



## Water Wastewater

### Client

Milwaukee Metropolitan Sewage District

### Location

Milwaukee, Wisconsin, USA

## Wastewater Treatment Plant Upgrade Design

### Project Description

CH2M HILL has served as lead consultant directing a team of 88 consulting engineering firms providing planning, design, and services during construction for the Milwaukee Pollution Abatement Program (WPAP). The WPAP is a 15-year effort that brought the Milwaukee Metropolitan Sewerage District (MMSD) into compliance with various federal and state court orders. The MMSD serves an area of 302 square miles and 1.3 million persons, of which 27 square miles (17,000 acres) and 291,000 people are served by combined sewers. Regulatory mandates and concern about water quality prompted Milwaukeeans and the MMSD to eliminate SSOs and control CSOs. The program had many objectives, including improvement and enlargement of treatment facilities, I/I capture and treatment, and CSO capture and treatment.



When CH2M HILL started on the project, the MMSD was under court order to eliminate all SSOs and CSOs. CH2M HILL used the results of previous water quality studies and modeling efforts to support successful court actions that overturned the earlier court-mandated, zero-discharge requirement. Regulatory agencies then demanded abatement of CSO, but could not quantify the required level of protection against CSO.

CH2M HILL's analysis of all water quality needs and limitations (an early watershed management approach) supported a recommendation for no more than a half-year level of CSO protection to comply with water quality objectives. Under this criterion, untreated combined sewer discharge to the receiving waters would be allowed on an average of twice per year. The local water quality management agency undertook an independent review of the CSO control needs that verified CH2M HILL's conclusions but still required complete elimination of SSOs.

Project control remained in the hands of the MMSD, but as lead consultant, CH2M HILL was directly responsible for coordinating work done by the other consultants working on the project. CH2M HILL participated in the planning and design of many of the system components including:

- I/I cost-effectiveness analysis and SSO elimination
- Service area master planning
- CSO storage, conveyance, and treatment facility planning
- Treatment facilities at the Jones Island treatment complex
- System controls and evaluation of system hydraulics

During development of the CSO facilities plan, CH2M HILL and the associate firms considered several major conveyance alternatives, including shallow tunnels, gravity pipelines, pressure pipelines, river conduits, existing interceptors, oversized deep tunnels, and complete and partial sewer separation. Storage alternatives included deep shafts, shallow pits, artificial



offshore islands, floating concrete tanks, inflatable tanks, quarries, oversized deep tunnels, and mined caverns.

Several types of treatment were also evaluated. As part of the evaluation of alternatives for capturing and treating CSOs, CH2M HILL designed and operated a pilot plant to evaluate CSO treatability.

Because the WPAP was intended to be a completely integrated system of facilities designed to upgrade wastewater treatment, eliminate SSOs, and reduce CSOs, our control recommendations balanced the need for expanded and upgraded treatment, I/I reduction, sewer relief, and CSO capture. We found that facilities required to provide the treatment upgrade and SSO control, namely inline tunnel storage, could also be used to help meet CSO control objectives. This finding, achieved through comprehensive sewershed modeling and optimization, saved \$500 million over preliminary recommendations that addressed CSO separately.

Many innovations in facility design and construction were incorporated into the project, including the design of dropshafts as vortex generators and the use of precast segmented pipe to expedite pipeline construction. The real-time control system for the ISS is another feature that is essential to maximizing the benefits of the sewer network. The customized computer control system monitors flows and storage capacity throughout the interceptors. This real-time information allows continuous refinement of the algorithms that operators use to track gate positions, flow rates, and tunnel capacity. These innovations saved the MMSD considerable time and construction cost.

Facility improvements required to use the available capacity of the deep tunnel system to control CSO are:

- Rehabilitate and maintain intercepting structures to provide better ongoing flow control
- New collector sewers to direct CSO to deep tunnels
- Instrumentation and control (I&C) system to maximize use of available storage capacity
- New CSO dropshafts and connecting tunnels

The tunnel and underground facilities are emptied through a new 150-mgd inline pump station that pumps flow from the District's deep tunnel system to the Jones Island and South Shore WWTPs. The total lift is approximately 350 feet. The station includes three 50-mgd variable speed pumps with 4,000-hp motors.

The control system, which has been operational since 1986, is already having a profound effect on the MMSD's historical sewage overflow problem. Since the deep tunnel system came online in July 1993, the MMSD overflows of sanitary sewage have been eliminated and combined sewage overflow occurs less than twice a year rather than the historical 50 to 60 times per year.