

P8-UCM: Program for Predicting Polluting Particle Passage through Pits, Puddles, and Ponds—Urban Catchment Model

Contact Information

William Walker, Jr.,
 Environmental Engineer
 1127 Lowell Road
 Concord, Massachusetts 01742-5522
 (978) 369-8061
wwwalker@wwwalker.net
<http://www.wwwalker.net>

Download Information

Availability: Nonproprietary
<http://wwwalker.net/p8/>
 Cost: N/A

Model Overview/Abstract

P8 is a model for predicting the generation and transport of stormwater pollutants in urban watersheds. Continuous water balance and mass balance calculations are performed on a user-defined system consisting of watersheds, devices (runoff storage/treatment areas, BMPs), particle classes, and water quality components. Simulations are driven by continuous hourly rainfall and daily air temperature time series data. The model simulates pollutant transport and removal in a variety of treatment devices (BMPs), including swales, buffer strips, detention ponds (dry, wet, and extended), flow splitters, and infiltration basins (offline and online), pipes, and aquifers. Water quality components include total suspended solids (TSS) (five size fractions), total phosphorus (TP), total Kjeldahl nitrogen (TKN), copper, lead, zinc, and hydrocarbons.

Model Features

- Urban watershed hydrology
- Urban pollutants
- Stormwater BMPs

Model Areas Supported

Watershed	Medium
Receiving Water	Low
Ecological	None
Air	None
Groundwater	Low

Model Capabilities

Conceptual Basis

In P8-UCM, continuous water balance and mass balance calculations are performed on a user-defined system consisting of watersheds (pervious and impervious areas are separately considered), devices (runoff storage/treatment areas, BMPs), particle classes, and water quality components.

Scientific Detail

Runoff from pervious areas is computed using the Soil Conservation Service's (SCS) curve number technique. Antecedent moisture conditions are adjusted, based on 5-day antecedent precipitation and season. Percolation from pervious areas is estimated by water balance at the surface (percolation = precipitation – runoff – evapotranspiration). Evapotranspiration is computed from air temperature and season using Hamon's method. Runoff from impervious areas starts after the cumulative storm rainfall exceeds the specified depression storage. Both rainfall and snowmelt are considered in runoff estimations. Particle concentrations in runoff from pervious areas are computed using a method similar to the sediment rating curve included in EPA's Stormwater Management Model (SWMM). Particle loads from impervious areas are computed using either or both of two techniques: (1) particle accumulation and washoff and/or (2) fixed runoff concentration. The first method is used in default particle datasets. An exponential washoff relationship similar to that employed in SWMM is used to simulate particle buildup and washoff from impervious surfaces.

Receiving water processes are limited to devices, ponds, infiltration basins, and shallow channels. Storage area or volume and outflow relations represent flow in ponds. Shallow channel flow is estimated by Manning equation. Settling and transport of sediments are simulated in the model.

Model Framework

- Watershed model
- Shallow channels, ponds, infiltration basins, and storage devices

Scale**Spatial Scale**

- Subwatersheds

Temporal Scale

- Hourly

Assumptions

- A watershed is divided into a lumped pervious area and a lumped impervious area.
- SCS Curve Number approach is appropriate for estimating surface runoff.
- All the pollutants entering the waterbodies are sediment-adsorbed.

Model Strengths

- A simple model that requires moderate effort to setup, calibrate, and validate
- Simulates urban stormwater BMPs and wetlands

Model Limitations

- SCS Curve Number approach at hourly timestep requires substantial calibration
- Limited capability in flow and pollutant routing
- Limited capability in groundwater process and groundwater and surface water interaction

Application History

P8 is widely applied in the Northeast and Midwest regions of the United States, especially to size stormwater BMPs in urban watersheds.

Model Evaluation

P8 documentation presents model evaluation in various applications.

Model Inputs

- Climate data: hourly precipitation and daily air temperature
- Device (hydraulic) parameters for pond, basin, buffer, pipe, splitter, and aquifer
- Watershed parameters: areas, impervious fraction and depression storage, street-sweeping frequency, SCS runoff curve number for pervious portion
- Particle parameters: accumulation/washoff parameters, runoff concentrations, street-sweeper efficiencies, settling velocities, decay rates, filtration efficiencies
- Water quality component parameters: pollutant concentrations

Users' Guide

Available online: <http://www.wwwalker.net/p8/p8v1doc.pdf>

Technical Hardware/Software Requirements

Computer hardware:

- PC

Operating system:

- PC-DOS

Programming language:

- FORTRAN

Runtime estimates:

- Minutes to less than an hour

Linkages Supported

None

Related Systems

None

Sensitivity/Uncertainty/Calibration

Built in capability for calibration and sensitivity analysis

Model Interface Capabilities

- DOS User Interface
- P8CONV – a preprocessor to develop precipitation input file

References

Palmstrom, N. & W. Walker. 1990. *The P8 Urban Catchment Model for Evaluating Nonpoint Source Controls at the Local Level, Enhancing States' Lake Management Programs*. U.S. Environmental Protection Agency, Washington, DC.

U.S. Environmental Protection Agency (USEPA). 1992. *Compendium of Watershed-Scale Models for TMDL Development*. EPA841-R-92-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

HDR Inc. 1992. *Evaluation of Storm Water Computer Models*. Prepared for City of Minneapolis by HDR Inc.

U.S. Environmental Protection Agency (USEPA). 1997. *Compendium of Tools for Watershed Assessment & TMDL Development*. EPA841-B-97-006. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Walker, W. 1990. *P8 Urban Catchment Model Program Documentation Version 1.1*. (Computer program). IEP, Inc., Northboroug, MA and Narragansett Bay Project, Providence, RI.