LANDSCAPE ARCHITECTURE FOUNDATION

Charles City Permeable Streetscape Phase 1

Landscape Peformance Benefits

- Reduced stormwater peak flows by at least 75% for 10-year storm events and 40% for 100-year storm events.
- Reduced the runoff volume by over 60% up to the 10-year 24-hour storm event, and over 30% for the 100-year 24-hour storm event. This eliminated the need to replace downstream storm sewers, thereby reducing infrastructure costs and neighborhood disruption.
- Expected to improve water quality by reducing the need for winter salt application by up to 75% because snowmelt and stormwater can infiltrate. This should also lead to savings in the city's winter operations budget.
- Saved $57,000 by preserving 192 street trees instead of removing them and installing new trees.
- Secured $731,000 in additional funding to implement this major street reconstruction project -- funding that would not be available for conventional street reconstruction.

Designer
Conservation Design Forum

Land Use
Residential
Retrofit

Project Type
Streetscape
Transportation

Location
Hulin Street and N. Joslin Street
Charles City, Iowa 50616

Size
5 acres (16 blocks of street ROW)

Budget
$3.7 million

Completion Date
2009

Overview

The Charles City, Iowa, Green Street project addressed serious issues with street deterioration and nuisance street and adjacent yard flooding for a 16-block residential area. The project combines durable permeable paving materials with sustainable stormwater Best Management Practices, while maintaining the historical character of the neighborhood. By integrating stormwater management, the City was able to leverage additional funding that would not be available for conventional street reconstruction. Because of the success and the lessons learned in design and maintenance, the project has spurred additional phases in adjacent neighborhoodsand serves as an important blueprint for others considering similar sustainable stormwater systems.

Sustainable Features

- The permeable roadway surface consists of interlocking precast concrete unit pavers on a gravel bed. Water infiltrates between the pavers at a rate of 2 inches per hour, to the gravel storage below.
- A 24-inch deep layer of gravel with 36% porosity provides water storage below the pavement. In the center of the roadway, the gravel deepens to approximately 42 inches with a 6-inch perforated pipe running through it at a depth of 24 inches. Directly beneath the gravel is a layer of geotextile filter fabric, a layer of silty-sand subgrade soil, and then a 36-inch layer of sugar sand subgrade soil. During large storm events, as the water level rises in the gravel storage, it enters the pipe through the perforations and is conveyed to the existing storm sewer system.
- Cobble infiltration areas are used at the corners of all intersections. Excess water from the permeable street runs down the gutter and is channeled into the cobble infiltration area through a curb cut. The water infiltrates through the layer of cobble then an 8-inch layer of gravel before entering the gravel storage below the permeable pavement system. The cobble infiltration areas have a design infiltration capacity of 100 inches per hour. If water accumulates in the cobble infiltration areas, it will enter an elevated storm inlet and be conveyed to the existing storm sewer system.

- Amended soil infiltration areas were added in the space between the curb and sidewalk along all of the streets to capture and infiltrate runoff from adjacent yards and sidewalks. Lined with turf and sloped to 4 inches below the top of the curb, the infiltration areas detain water and allow it to infiltrate into the amended soil, a mix of topsoil, sand, and compost. The gravel storage below the permeable pavement of the roadway extends beneath the amended soil infiltration areas. Excess water flows over the curb to the gutters, where it is conveyed to the cobble infiltration areas.
- Alley trench grates were installed across alley aprons on Spriggs Street and Hulin Street to infiltrate runoff and prevent sediment from backyards and the unpaved alleys from clogging the permeable pavement of the roadway. Water flows from the alley into the metal trench grate, through a 4-inch deep gravel filter layer, and then into the gravel storage layer, which extends from under the street.
- The roadway was narrowed from 44 to 31 feet. This design reduced the pavement surface, increased vegetated area, and increased the volume of soil available for trees.

Challenge

Landscape maintenance was a major concern for the design team as the long-term maintenance budget would be limited. Ideally, a wider range of vegetated stormwater management features such as roadside bioretention swales, intersection curb extensions, and rain gardens would be used. However, substantial maintenance would then be needed to weed, supplement plantings, and remove leaves and other debris to prevent clogging. The permeable unit pavers would also require diligent maintenance to remain functional for their design life.

Solution

Rather than typical rain garden plantings of perennial grasses and forbs, amended soil infiltration areas were planted with turf so that they can be mowed by residents, just as they were prior to the street reconstruction. For the intersections, cobblestone infiltration areas were selected instead of rain gardens due to the lower maintenance requirements. A strict maintenance regime was developed to maintain the permeability of the pavement, with guidelines that include no use of sand and minimal use of salt for winter maintenance.

