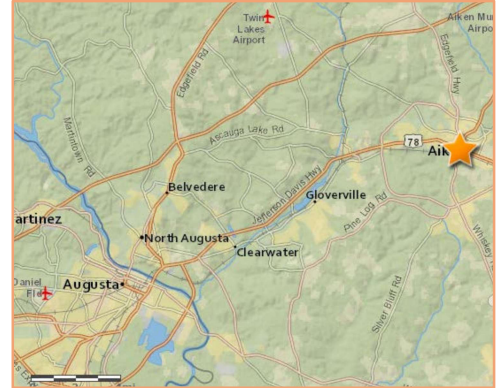


VI. SAND RIVER HEADWATERS GREEN INFRASTRUCTURE PROJECT

AIKEN, SOUTH CAROLINA

A downtown project incorporating green infrastructure into public spaces enhances a small town's historic charm while helping to preserve a beloved urban forest and restore a degraded river.



Project type: Transportation; historic preservation

Green infrastructure practices: Rain gardens, bioswales, porous asphalt, pervious concrete, permeable interlocking concrete pavers, and underground cisterns

Completion date: 2011

Over decades, stormwater eroded a 70-foot-deep canyon below the Aiken, South Carolina, stormwater outfall (Exhibit 23). The banks of the Sand River destabilized, destroying vegetation and choking downstream wetlands with sediment as they collapsed. The city chose a restoration plan for the Sand River that focuses on upstream reduction of stormwater runoff through green infrastructure in downtown Aiken, including bioswales, porous asphalt, permeable pavers, and rain gardens. The city chose this approach as the most cost-effective way to remedy environmental degradation that could also improve the city's historic parkways and boulevards with wide, landscaped medians.



Exhibit 23. Stormwater has eroded a deep canyon in the banks of the Sand River.

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A. SITE CONTEXT

Aiken is in western South Carolina near the Georgia border. The city of approximately 30,000 people has one of the largest urban forests in the country, a 2,100-acre public green space next to



Exhibit 24. Aiken's downtown is next to Hitchcock Woods, which receives stormwater runoff from city streets.

downtown called Hitchcock Woods (Exhibit 24). Through the forest flows the Sand River, an ephemeral stream that runs dry between periods of rain.

Downtown Aiken has 105 acres of 150-foot-wide parkways and boulevards with landscaped medians, giving the city a distinctive charm and character. Stormwater runoff from the streets originally flowed through open channels and a relatively natural drainage system. That changed in the 1950s, when the city paved the streets and installed a conventional storm sewer system that conveys stormwater to an outfall at the headwaters of the Sand River.⁷² As impervious cover has increased with new development, stormwater runoff has eroded a 70-foot-deep canyon in the Sand River, sending loose sand downstream where it degrades forested wetlands.⁷³ The Sand River has been listed as an impaired waterbody since 1998 for exceeding standards for fecal coliform bacteria, with stormwater runoff listed as a potential major source of contamination.⁷⁴

B. PLANNING AND REGULATORY CONTEXT

In 2008, the city awarded the Clemson University Center for Watershed Excellence (Clemson) a grant to develop a river restoration master plan. Clemson convened a series of workshops and meetings with the city, community members, and other stakeholders to explore alternatives. The preferred approach for river restoration would cost approximately \$16 million to \$18 million, including remediation of the canyon and wetlands, new pipes to convey flow below the

restored canyon, energy dissipation and storage devices, and tributary stabilization. The parties ultimately chose a strategy focused initially on reducing runoff in the watershed through green infrastructure to fix the root cause of the problem. The city hopes this approach will improve the flow conditions at the outfall and potentially reduce the overall cost of the downstream river restoration project.⁷⁵

⁷² Eidson, G.W., et al. "Sand River Headwaters Green Infrastructure Project, City of Aiken, South Carolina: A Collaborative Team Approach to Implementing Green Infrastructure Practices." Proceedings of the 2010 South Carolina Water Resources Conference. Oct. 13-14, 2010.

⁷³ Clemson University. *Sand River Headwaters Green Infrastructure Project*. 2013. http://media.clemson.edu/public/restoration/sand%20river/agi_finalreport_022113-web.pdf.

⁷⁴ South Carolina Department of Health and Environmental Control. *Total Maximum Daily Load Horse Creek (Hydrologic Unit Code: 03060106060, -030, -040 & -050) Stations SV-069, SV-072, SV-073 & SV-250 Fecal Coliform Bacteria*. 2005. https://www.scdhec.gov/HomeAndEnvironment/Docs/tmdl_horse.pdf.

⁷⁵ Clemson University 2013 *op. cit.*

C. DESIGN AND PERFORMANCE

The Sand River Headwaters Green Infrastructure Project includes multiple green infrastructure practices installed near the intersection of Park Avenue and Newberry Street in downtown Aiken.

