METER
ENVIRONMENT

NEW INFILTROMETER HELPS CITY OF PITTSBURGH LIMIT TRADITIONAL STORMWATER INFRASTRUCTURE

Though difficult and expensive to restore, the brick-paved streets that still exist in some Pennsylvania neighborhoods are worth preserving, according to the City of Pittsburgh. Dellrose Street, an aging, 900 ft. long, brick road, was in need of repair, but the city of Pittsburgh wanted to limit traditional stormwater infrastructure, such as pipes and catch basins.

To save the aesthetics of the neighborhood, they hired ms consultants, inc. to design a permeable paver solution for controlling stormwater runoff volumes and peak runoff rates that would traditionally be routed off-site via storm sewers. Jason Borne, a stormwater engineer for ms consultants who worked on the project says, “What we try to do is understand the in situ infiltration potential of the subsoils to determine the most efficient natural processes for attenuating flows; either through infiltrating excess water volume back into the soil or through slow-release off-site.” He used the SATURO Infiltrometer to get an idea of how urban fill material would infiltrate water.

GREEN INFRASTRUCTURE AIDS NATURAL INFILTRATION

As Borne and his team investigated what they could do to slow down the runoff, they decided permeable pavers would be a viable solution. He says, “There’s not much you can do once you put in a hardened surface like a pavement. Traditional pavement surfaces accelerate the runoff which requires catch basins and large diameter pipes to carry the runoff off-site. We were interested in investigating what some of the urban subsoils or urban fill would allow us to do from an infiltration perspective. As we started looking at some of these subsoils, we decided a permeable paver system would be ideal for this particular street.”

INFILTROMETERS DETERMINE NATURAL INFILTRATION POTENTIAL

Once the water flowed into the aggregate, the team began to figure out ways to slow it down and promote infiltration. Borne says, “Basically we came up with a tiered subsurface flow barrier system. We had about 60 concrete flow barriers across the subgrade within the aggregate base of the road. We needed so many because the longitudinal slope of the road was fairly significant. Behind each of these barriers we stored a portion of the stormwater that would typically run off the site. The ideal was to remove the stored water through infiltration—to get it down to the subgrade and away, so we used infiltrometers to help us establish where we could maximize infiltration and where we might need to rely on other management methods.”

A NEED FOR FASTER TEST TIMES

Borne says that USDA soil surveys are too generalized for green infrastructure applications in urban areas and only give crude approximations of the soil hydraulic conductivity. Understanding the best way to promote natural infiltration requires a very specific infiltration rate or hydraulic conductivity for the location of interest. He says, “The goal is to excavate down to the desired elevation before construction and find out, through some kind of device what the infiltration potential of the subsoil is. Typically we use a double ring infiltrometer, but it’s a very manual device. We’re constantly refilling water, and it requires us to be on-site and attentive to what’s happening. We can’t really multitask, especially in areas of decently infiltrating soils where the device might run out of water in 30 minutes or less. So, in the interest of saving water and time, we used the automated SATURO infiltrometer and the manual double ring infiltrometer concurrently for comparison purposes.”

SATURO infiltrometer

SHORTENED TEST TIMES ALLOW DESIGN CHANGES ON THE FLY

Though most of the subsoil was a clay urban fill, there was a distinct transition between that clay material to a broken shale/clay mixture. Borne says, “After excavation, it rained, and we saw that the water was disappearing through the broken shale/clay material. When we did the infiltration tests, the broken shale/clay showed a higher infiltration potential than the clay fill material. That led us to modify the design of the subsurface flow barriers based on specific observed infiltration rates of the subsoils. Where the tests showed higher hydraulic conductivity values, we were able to rely on infiltration entirely to remove the water from behind the check dams.” Borne adds that in the areas where infiltration was poor, they augmented infiltration with a slow release concept. “We put some weep holes in the flow barrier and let the water trickle out down to the next barrier and so on. Basically, the automated SATURO infiltrometer allowed us to do many tests in a short amount of time to establish a threshold of where good infiltrating soils and poor infiltrating soils were located. This enabled us to change the design on the fly. The double ring infiltrometer takes significantly more time to do a test, and time is of the essence when the contractor wants to backfill the area and get things moving. It was nice to have a tool that got us the information we needed more rapidly.”

HOW DID THE DOUBLE RING AND SATURO COMPARE?

Borne says the SATURO Infiltrometer was faster and reduced the possibility of human error. He adds, “We liked the idea of it being very standardized. The automated plot of flux over time was also of great interest to us, because we could see a trend, or anomalies that might invalidate the results we were getting. The double ring infiltrometer takes a long time to achieve a state of equilibrium, and it’s hard to know when that occurs. You’re following the Pennsylvania Department of Environmental Protection suggested guidelines, but they’re very generalized. To me it doesn’t suit all situations. What we found with the SATURO infiltrometer is it records information at very discreet intervals, plots a curve of the flux over time, and when it levels out, you basically achieve equilibrium. You get to that state of equilibrium faster. There’s a water savings, but there’s also a time savings. And there’s the satisfaction of getting standardized results rather than the possibility of each technician applying the principles in a slightly different way, as they might with the double ring infiltrometer.”

Borne and his team were ultimately able to prepare a permeable paver street design which allowed for the exclusion of traditional storm sewer infrastructure, reducing both capital costs and long-term maintenance life cycle costs. The permeable paver concept is intended to provide a template for the city of Pittsburgh to apply to the future reconstruction of other city streets.

Discover the SATURO