Cost Comparison

- The project uses permeable interlocking concrete unit pavers as a high-performance, cost-effective pavement, which saves approximately $395,000 in construction and permitting costs when compared to cast-in-place porous concrete for the 5,670 linear feet of streets that were replaced.
- By preserving 192 of the existing street trees, the City saved $57,000 over the cost of removing them and installing new trees.

Lessons Learned

- The cobble infiltration areas used in this first phase collected debris, which reduced the effectiveness of the system. Because they were deemed to require too much maintenance, these infiltration areas were discontinued in the second phase and an alternative system was utilized with curb intakes at the back of the curb. Instead of having a direct connection between the storm sewer system and the intake, storm water runoff enters the intake structure and is directed into the rock sub base where it infiltrates into the soil. During large rain events when runoff exceeds the infiltration rate, there is an overflow connection to the storm sewer system. Weep holes in the bottom of each intake structure allow water to empty out of the structure and into the soil to eliminate standing water at the bottom of the intake.

Project Team

Landscape Architect/Civil Engineer: Conservation Design Forum
Installation Contractor: Wick's Construction

Role of the Landscape Architect

The landscape architect/civil engineer worked with Charles City to develop a comprehensive plan that addressed the crumbling streets and flooding problems. They prepared models and evaluated the exisiting and proposed roadway designs to determine the expected performance of the permeable streetscape.

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August 2012

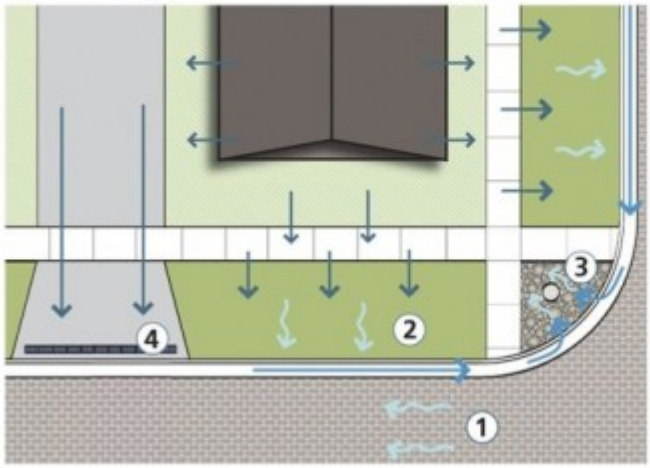
References & Resources

Conservation Design Forum: Charles City Permeable Streetscape
Charles City Green Streets Green Infrastructure Guide
ASLA Green Infrastructure & Stormwater Management Case Study
Iowa Environmental Focus: Charles City- Paving a more sustainable Iowa (2011)
Governor's Environmental Excellence Award for Water Quality, 2011

