TEXAS TRANSPORTATION INSTITUTE
THE TEXAS A&M UNIVERSITY SYSTEM

PROJECT SUMMARY REPORT

Project Summary Report 1837-S
Project 0-1837: Effectiveness of "Low-End" Stormwater Runoff Mitigation Efforts in Austin, Texas

Authors: Harlow C. Landphair, Jett A. McFalls, and David Thompson

Estimating Pollutant Loads for Stormwater Quality

The U.S. Environmental Protection Agency's (EPA) National Pollutant Discharge Elimination System (NPDES) Phase I rules require stormwater discharge permits for major urban centers. However, new Phase II rules have been established that expand the impact of the original Phase I rules for meeting the Clean Water Act, Section 401 provisions. In order to comply with Phase II rules, all TxDOT districts with urbanized areas of over 50,000 in population will be required to obtain stormwater discharge permits. In addition, new regulations for reducing stormwater pollutant loads may require either installing permanent water quality structures on new construction, or retrofitting existing structures, or both. Essentially, all districts will be required to install and maintain some permanent water quality structures in order to comply with these provisions.

In order to obtain Section 401 clearance, districts must demonstrate that they meet a variety of stormwater quality compliance measures. This project specifically addresses permanent, surface Best Management Practices (BMPs), which constitute one element of the overall compliance requirement. These permanent structures collect and treat stormwater prior to its release to adjacent water bodies. The structural BMPs examined in this research have been grouped into the following general categories, according to one of the following primary methods of pollutant removal:

- infiltration,
- retention,
- detention, and
- filtration.

This project's purpose was to:

- Identify any new stormwater quality measures that could reduce the long-term cost of meeting stormwater quality requirements.
- Evaluate new and existing technologies and identify the most cost-effective and efficient BMPs available for meeting TxDOT needs.
- Evaluate and make recommendations for selection and design of stormwater quality BMPs.
- Provide guidance for preparation of permanent stormwater quality BMP specifications.

What We Did . . .

Research activities included a review of current literature, an assessment of current practice, and field monitoring of existing stormwater quality structures in order to determine differences in relative performance compared to construction, operational cost, and complexity.

The literature review referenced over eighty publications specifically related to stormwater quality BMPs, their application, and performance.

The field monitoring effort was intended to determine the relative difference in performance between high-cost structures and lower-cost stormwater quality structures. The field monitoring effort occurred in the southwest part of Austin in the vicinity of U.S. 290 West and the southern end of MoPac. There are several TxDOT structures, as well as

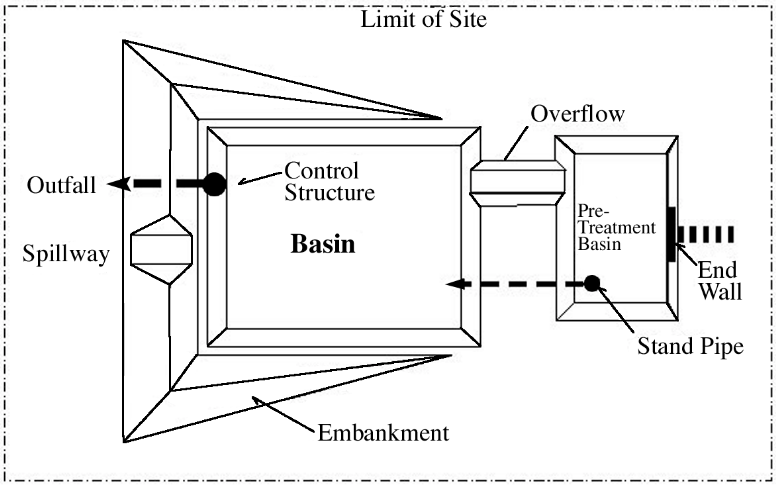

Figure 1. Basic prototype used to develop cost data

numerous low-cost BMPs in this area, that are under the City of Austin's jurisdiction. The goal was to identify a group of BMPs of different size, design, and age within a relatively small geographic space. This activity was intended to minimize the variations in rainfall distribution that could occur and to facilitate the collection of samples.

