State Water Quality Requirements Addressed Through the Use of an Innovative Pavement

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FIGURE 1 Visual comparison of the reduction in spray from PFC containing crumb rubber (left-hand lane) and continually reinforced concrete pavement (right-hand lane).

Requirements for stormwater treatment often are difficult to address in the limited space available in highway rights-of-way (ROWs). This is especially true in urban areas where the pavement of many roadways extends almost to the edge of the ROW. Texas Department of Transportation (DOT) had an opportunity to investigate how pavement type affects the quality of stormwater runoff.

Problem

The Clean Water Act enacted by Congress in 1972 requires an assessment of waterbodies to determine whether they meet water quality standards for their intended uses. U.S. Environmental Protection Agency (EPA) data from 2004 to 2016 indicate that more than 43,000 waterbodies do not meet standards and are considered impaired (*1*). The pollutant responsible for the impairment is termed the "constituent of concern." A Total Maximum Daily Load (TMDL) is developed for each of these systems to determine the total discharge of the constituent of concern that would allow the waterbody to meet standards. Entities, including state DOTs, must then reduce their discharge of that constituent.

Stormwater runoff is a common source of many pollutants. For state DOTs, reducing their discharge requires implementing stormwater treatment facilities within the ROW to treat the runoff prior to discharge to a natural waterbody. Because of space constraints in the ROW, state DOTs often struggle to implement these facilities, particularly in urban areas. In addition, the State of Texas has also adopted requirements for stormwater treatment from new highways located in the Edwards Aquifer recharge and contributing zones. The Edwards Aquifer extends from north of Austin through San Antonio, a highly developed area where implementation of stormwater treatment facilities is also limited by available ROW—especially for projects involving roadway expansion.

Solution and Application

Texas DOT funded a multiyear study, conducted by the University of Texas at Austin, to determine the quality of runoff from various pavement types, including permeable friction course (PFC) and conventional hot-mix asphalt, as well as a PFC containing crumb rubber. This was the first study in the United States to investigate the potential water quality benefits of PFC. PFC is known in many states as open-graded friction course (OGFC). PFC is a roughly 50-millimeter-thick porous asphalt overlay with widely recognized benefits, including reduced noise, elimination of splash and spray, and better friction characteristics in wet weather. The reduction in spray is readily apparent in Figure 1, in which the left-hand lane is PFC containing crumb rubber and the right-hand lane consists of continually reinforced concrete.

Several locations in the Austin area were selected to compare stormwater runoff quality from roadways paved with PFC to those paved with conventional asphalt. The monitoring results showed that runoff from the PFC pavements had substantially lower concentrations of total suspended

solids (TSS), phosphorus, copper, lead, and zinc compared with conventional asphalt pavement (*2*). The reduction in TSS, which is the regulated constituent for the Edwards Aquifer area, is especially high, exceeding 90% reduction. Figure 2, from a site on Loop 360 in Austin, provides a dramatic example of the lower TSS concentrations—storm by storm—compared with conventional asphalt from two sites located less than 100 meters apart.

Additional studies of the pollutant removal abilities of PFC have been conducted by other researchers in North Carolina and California (*3–4*), as well as in European countries such as The Netherlands and France (*5–6*), with similar findings. One of the surprising findings of the North Carolina DOT study was that the sites monitored were nearly 10 years old, yet they provided the same water quality benefits as new PFC in Texas. This was the case even though no maintenance was performed to restore or preserve the permeability (*3*). At 10 years, North Carolina DOT determined that the structural life of the pavement had been reached, so it was milled and replaced.

These results indicate that the water quality benefits will last for the entire structural life of the pavement without any maintenance. These pavements will clog at the lower traffic speeds typical of city streets, however, and in these cases the impact of tires on standing water is insufficient to redistribute the accumulated sediment. Texas DOT funded research indicates that 55 mph is sufficient to keep the pavement porous and permeable.

Benefits

This research showed that roadways paved with PFC/OGFC produced runoff with substantially reduced concentrations of solids, phosphorus, and metals compared with conventional pavement. Texas DOT presented the results of this monitoring effort to the Texas Commission on Environmental Quality, which approved the use of PFC to meet state standards for pollutant reduction on the Edwards Aquifer. This means that Texas DOT now has a way to achieve compliance with regional water quality standards by treating the runoff within the pavement itself and that no routine maintenance is required when used on roadways with a posted speed limit of 55 mph or greater. The only potential downside is that PFC costs approximately 25% more than conventional asphalt. It has been widely used in Texas just for the benefits associated with better visibility and greater safety, however.

PFC may provide a solution for other agencies, as well. Since the runoff is treated within the footprint of the roadway, no additional ROW is required. That makes implementation relatively easy compared with other approved stormwater treatment systems. Potential cost benefits may depend, in part, on the cost of additional ROW and materials needed to install more traditional treatment systems. The PFC option can be especially beneficial for state DOTs responding to TMDLs, where retrofit of existing highways in urban areas may be required and where space is extremely limited. Further, many state DOTs already have a standard specification for PFC/OGFC, which means that they can achieve the environmental benefits using a paving system that they have already approved.

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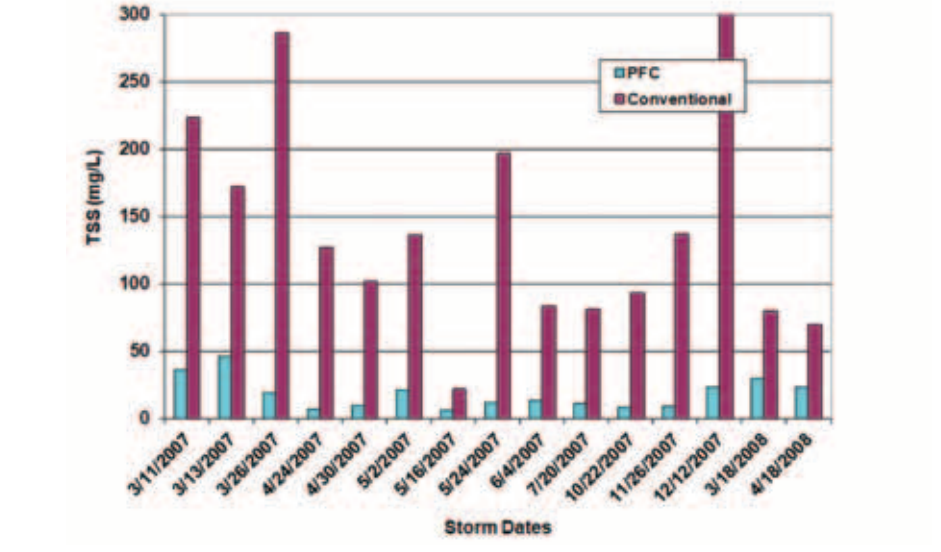

FIGURE 2 Example of lower TSS concentration—storm by storm—in PFC compared with conventional asphalt from Loop 360 in Austin, Texas.