STORMWATER MANAGEMENT GUIDEBOOK

DEQ

Michigan Department of Environmental Quality
Land and Water Management Division

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Bruce E. Menerey, P.E.

Michigan Department of Environmental Quality
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EXECUTIVE SUMMARY

Currently, the lack of standard stormwater-management practices within Michigan can result in facilities that do not function properly or are counterproductive. The purpose of this guidebook is to provide a reference for state and local officials and engineering consultants on stormwater management for both water-quantity and water-quality concerns. The primary focus will be on the design of stormwater retention/detention basins. In addition, the following topics are also included:

- Stormwater-management measures
- Hydraulics
- Hydrology
- Operation & maintenance
- Financing
- Laws & Ordinances relating to stormwater management

The guidebook also includes a reference listing sources of additional information on stormwater management.

It is not the intent of this guidebook to recommend design practices that will be used statewide, under all circumstances, or in all communities. Instead, the guidebook is intended to be used as a reference when considering solutions to specific problems, as it discusses what is being done in stormwater management throughout the country.

DEFINITIONS

Acre-foot - a volume of water 1 foot deep and 1 acre in area, or 43,560 cubic feet.

Aerator - a device that sprays water into the air, bubbles air through the water, or agitates the water, to incorporate oxygen into the water.

Antecedent Moisture Condition (AMC) - the quantity of moisture present in the soil at the beginning of a rainfall event. The Natural Resources Conservation Service has three classifications, AMC I, II, and III.

Backwater - the increased depth of water upstream of an obstruction, such as a dam or bridge, in the stream channel.

Base Flow - the part of the stream flow that is not due to direct runoff from precipitation; it is usually supported by water draining from natural storage in groundwater bodies, lakes, or wetlands.

Bedload - the sediment in a stream channel that moves by sliding, rolling, or skipping on or near the stream bottom.

Best Management Practice (BMP) - a practice or combination of practices that form an effective, practicable means of preventing or reducing the amount of pollution generated by non-point sources.

Bottomland - the land of a lake or stream which lies below the ordinary high-water mark of the lake or stream.

Culvert - a closed conduit used for the passage of surface water under a road or other embankment.

Curve Number - see runoff-curve number.

Detention Basin - temporarily stores water before discharging into a surface-water body. Primarily used to reduce flood peaks. Can be classified into three groups:

1. Dry Detention Basin - usually dry except for short periods following large rainstorms or snowmelt events. Not effective at removing pollutants. Pollutants that may settle in the basin will be "picked up" by future floods.

2. Extended Dry Detention Basin - is a dry detention basin that has been modified to increase the time which the stormwater will be detained in the basin. The typical detention time is 24 to 48 hours. Not effective at removing nutrients such as phosphorus and nitrogen, unless a shallow marsh at the outlet is incorporated into the design.

3. Wet Detention Pond - a detention basin that contains a permanent pool of water that will effectively remove nutrients in addition to other pollutants.

Detention Time - the amount of time that a volume of water will remain in the detention basin.

Discharge - the rate of flow (volume of water passing a point in a given period of time). Usually expressed as cubic feet per second.

Drainage Area - the area of a watershed usually expressed in square miles or acres.

Drainage Divide - the line which follows the ridges and high points of the ground surface that separate one drainage basin from another.

Emergency Spillway - a depression in the embankment of a pond or basin which is used to pass peak discharges in excess of the design storm.

Eutrophication - the process of enrichment of water bodies by plant nutrients which may lead to increased growth of algae or rooted plants.

First Flush - highly concentrated pollutant loading during the early portion of stormwater runoff due to the rapid runoff of accumulated pollutants.

Forebay - an extra storage area provided near the inlet to a detention basin to trap incoming sediments before they accumulate in the basin.

Hydraulic Radius - the area of the culvert or stream section divided by wetted perimeter (A/WP).

Hydrograph - a graph, usually of discharge or stage versus time, at a given point along a stream.

Hydrologic Cycle - the continuous process of the exchange of water between the earth and the atmosphere.

Impervious - a surface through which little or no water will move. Impervious areas include paved parking lots and roof tops.

Infiltration - the absorption of water into the ground.

Infiltration Capacity - the maximum rate at which the soil can absorb falling rain or melting snow. Usually expressed in inches/hour or centimeters/second.

In-line Detention - the detention is provided within the flow-carrying network (stream) .

Manning's Roughness Coefficient ("n") - a coefficient used in Manning's equation to describe the resistance to flow due to the roughness of a culvert or stream channel.

Mean Storm - over a long period of years, the average rainfall event, usually expressed in inches.

Mean Storm Volume - the runoff volume produced by the "mean storm."

Moisture Content - see antecedent moisture condition.