Installation of samplers began in late November 1999 and was complete on most structures around the first of January 2000. Between six and 12 good sample sets were obtained for each site in the study. The constituents monitored were:

- total suspended solids (TSS),
- total Kjeldahl nitrogen (TKN),
- total phosphorous (TP),
- zinc (Zn),
- lead (Pb), and
- oil and grease.

What We Found . . .

Literature Review

The literature review revealed that almost all of the literature on permanent stormwater quality structures is based on work done by Thomas Schueler, Metropolitan Washington Council of Governments; M. Barrett et al, TxDOT; K. Young et al, Federal Highway Administration; and the City of Austin. Certainly, there are other studies that have contributed to the knowledge base, but these sources are by far the most rigorous and frequently cited in the literature. This base of information, developed in the Austin area, provides an excellent foundation for developing meaningful guidance for selection and design of stormwater quality structures in Texas.

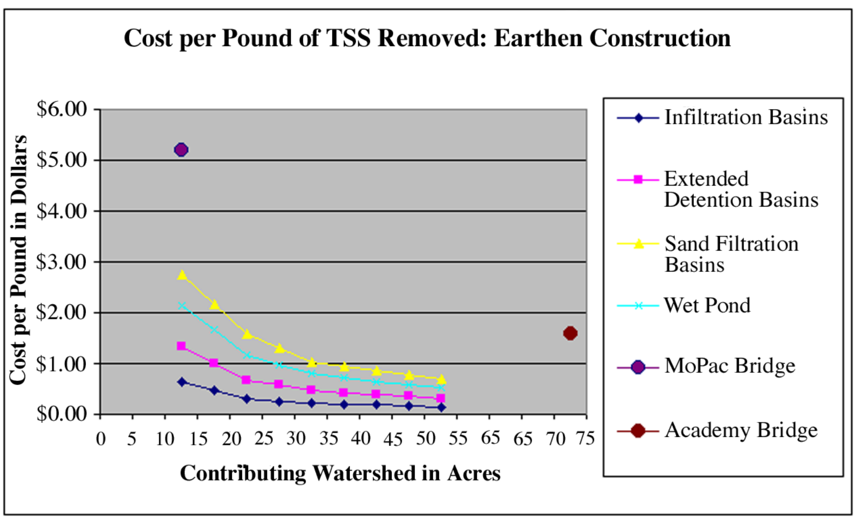

Figure 2. Earthen construction

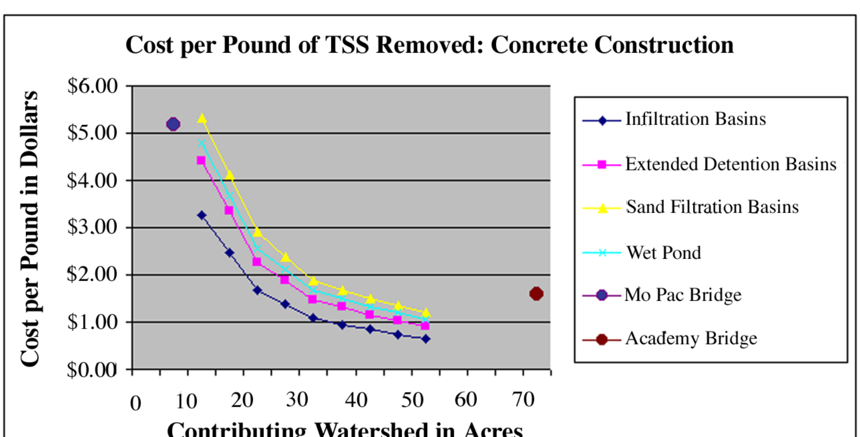

Figure 3. Concrete construction

The information obtained from the literature review and subsequent follow-up with researchers and practitioners in TxDOT and other state transportation agencies led researchers to conclude that there are no new technologies that appear to offer any cost savings or to improve water quality significantly over existing technology. There are numerous proprietary water quality devices being marketed, but many of them represent a repackaging or refinement of existing technology.

