

Unit hydrograph is a fundamental tool in hydrology used to estimate the runoff response of a watershed to a unit amount of rainfall over a specific duration. This graphical representation helps hydrologists and engineers understand and predict the flow of water through a watershed. The concept is built upon certain assumptions regarding the uniform distribution of rainfall and consistent watershed characteristics. By studying the unit hydrograph, hydrologists can make informed decisions about water resource management, flood forecasting, and infrastructure design, contributing to more effective and sustainable water-related practices.

What is Unit Hydrograph?

A unit hydrograph is the hydrograph depicting the direct runoff resulting from a uniform rainfall excess of one unit depth (1cm) occurring evenly across the basin and at a constant rate for a specified duration (D hours). This hydrograph provides a consolidated representation of the catchment's reaction to a unit rainfall excess lasting D hours, resulting in the formation of a direct runoff hydrograph. The unit hydrograph exclusively correlates direct runoff to rainfall excess, ensuring that the volume under the hydrograph equals the given rainfall excess. With the definition considering a rainfall excess of 1 cm, the area under the unit hydrograph corresponds to the volume represented by a 1 cm depth of water over the entire catchment area.

Assumptions of Unit Hydrograph Theory

The assumptions of Unit Hydrograph are:

Time Invariance

The concept of time invariance in hydrology asserts that the direct runoff response (i.e., the direct runoff hydrograph - DRH) for a specific effective rainfall (ER) in a catchment remains constant, irrespective of when it occurs.

Linear Response

The assumption of linear response in hydrological analysis implies that the direct runoff response to rainfall excess follows a linear relationship. In practical terms, if an input (e.g., precipitation) causes a certain output (e.g., runoff), then a proportional increase in the input will result in a corresponding increase in the output. This linearity allows for the use of the superposition method to derive DRHs. For instance, if the rainfall excess is r times the unit depth for a duration of D hours, the resulting DRH ordinates will be r times those of the corresponding D -hour unit hydrograph. This assumption facilitates combining the effects of consecutive rainfall events by superposing their individual DRHs while maintaining the proper sequence of events.

Derivation of Unit Hydrograph

Determining DRH in a Catchment:

The calculation of the Direct Runoff Hydrograph (DRH) in a catchment for a given storm becomes possible when an appropriate unit hydrograph is available.

Assuming Availability of D -h Unit Hydrograph and Storm Hyetograph:

Assuming the availability of a D-hour unit hydrograph and the storm hyetograph, the process involves estimating initial and infiltration losses, deducting them from the storm hyetograph to obtain Effective Rainfall Hydrograph (ERH).

Estimation of Losses and Formation of ERH:

Initial losses and infiltration losses are estimated and subtracted from the storm hyetograph to derive the Effective Rainfall Hydrograph (ERH).

Division into D-h Duration Blocks:

The ERH is divided into M blocks, each of D-hour duration.

Operation on Unit Hydrograph for DRH:

The rainfall excess in each D-hour duration is sequentially applied to the unit hydrograph, generating various DRH curves. These DRHs' ordinates are appropriately lagged to ensure the correct time sequence and are then cumulatively added at each time interval, resulting in the net DRH attributable to the storm.

Considering a sequence of M rainfall excess values, each of duration D hours, where $u(t)$ represents the ordinate of a D-hour unit hydrograph at time t hours from the beginning.

At any time, the total direct runoff is

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Unit hydrograph

Unit Hydrograph - Definition, Assumptions and Applications

Unit Hydrograph - Definition, Assumptions and Applications

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Overview

Test Series

Unit hydrograph is a fundamental tool in hydrology used to estimate the runoff response of a watershed to a unit amount of rainfall over a specific duration. This graphical representation helps hydrologists and engineers understand and predict the flow of water through a watershed. The concept is built upon certain assumptions regarding the uniform distribution of rainfall and consistent watershed characteristics. By studying the unit hydrograph, hydrologists can make informed decisions about water resource management, flood forecasting, and infrastructure design, contributing to more effective and sustainable water-related practices.

This article covers the definition, assumptions and applications of Unit Hydrograph. This topic is important in the context of different Engineering Examinations, including SSC JE CE and RRB JE Civil.

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Applications of Unit Hydrograph

Unit Hydrograph can serve the following purposes:

Runoff Prediction:

The unit hydrograph is used to predict the runoff response of a watershed to a specific amount of rainfall over a given duration.

Hydrological Analysis:

It serves as a fundamental tool for hydrologists to analyze and understand the runoff characteristics of a catchment.

Flood Forecasting:

Unit hydrographs aid in forecasting and managing floods by providing insights into the timing and magnitude of peak flows.

Infrastructure Design:

Engineers use unit hydrographs to design water-related infrastructure such as stormwater management systems and reservoirs.

Water Resource Management:

It contributes to effective water resource management by assisting in the assessment of water availability and distribution in a watershed.

This blog uncovered all about Unit Hydrograph, its assumptions and the different applications of Unit Hydrograph.