Non-Point Source Pollution - pollution that is not identifiable to one particular source, and is occurring at locations scattered throughout the drainage basin. Typical sources include erosion, agricultural activities, and urban runoff.

Off-Line Detention - detention placed outside of the natural watercourse or storm sewer system.

Off-Site Detention - detention is provided at a regional detention facility as opposed to storage on site.

One-Hundred-Year Flood (100-year flood) - the flood that has a 1-percent chance of occurring any given year.

On-Site Detention - stormwater is detained on the property as opposed to a regional site.

Ordinary High Water - marks the line between upland and bottomland which persists through successive changes in water level, below which the presence of water is so common or recurrent that the character of the soil and vegetation is markedly different from the upland.

Orifice - an opening in a wall or a plate.

Peak Discharge - the maximum instantaneous rate of flow during a storm.

Pervious - a surface that will allow water to infiltrate into the ground.

Pilot Channel - a channel that routes runoff through a detention basin to prevent erosion of the basin.

Point-Source Pollution - pollution that occurs at a specific location, such as an outlet pipe, and is usually continuous.

Precipitation - the supply of water received from the atmosphere, such as rain, snow, and hail.

Rating Curve - a curve that expresses a relationship between dependent quantities. Typically the graph will plot stage (elevation) versus discharge.

Regression Analysis - independent variables (such as drainage area and precipitation) are selected which relate to a dependent variable (discharge). Once an equation is developed, a discharge may be computed by knowing the independent variables. Such an analysis has been developed based on an evaluation of the stream gaging stations throughout Michigan.

Retention Pond - a stormwater management practice that captures stormwater runoff and does not discharge directly to a surface water body. The water is "discharged" by infiltration or evaporation.

Retrofit - to modify an existing structure to improve the pollutant-removal or flood-peak-reduction capability.

Riser - a vertical pipe attached to the outlet pipe of a detention basin that is used to control the discharge rate from the basin.

Routing - the derivation of an outflow hydrograph for a given reach of stream or detention pond from known inflow characteristics. The procedure uses storage and discharge relationships and/or wave velocity.

Runoff - the excess portion of precipitation that does not infiltrate into the ground, but "runs off" and reaches a stream, water body, or storm drain.

Runoff-Curve Number - indicates the runoff potential of a parcel and is based on soil group and land use. The higher the runoff-curve number, the higher the runoff potential.

Sediment - material that is being transported from its site of origin by water. May be in the form of bedload (along the bed), bouncing along the bed, suspended or dissolved.

Short Circuiting - the runoff does not spend enough time in a detention facility to remove the pollutants for which the facility was designed to remove.

Stormwater Utility - a source of funding the construction and maintenance of stormwater management facilities. User fees are typically charged based on the amount of runoff that may be anticipated from a property.

Swale - a slight depression or shallow ditch which can be used to convey, store, or filter runoff.

Time of Concentration - the time it takes for runoff to travel from the hydraulically farthest portion of the watershed to the design point.

Timing - the relationship in time of how runoff from sub-watersheds combines within a watershed.

Weir - a device that has a crest and some side containment, and is used to measure, regulate, or restrict flow. The amount of flow that may pass over the weir is a function of the weir geometry and upstream height of water above the crest.

Wetted Perimeter - the wetted surface of a stream (culvert) cross section which causes resistance to flow. The water-to-surface interface is a length, usually expressed in feet.

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INTRODUCTION

It was not very long ago that stormwater management meant increasing the size of the storm-sewer pipes or enlarging drains to allow stormwater to get away from an area as quickly as possible. However, in many instances this "solution" resulted in increased flooding, erosion, and water-quality problems in downstream areas.

Over the years, people have become more aware of the potential problems caused by increased runoff due to urbanization and increased flood peaks due to drain improvements. In an attempt to remedy the increased flooding and erosion problems, communities (and some states) began to implement stormwater detention.

Typically, stormwater detention involved the construction of dry detention basins that would reduce downstream discharges. The detention basins would "hold back" some of the runoff to be released at a later time. However, in some instances, detention basins were constructed that did not consider the hydrology of the entire watershed. As a result, the basins had little impact on flood discharges and, at times, actually increased flood peaks.

Stormwater management was originally concerned with the quantity of water and the downstream flooding potential. However, over the last 10 to 15 years, there has been a growing concern with the **quality** of the stormwater runoff and its impact on the environment. Stormwater runoff picks up pollutants that have accumulated on the land surface and washes them into receiving waters. The pollutants can include sediment, nutrients, and heavy metals to name a few. They enter the food chain, destroy aquatic habitat, and can essentially "kill" a lake or stream.

As a result of the water quantity and quality concerns, stormwater management has begun to evolve into a field that tries to integrate reducing future flood damages with water-quality improvements. The information presented in this guidebook will provide some background in stormwater management and will offer some approaches to addressing the urban runoff problem.