Field Monitoring

The results of the monitoring effort were hampered by the short duration of the project and by the fact that there were significantly fewer than expected rainfall events due to the statewide drought. Therefore, the results of the data collected proved rather inconclusive in terms of being able to identify any significant differences in performance between BMP structure types. On the surface, the more expensive TxDOT structures seem to be more consistent and exhibit higher rates of pollutant removal. However, this may be explained by the relative consistency of the pollutant loads in the immediate watershed compared to other structures, and by a more consistent level of maintenance. More specifically, the runoff from neighborhood streets and yards tends to be dirtier, and more inconsistent in terms of constituents, than runoff from parking lots, highways, and roadside areas.

The variation in performance observed between events appears to correspond with that observed in other monitoring studies. That is, the pollutant removal from one storm event to the next is not consistent. Discrepancies can be attributed to a variety of variables, such as the volume of a storm event, the intervening dry periods, the actual quality of the influent, and the quality of maintenance the structure receives. Both the literature consulted and the monitoring conducted in this project substantiate this conclusion.

The Project Advisory Committee considered extending the research to allow another year of data collection. However, the development of a reasonable range of performance expectations requires a great deal more data collection than could be provided by this project, due, in large part, to the variability observed among similar BMPs. Since this is a matter of national concern, U.S. Environmental Protection Agency (EPA) is supporting an effort being undertaken by the American Society of Civil Engineers to develop a "National Pollutant Removal Performance Database" for stormwater practices. This effort acknowledges that there is a knowledge gap that will take many years to fully understand. In the interim, the design and application of stormwater quality BMPs will continue to have gray areas, which will require professional judgment and experience.

Cost Data

The initial concept for developing the cost data for permanent BMP structures was to obtain real cost data from sources such as the City of Austin, TxDOT, and other literature sources that reported cost data. A review of these data quickly demonstrated that variations in materials, site conditions, land cost, and watershed area served would not permit any meaningful comparison of costs. For this reason, a prototype approach was used to develop the cost data.

The diagram shown in Figure 1 shows the basic prototype used. The actual size of the chambers, the size of pipes, and other structures were increased to correspond to the size of the contributing watershed. In addition, separate estimates were made for three different material mixes. Type 1 is an all-earthen structure, type 2 is a hybrid of earth and concrete, and type 3 is an all-concrete structure. The watershed service areas for basin-type structures were 10, 20, 30, 40 and 50 acres. The graphs in Figures 2-5 summarize the cost analysis results. The graphs indicate that earthen structures will clearly be the most economical where land and site conditions permit. In addition, they show that cost-effectiveness increases when the size of the watershed served increases. Ultimately, the land cost will determine the most cost-effective solution for a given site. Based on