City staff and residents were concerned that this project would affect the general appearance of the historic parkways and disturb existing mature trees. To address this concern, designers chose bioswales and rain gardens that complement the existing parkway landscaping, using native plants to blend in with the surroundings (Exhibit 25). Water from adjacent roads and sidewalks flows to the bioswales and rain gardens, which filter out nutrients and bacteria, reduce peak discharge flows, and recharge ground water. Street improvements include porous asphalt; pervious concrete; and permeable, interlocking pavers in the parking lanes, which infiltrate runoff from the adjacent road as well. Overflow systems direct excess runoff to the existing storm sewer system for large storm events. Underground cisterns at several locations store runoff for irrigation.⁷⁶

In 2008, the city did not have regulations specifying minimum design requirements for green infrastructure practices. Therefore, the practices are sized to meet the minimum standard design criteria issued by the South Carolina Department of Health and Environmental Control in 2002, which include:

- Infiltration practices must capture and treat the first inch of runoff from the contributing impervious surfaces.
- Post-development peak flows from best management practices must not exceed pre-development discharge rates for the 2- and 10-year, 24-hour storm events.⁷⁷



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Exhibit 25. Rain gardens in street medians help manage stormwater while providing attractive landscaping.

In addition to meeting these requirements, the green infrastructure practices infiltrate at least the 2-year, 24-hour storm event (approximately 3.7 inches) within 72 hours.⁷⁸

The first phase of construction was completed in February 2011. Monitoring equipment measures the performance of the green infrastructure practices as part of the online Clemson University Intelligent River Program, which displays real-time data. The program is an educational tool that the community, educators, and designers can view online.⁷⁹ The data include baseline measurements of stormwater hydraulics before installation of the green infrastructure practices to evaluate their impact.

Preliminary monitoring results indicate that in many cases, the bioinfiltration practices are infiltrating all stormwater runoff and discharging none into the sewer system through the overflow pipes. However, the Sand River watershed overall showed no statistically significant improvement, likely because the surface area of the bioretention practices represented just 0.4 percent of the total watershed. All three types of permeable pavement worked as expected, with average infiltration rates adequate for stormwater management.⁸⁰

⁷⁶ Ibid.

⁷⁷ South Carolina Department of Health and Environmental Control. *Standards for Stormwater Management and Sediment Reduction Regulation 72-300 thru 72-316*. 2002. <https://www.scdhec.gov/Agency/docs/water-regs/r72-300.pdf>.

⁷⁸ Clemson University 2013 *op. cit.*

⁷⁹ Clemson University. "Intelligent River Data Browser for Sand River, Aiken." <https://www.intelligentriver.org/data?p=7>. Accessed May 14, 2015.

⁸⁰ Clemson University 2013 *op. cit.*

D. COSTS AND FUNDING

The city of Aiken was awarded \$3.34 million under the American Recovery and Reinvestment Act of 2009 through the Clean Water State Revolving Fund for design, construction, and post-construction monitoring of green infrastructure practices to control stormwater runoff into the Sand River, the first phase of the Sand River restoration master plan.⁸¹ The city awarded two related grants to Clemson:

\$293,187 for the design of the green infrastructure practices and \$126,359 for a research and monitoring program.⁸²

The city is responsible for the operation and maintenance of the green infrastructure practices installed as part of this project. The city pays for those costs through a stormwater utility fee assessed to city property owners.⁸³

E. BENEFITS

The green infrastructure practices installed as part of the master plan for restoring Sand River complement the landscaping of the city's historic parkways and boulevards. The city plans to use similar approaches to improve stormwater management in other parkways in and around the city to revitalize neighborhoods and further lessen the amount of stormwater the city discharges to the Sand River headwaters.

The monitoring program established as part of this project helps educate residents and leaders in the city of Aiken and other communities, educators, designers, and the scientific community, providing valuable information on the design effectiveness of green infrastructure practices. In the first three years, more than 5,000 people viewed the website.⁸⁴

F. LESSONS LEARNED

- Green infrastructure can complement and enhance historic city landscapes. Residents in Aiken were initially concerned about possible damage to mature trees that lined the city's parkways and boulevards, and they did not want to detract from the city's overall historic charm. Permeable pavement and careful design of bioswales allowed green infrastructure to enhance the city's aesthetics.
- Green infrastructure in historic downtowns can help protect natural areas that residents cherish. The Aiken green infrastructure project benefits Hitchcock Woods, a natural area next to downtown that serves as a city park and is central to the area's identity. After residents understood the link between downtown stormwater and the health of their local ecosystem, they supported green infrastructure as an innovative approach for environmental protection.

G. PROJECT TEAM

- **Owner:** City of Aiken
- **Engineering:** Clemson University Center for Watershed Excellence and Woolpert, Inc.

⁸¹ Ibid.

⁸² Greenville.com Community News. "Aiken, Clemson, EPA Kick Off Project to Make Stormwater 'Green'." <http://www.greenville.com/news/epa0310.html>. Accessed Sep. 3, 2015.

⁸³ City of Aiken. *Storm Water*. 2015. https://www.cityofaiken.sc.gov/wp-content/uploads/downloads/2015/01/brochure_stormwater.pdf.

⁸⁴ Clemson University 2013 *op. cit.*