UNIT VII
TIME OF CONCENTRATION

INTRODUCTION

Time of concentration is one of the principal inputs for calculating runoff. It establishes the path water is going to take as it travels across a development site and estimates the time it will take water to travel from the most hydraulically distant point in the watershed to the analysis point. Understanding how time of concentration is determined and how it is affected by development is important in checking runoff computations.

LEARNING OBJECTIVES

1. To understand what role the analysis point and the drainage area play in determining the time of concentration.

2. To become familiar with the three types of flow that affect the time of concentration.

3. To understand how development affects the time of concentration.

INSTRUCTION ELEMENTS

VII.1 WORKING FROM AN ANALYSIS POINT

The first step in determining runoff from a development site is to select an analysis point in the watershed being developed. This analysis point is where the comparison between runoff prior to development (pre) and runoff after development (post) takes place. Typically, the analysis point is going to be located where runoff from the site discharges into a channel, stream, or pond. Once the analysis point has been identified, the contributing drainage area to that analysis point must be delineated. Figure 7.1 depicts a point of analysis and a corresponding watershed associated with new development.

VII.2 Tc AND TYPES OF FLOW

The next step is to determine the time of concentration (Tc), which is the time it takes for runoff to flow from the most hydraulically remote part of the drainage area to the point of analysis. In Figure 7.1, the time of concentration is depicted by a dashed line. As runoff flows down this path, it is going to take on three types of flow:[4]

* ***Overland Flow*** consists of rainfall traveling as shallow, sheets of water. This occurs in the upper reaches of the watershed and should be limited to 200 feet or less.

* ***Shallow Concentrated Flow*** takes place where overland flow converges in rills, gullies, and swales. This can occur in small, manmade ditches (paved and unpaved) and in curb and gutters. The recommended maximum length is 1,000 feet.

* ***Channel Flow*** is assumed to exist in perennial streams or in channels with a well-defined cross-section. This includes pipes not running full.

Calculating the time of concentration requires that the flow path be analyzed to determine the length of each type of flow. These flow lengths are individually measured and a travel time (Tt) is computed for each type of flow. The travel times are then added together to compute the time of concentration.

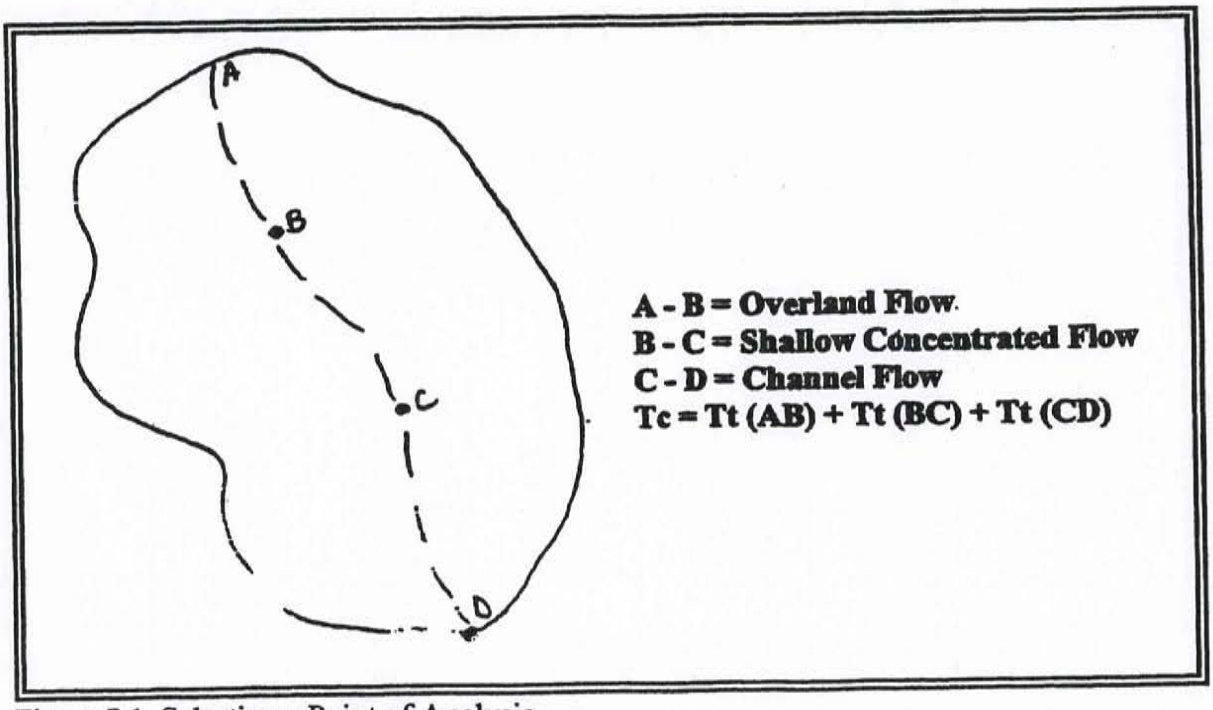

Figure 7.1. Selecting a Point of Analysis

In short, the time of concentration is the time it takes a raindrop to flow from the most distant point in the watershed to the point of analysis. The methods used to determine the time of concentration for each type of flow are found in Step 4 (under the Rational Method) of the VESCH (pages V-5 through V-7). Manning's Equation, presented in Unit V, is used to determine channel flow (refer to Unit VI for examples).

VII.3 EFFECTS OF DEVELOPMENT

Time of concentration is the way in which topography is factored into runoff calculations. One of the principal ways to affect the time of concentration is to change the slope of the site. If the site is made flatter, the time of concentration becomes longer because water is not flowing as quickly across the site.

As one of the inputs used in determining runoff, verifying the time of concentration is a key aspect of plan review. In general, as a site becomes developed, the time of concentration will become shorter, since water moves more quickly over paved surfaces and through pipe than it does over impervious surfaces, such as grass. Therefore, it follows that, regardless of the method used, the time of concentration for the post-developed condition should be shorter than the pre-developed condition. There are some exceptions to this rule. For example, slopes are sometimes flattened by construction and pavement is sometimes changed to grass, however, the reviewer should verify these conditions when the post-developed time of concentration appears to become longer in the calculations.