roof water through a downspout.
Source: SvR Design Company Green Factor Workshop

Stormwater drains through this permeable paver drive to a stone storage layer.
Source: SvR Design Company Green Factor Workshop

This roadside bioretention collects and treats roadway stormwater.
Source: SvR Design Company Green Factor Workshop

Case Studies

Rain Gardens, built 2004, Madison, WI

In 2003, the US Geological Survey installed four rain gardens next to municipal buildings in Madison, Wisconsin to test the effect of soil type and plant type on the rain garden's ability to absorb stormwater. Two rain gardens were installed in sandy soils and two rain gardens were installed in clay soils. For each soil type, one rain garden was planted with turf, and the other with native prairie grasses. The rain gardens were 100 to 400 square feet in area and 0.5 feet in depth, and were not equipped with underdrains. The USGS monitored the rain gardens for 4 years, observing inflows, outflows, rainfall amounts, and evapotranspiration amounts.

Roof stormwater drain to these monitored rain gardens in Madison, Wisconsin.
Source: Selbig and Balster, 2010.

Results

- The rain gardens were able to infiltrate nearly 100% of the stormwater they received over four years of operation in both clay soil and sandy soil!
- The rain garden planted with the prairie species infiltrated stormwater better than the rain garden planted with turf grass.
- Roots in the rain garden planted with native prairie grass species extended 4.7 feet deep compared with 0.46 feet in the rain garden planted with turf grass.

Source: Selbig, W.R., and Balster, Nicholas. 2010. Evaluation of turf-grass and prairie-vegetated rain gardens in a clay and sand soil, Madison, Wisconsin, water years 2004–08: U.S. Geological Survey Scientific Investigations

Roadside Bioretention, built 2009, Toledo, OH

Nearly 800 feet of residential roadside bioretention and permeable sidewalk were constructed in Toledo, Ohio to help reduce the occurrence of sewer overflows during heavy rainfall events. The project was constructed in clay soils and included underdrains to help drain the system if needed. Underground water storage was provided beneath the permeable sidewalk. Flow monitors were installed before and after construction to assess the effectiveness of the system at absorbing stormwater.

Roadway and sidewalk stormwater drain to this roadside bioretention system on Maywood Avenue in Toledo, Ohio.
Source: Tetra Tech, 2009.

Results

- Long-term modeling shows an annual average stormwater volume reduction of about 64 percent.
- Peak flow rates are reduced by 60 percent to 70 percent. The peak flow rate of a storm is the maximum measured volume of water that moves past a point in a given amount of time.
- Reducing peak flow can help to reduce flooding.

Source: Tetra Tech. 2009. City of Toledo, OH, Maywood Avenue Storm Water Volume Reduction Project Construction Plan Set.

Studies have shown that green infrastructure can be very effective when installed on clay soils.