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# **Water Quality** Research Program

*Providing Research Solutions to Manage Water Quality*

## The Experimental Stream Facility Clermont County, Ohio

### Introduction

A watershed is the natural land area that drains into a common waterway, such as a stream, lake, estuary, wetland, aquifer, or even the ocean. Watersheds are important—they supply drinking water, provide recreation, and sustain life. So it's also important to reduce the loading of stressors (pollutants) to watershed streams and lakes.

Part of EPA's Sustainable Water Infrastructure Initiative is encouraging the adoption of the "watershed approach," which is incorporating watershed-sensitive alternatives into utility planning and management practices. The watershed approach is supported by the results from the research conducted at the Experimental Stream Facility (ESF).

### Background

ESF is a research facility located in Milford, Ohio. EPA leases ESF from Clermont County, and scientists and engineers from the Water Quality Research Pogram in EPA's National Risk Management Research Laboratory (NRMRL) share space with the Clermont County Sewer District Water Quality Testing Laboratory.

ESF is in the watershed drained by the Lower East Fork of the Little Miami River. Water is pumped through ESF from the Lower East Fork to provide a balance between the controlled conditions of a laboratory and the variability of the natural environment necessary to sustain native communities. Studies are performed to understand the relationship dynamics between the plant and animal life in the laboratory and those in the river.

Small-stream ecosystems comprise over 72 percent of the river miles in the United States. Yet the role they play in managing watershed-level water quality remains uncertain and they are commonly overlooked in watershed models. Many small streams remain unregulated, so they are put into culverts or replaced with storm sewers during land development, which eliminates any role they may play in maintaining water quality. Researchers in the Water Quality Research Program conduct studies to better understand the relative importance of small-stream ecosystems and the role they play in watershed management.

ESF is the result of collaborative efforts from a number of sources. The facility was originally designed for the needs of a multinational corporation (the Proctor and Gamble Company). Today, cross-laboratory collaboration takes advantage of expertise within several divisions within EPA's Office of Research and Development, while biweekly meetings attended by project officers, technicians, and contractor staff guide the research activities.

### Features

ESF is unique in design and experimental setup. Because some stream channels receive test chemical doses while others do not, it is possible to distinguish chemical effects from natural environmental influences on stream organisms. Emerging contaminants of concern, such as endocrine-disrupting compounds, can be added precisely and simultaneously with the influent river water at the head of each experimental channel. Suspended solid and nutrient concentrations in the supplied river water can be manipulated as well. Very few operations other than ESF have the level of dosing precision and fail-safe design hardwired into their experimental setup.

Furthermore, incoming and outgoing river water and effluents can be automatically monitored and recorded every few minutes for temperature, pH, dissolved oxygen, conductivity, stream flow conditions (light levels, temperature, and humidity), turbidity, and weather conditions.

ESF allows researchers to explore the effects of contaminants on traditional assessment endpoints, as well as to develop new and more effective measures (e.g., early warning biologically based monitors and reproductive endpoints), in a setting that can be scaled up to field conditions. Plus, connections between pollutant loads and biotic endpoints can be identified, a critical step in developing effective models in support of EPA water

quality regulations, and implementation and monitoring plans.

The facility features:

- Stream channels – eight 40-foot-long channels with upper and lower sections and a tail tank; many flow configurations are possible
- Water sources – two natural sources (the East Fork of the Little Miami River and the Heiserman Stream) and final effluent from the adjacent wastewater treatment plant
- Solar irradiance – special lights simulate a stream with a forest canopy and a stream in an open field
- Chemical dosing system
- Supervisory Control and Data Acquisition (SCADA) system – sensors, valves, and meters connected to a central computer to monitor and control flows, lights, chemical delivery, and data collection

