

Bring on the Rain!

Alabama facility implements direct filtration
for wet weather conditions

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During significant rain events, flow at the Village Creek Wastewater Treatment Plant (Birmingham, Ala.) can increase from a normal 30 mgd (114,000 m³/d) to more than 360 mgd (1.4 million m³/d). In the past, any flow beyond about 80 mgd (303,000 m³/d) had to be bypassed to the Village Creek waterway, which feeds Bayview Lake. Both the creek and the lake are impaired and have been the focus of ongoing cleanup efforts by community groups and government agencies for nearly 2 decades.

Based in part on successful pilot-testing of deep-bed sand filtration at the plant in the summer of 2000, a new \$300 million peak-flow treatment facility has just been built at Village Creek that will significantly improve water quality. Along with deep-bed sand filters, the new system includes a diversion interceptor and tunnel to partially bypass the biological treatment plant during rainstorms and to supply a base flow to a second new biological plant between rain events. The system also includes a 340-mgd (1.3 million-m³/d) pump station; 20 surge basins, with a total capacity of 90 million gal (341,000 m³), that can handle up to 4 hours of peak flow; a second new biological treatment plant; and ultra-violet (UV) disinfection.

Deep-Bed Filtration Testing

The pilot filtration study was commissioned by the Environmental Services Department of Jefferson County, Ala., and by consulting engineers Gary L. Owen & Associates (Birmingham, Ala.). A pilot filter plant containing two 10-ft² (0.9-m²) filters, each housing a 6-ft (1.8-m) depth of large rounded sand filter media, was supplied by Severn Trent Services (Fort Washington, Pa.) and operated with help from plant personnel.



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The Village Creek stormwater filtration plant nearing completion. The \$300 million facility can handle up to 360 mgd (1.4 million m³/d) of wet weather flow for 4 hours.

The filter system was set up near the front end of the Village Creek plant, next to a source of raw plant influent treated only by coarse screens and grit chambers. The raw wastewater was first piped to a mixing tank, where plant reuse water was added to adjust the total suspended solids (TSS) content to projected wet weather conditions of 100 mg/L. A submersible pump in the tank then sent wastewater to the filter plant. On its way to the top of the filters, the pumped flow passed through an in-line mixer (for possible chemical addition) and a flowmeter.

Effluent from the filters passed through a clear well with the same overflow elevation as the top of the filter media. As head loss increased, the water level rose above the media. When needed, the filters were backwashed from the clear-well supply with a vigorous combined air–water backwash. Very short backwashes using water alone were employed to control head loss. Automatic samplers collected filter influent and effluent composites for each filter run.

The pilot program lasted more than 2 months while a variety of flows, solids loadings, and operating techniques were investigated. For future design purposes, operations focused on loading the pilot filters with about 100 mg/L TSS wastewater at 10 gal/ft² · min (407 L/m² · min) of filtration area. This represented applied loading rates that were two to four times higher than previous experience and required developing new ways to maintain filter flow.

Monthly average effluent limits were 30 mg/L

Deep-Bed Sand Filter Pilot Testing Results		
Parameter	Quantity	Average
Influent TSS	37 to 197 mg/L	94 mg/L
Effluent TSS	7 to 18 mg/L	12 mg/L
Influent CBOD	28 to 92 mg/L	49 mg/L
Effluent CBOD	10 to 26 mg/L	17 mg/L

TSS – total suspended solids
CBOD – carbonaceous biochemical oxygen demand

TSS and 25 mg/L carbonaceous biochemical oxygen demand. Results from weeks of repetitive testing were very good, as the pilot plant met these limits with room to spare (see the table, below). The best effluent and longest filter runs were achieved with no chemical addition.

With such high influent flow and solids loadings, conventionally operated filters would quickly plug. During the pilot study, new methods of operating and backwashing were developed to keep the water moving. These methods are now patented or patent-pending.

One proprietary operating method, called SpeedBump, involved stopping effluent flow from the first filter, reversing the flow using the backwash pumps for a short period (about 1 minute), then proceeding immediately to the next filter while flow was restored to the first filter, and so on. Closing influent valves during this process was optional, depend-



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Village Creek's filter influent piping and valves conduct plant influent from a concrete influent channel to the facility's filters.

ing on the initial water level in the filter. This continuous process provided a surprisingly effective reduction in backed-up wastewater and allowed water levels in the filters to drop below the overflow point for a period of 20 minutes to as much as 2 hours. The technique was a key to achieving reasonable filter run times when handling high wastewater flows and heavy solids loadings.