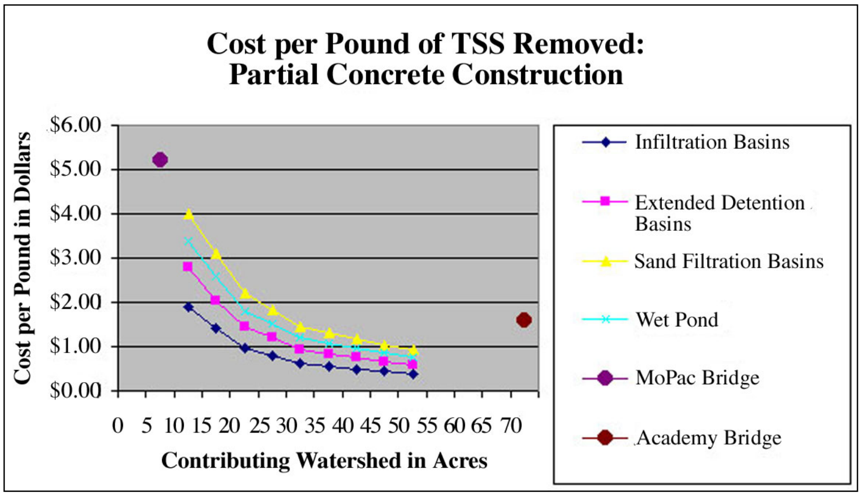

Figure 4. Partial concrete construction

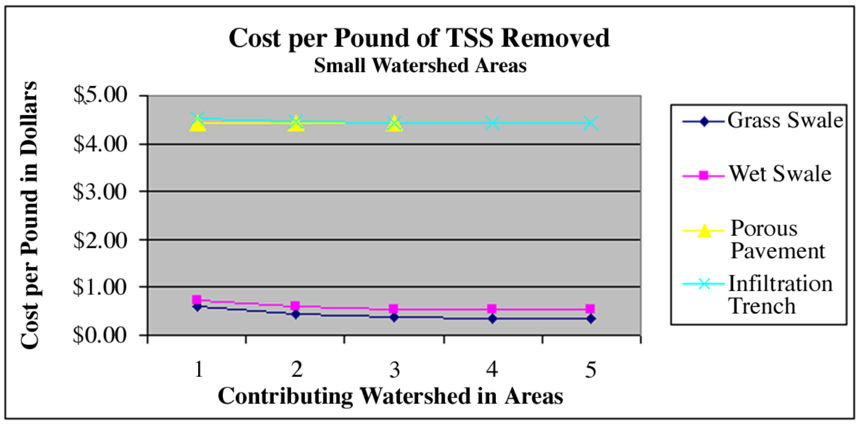

Figure 5. Small watershed areas

information generated in this research, it appears that surface-based BMPs will be cost-effective until land costs exceed $150,000 per acre. At that point, underground options should be considered. Additionally, the improved grass swale (water quality swale) is effective for small drainage areas and has a very low cost compared to other options for small drainage areas.

The Researchers Recommend . . .

1. Use surface-based earthen structures, where possible. This requires advanced planning to acquire sufficient right-of-way near streams and other water bodies.

2. Utilize borrow ditches and median swales. The simple addition of small check dams along a swale will significantly increase water quality. While the swales may not provide all of the treatment needed, they will significantly decrease the cost and size of end-of-channel structures.

3. Use the design guidance provided in this project's research report (1837-1) to estimate pollutant loads and determine BMP volume requirements, if more sophisticated hydrologic analysis tools are not available. These methods are used both nationally and by other Texas state agencies.

4. Consider extended detention and infiltration methods prior to other surface-based BMPs. The report gives more detailed guidance regarding the selection process.

For More Details . . .

The research is documented in Report 1837-1, *Design Methods, Selection, and Cost-Effectiveness of Stormwater Quality Structures*.

Research Supervisor : Harlow Landphair, TTI, h-landphair@tamu.edu, (979) 845-0133

Key Researchers: David Thompson, TTU, thompson@shelob.ce.ttu.edu, (806) 742-3485
Jett McFalls, TTI, j-mcfalls@ttimail.tamu.edu, (979) 845-0133

TxDOT Project Director: Norm King, nking@dot.state.tx.us, (512) 416-2705

To obtain copies of the report, contact Dolores Hott, Texas Transportation Institute, Information & Technology Exchange Center, (979) 845-4853, or e-mail d-hott@tamu.edu. See our on-line catalog at http://tti.tamu.edu.

TxDOT Implementation Status
August 2001

The research provided a framework of tools for the selection and design of cost-effective structural water quality Best Management Practices (BMPs) needed to meet federal, state, and local stormwater regulations. The research provided a simple method for planners and designers to evaluate water quality requirements, develop final design recommendations, and choose BMPs based on efficiency and cost-effectiveness. The procedures recommended are already in use in Texas.

For more information, please contact: Bill Knowles, P.E., RTI Research Engineer, at (512) 465-7648, or e-mail wknowle@dot.state.tx.us

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