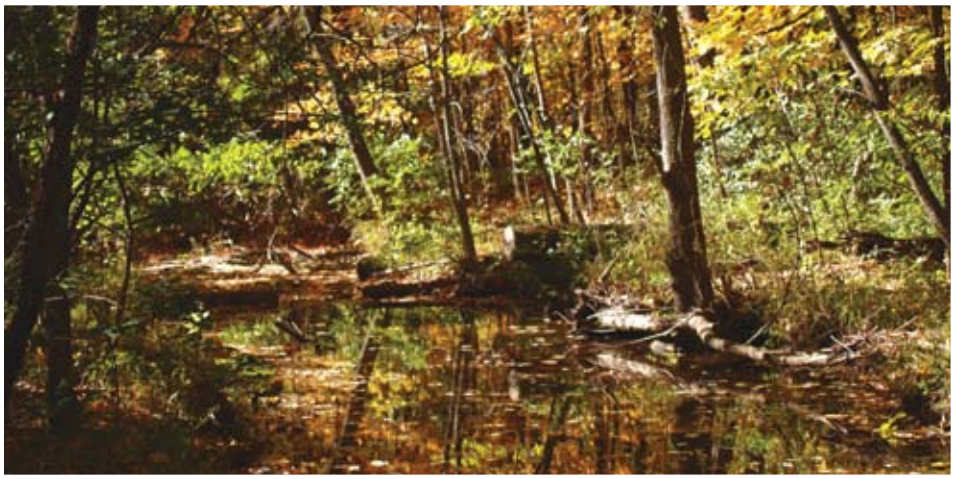
ESF may be used by scientists and engineers in other federal agencies, states, academic institutions, nonprofit organizations, and private companies. Provisions are in place to ensure that EPA research will not be impacted by any agreements. In most cases, EPA will provide federal employees to operate the facilities.

## Objectives

The research conducted at ESF identifies the links between known environmental stressors in stream flow and the structure and function of stream ecosystems. However, attempts to measure the effectiveness of specific watershed BMPs on stream ecology have been unsuccessful because the studies lacked a systematic framework for linking pollution reductions to in-stream biological conditions.

Water researchers are attempting to close that data gap with the operation of ESF and a watershed-level monitoring program to test, apply, and calibrate results. The goal is to amass sound scientific evidence of how well management practices meet a desired biotic endpoint.

ESF study results are incorporated into a watershed research plan designed to characterize, track, and model water quality for better watershed management, especially as the results relate to the



National Pollutant Discharge Elimination System and the Safe Drinking Water Act. Major objectives of ESF research include:

- Understanding the interaction between stream organisms and environmental stressors such as consumer product chemicals
- Assessing the relative sensitivity of acute, chronic, and mesocosm (between a microcosm and a macrocosm in size) studies for understanding the toxicity of consumer product chemicals in the environment
- Assessing the ability of laboratory fate tests to help researchers understand fate (the movement and transformation of pollutants over time) in surface water

## Results

In the first year of its operation, experimental results have been published and one proceedings paper delivered at national and international meetings. In 2005, standard operating procedures were developed during preliminary ESF studies that manipulated stream flow regime as a treatment effect. Baseline variables were defined for each experiment.

In 2006, collaborative research began with a dosing experiment that validated bivalve behavioral monitoring as an early warning of potential copper pollution. Two screening studies were conducted with endocrine-disrupting compounds. These studies compared the response of traditional indicators of ecological stress, biomonitors, and new biotic exposure endpoints in fathead minnows.

Since then, ESF research has evolved into a multidisciplinary program, relying on the expertise of ecologists, molecular biologists, toxicologists, and engineers. Each ESF study is designed to provide information on ecosystem structure and functions. The information is used in relation to the development and testing of new indicators of ecological stress, water quality monitoring technologies, and methods and models for water quality management.

The chief beneficiaries are the environmental decision makers who will use ESF data in watershed models to better characterize how streams react to and process emerging contaminants and stressful mixtures, and to quantitatively link known stressors in stream flow with the structure and function of stream ecosystems.

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**SEE ALSO**

Water Quality Research Program
http://www.epa.gov/ORD/npd/waterqualityresearch-intro.htm

Sustaining Our Nation's Water Infrastructure (PDF) (24 pp, 640 KB)
http://www.epa.gov/waterinfrastructure/pdfs/brochure_si_sustainingournationswaters.pdf

Sustainable Infrastructure for Water and Wastewater
http://www.epa.gov/waterinfrastructure/





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