Further testing was done to simulate the “first flush” of the collection system in the first few hours of a major rain event. This led to the development of new backwashing methods to allow for continuous application of 200 to 500 mg/L TSS undiluted raw wastewater to the filters at about 5 gal/ft² · min (204 L/m² · min). With this very high loading, filter run time was cut to about an hour, even with 20-minute interval speed bumping.

A short air–water backwash of only a few minutes was enough to expel most of the solids causing the backup and get the flow going again. This proprietary method, called SpeedWash, has been automated in the large filter plant to proceed continuously, seam-

lessly, and quickly from one filter to the next, completing the circuit in sufficient time to operate at elevated solids loading conditions.

These first flush treatment tests produced effluent quality of about 40 mg/L TSS, below the projected weekly permit average of 45 mg/L. This gives operators more options.

Results and Discussion

Successful piloting results allowed the full-scale plant to be designed and bid in late 2000. A contract for the full-scale filtration plant was awarded in early 2001, and at press time the plant was set for completion in late July. The final plant design includes 22 filters, each at 1167 ft² (108 m²).

The filters are laid out in two trains with room for expansion. The new control methods and innovative piping designs (a technology package referred to as StormMaster) will allow continuous, rolling execution of up to two simultaneous air-water backwashes and four water-only backwashes at the same time, divided among the two filter trains to control head loss and expel excess solids during wet weather events. These events will peak at up to 360 mgd (1.4 million m³/d) for 4 hours, with elevated flows persisting for as much as 24 hours. A portion of the peak flow will continue to be handled by the existing biological treatment plant. Dirty backwash water will be sent to thickeners in the biological treatment plants.



Village Creek stormwater filters in operation. The facility's 22 filters are laid out in two trains with room for expansion.

The full-scale, heavy-duty filter design has been proven in large new high-flow plants in Atlanta and in heavy industrial and steel mill services all over the world. In addition to handling wet weather flows, the filters serve a valuable role of effluent polishing for many municipalities. They will perform this function at Village Creek between significant rainstorms.

One key feature of the filters is the 6-ft-deep (1.8-m-deep) bed of large rounded sand, which allows high flow rates, large storage capacity for heavy solids loadings, and long run times. Self-flocculating

mechanisms for solids lodged within the filter media reduce the need for chemical addition.

A second key feature is the filter underdrain. Rows of arched concrete blocks rest on the filter floor, leaving large passages for water to flow under and between rows. This design, called a T-block system, is very resistant to biological fouling and so is ideally suited for wastewater applications. The blocks also protect the backwash air-distribution system.

A third key feature is a system of stainless-steel backwash air laterals under alternate rows of T-blocks. The system precisely meters air under the entire bottom of the filter, allowing for even, effective backwashing. The design stands up well to heavy-duty conditions: Many plants have used this system for more than 20 years with no major maintenance or loss of media.

Simultaneous air-water backwashing provides far superior cleaning capability and much lower water consumption than separate air scouring and high-rate water washing. This is important in a large, heavily loaded filter plant. Backwash water consumption during rare peak flow operation is calculated to be about 10% of forward flow, but only 1% to 2% for normal operation. A field survey found that other filter types were averaging 11% of forward flow for backwash, even for normal operations. Thus, it is likely that the Village Creek plant will benefit from reduced recycle flows and treatment costs.

Adjacent to the new filter plant are 24 surge basins that hold the first flush of undiluted wastewater with the highest concentration of pollutants for later processing. This water may be applied directly to the filters at the operator's discretion.

The new biological treatment plant also will take in some of the surge flow directly. To keep the plant active between storm events, a portion of the water now treated by the old plant will be diverted permanently to the new plant for treatment. All wastewater treated by the new facility also will pass through the new filters.

Final effluent is treated by UV disinfection before discharge to Village Creek. UV disinfection is greatly enhanced when supplied with filtered water, resulting in improved kill effectiveness, reduced power draw, and greatly lowered tube maintenance.

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