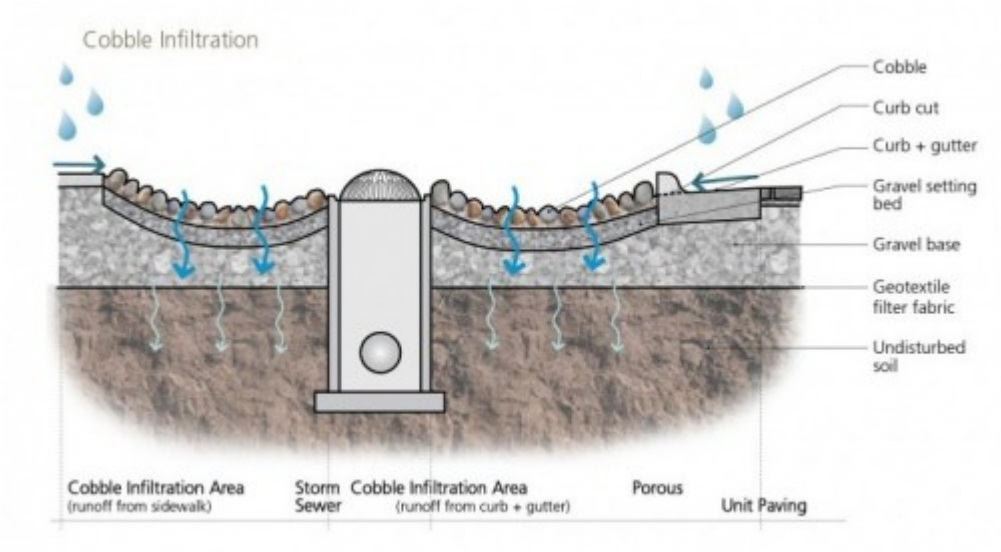
Additional Images

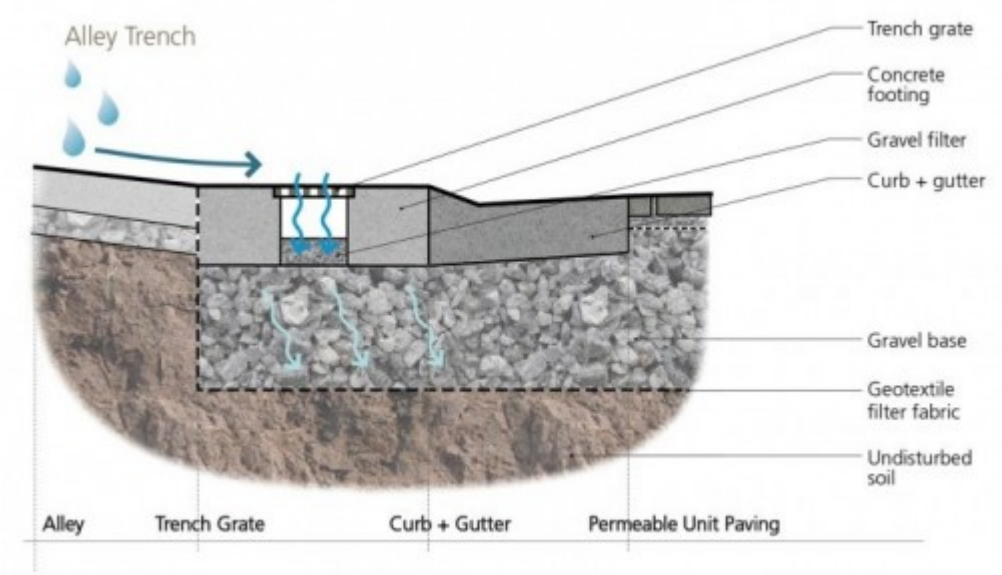
Charles City Green Streets *Rainwater Treatment System Overview*

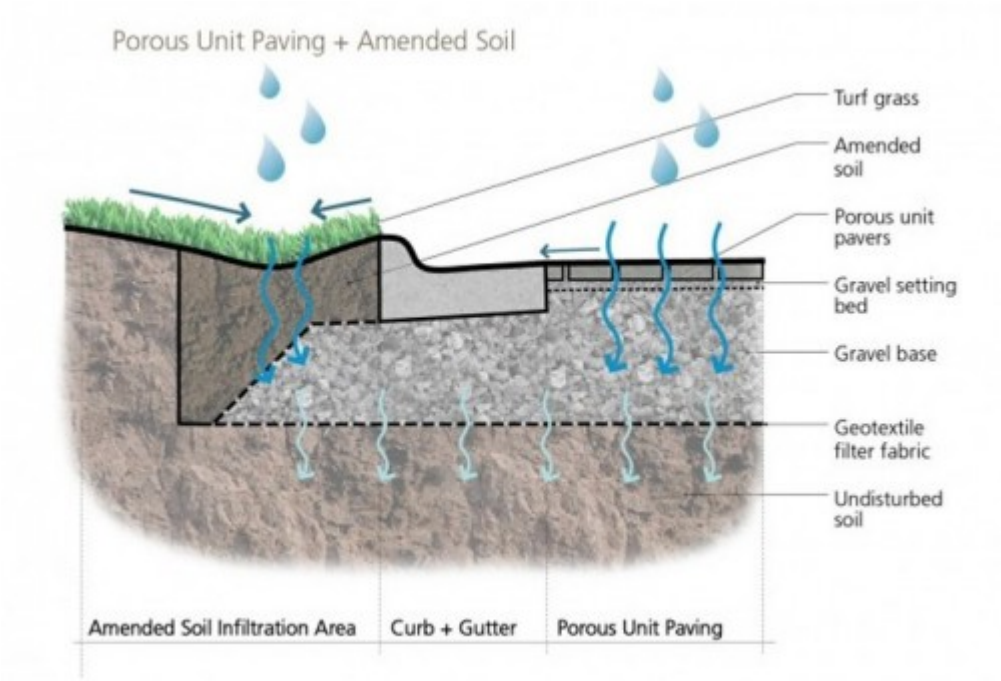
a. Rainwater Diagram



1. Porous Unit Paving
2. Amended Soil Infiltration Areas
3. Cobble Infiltration Areas
4. Alley Trench Grate


Cobble Infiltration
Cobble
Curb cut
Curb + gutter
Gravel setting bed
Gravel base
Geotextile filter fabric
Undisturbed soil
Cobble Infiltration Area
(runoff from sidewalk)
Storm Sewer
Cobble Infiltration Area
(runoff from curb + gutter)
Porous
Unit Paving


Alley Trench
Trench grate
Concrete footing
Gravel filter
Curb + gutter
Gravel base
Geotextile filter fabric
Undisturbed soil
Alley
Trench Grate
Curb + Gutter
Permeable Unit Paving


Porous Unit Paving + Amended Soil
Turf grass
Amended soil
Porous unit pavers
Gravel setting bed
Gravel base
Geotextile filter fabric
Undisturbed soil
Amended Soil Infiltration Area
Curb + Gutter
Porous Unit Paving