



3.1.9 Calculating Downstream Impacts (the Ten Percent Rule)

In the Knox County Stormwater Management Manual, the “ten-percent” rule has been adopted as the approach for ensuring that stormwater quantity detention ponds maintain pre-development peak flows through the downstream conveyance system.

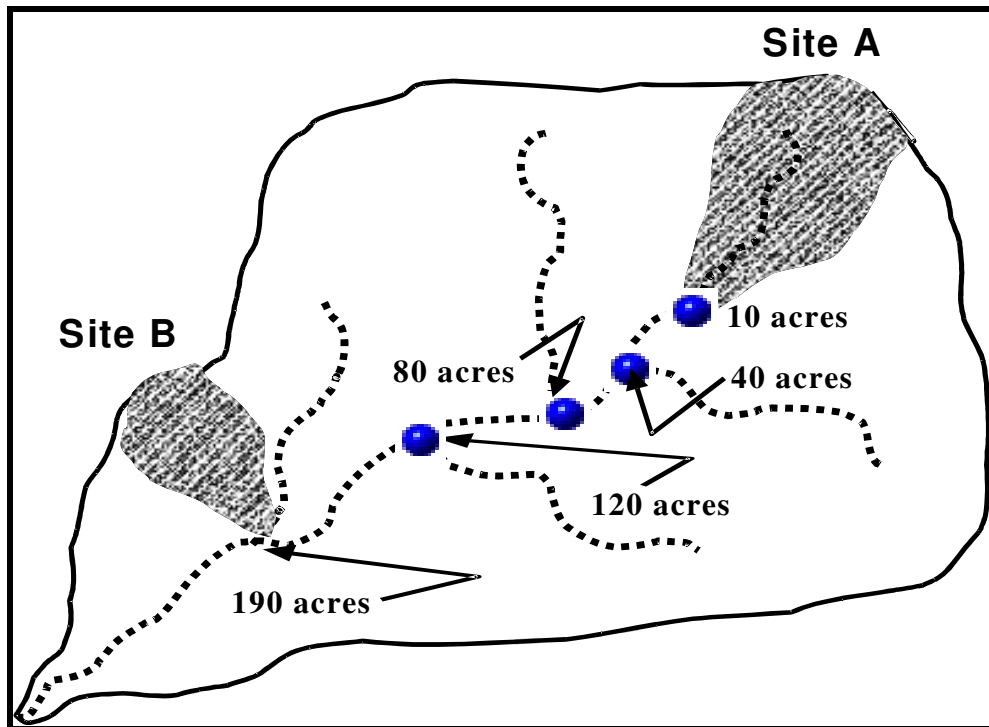
The ten-percent rule recognizes the fact that a structural control providing detention has a “zone of influence” downstream where its effectiveness can be observed. Beyond this zone of influence the structural control becomes relatively small and insignificant compared to the runoff from the total drainage area at that point. Based on studies and master planning results for a large number of sites, that zone of influence is considered to be the point where the drainage area controlled by the detention or storage facility comprises 10% of the total drainage area. For example, if the structural control drains 10 acres, the zone of influence ends at the point where the total drainage area is 100 acres or greater.

Typical steps in the application of the ten-percent rule are:

1. Using a topographic map determine the lower limit of the “zone of influence” (i.e., the 10% point), and determine all 10% rule comparison points (at the outlet of the site and at all downstream tributary junctions).
2. Using a hydrologic model determine the pre-development peak discharges (pre-Q_{p2}, pre-Q_{p10}, pre-Q_{p25}, and pre-Q_{p100}) and timing of those peaks at each tributary junction beginning at the pond outlet and ending at the next tributary junction beyond the 10% point.
3. Change the site land use to post-development conditions and determine the post-development peak discharges (post-Q_{p2}, post-Q_{p10}, post-Q_{p25}, and post-Q_{p100}). Design the structural control facility such that the post-development peak discharges from the site for all storm events do not increase the pre-development peak discharges at the outlet of the site and at each downstream tributary junction and each public or major private downstream stormwater conveyance structure located within the zone of influence.
4. If post-development conditions do increase the peak flow within the zone of influence, the structural control facility must be redesigned or one of the following options must be chosen:
 - Control of the Q_{p2}, Q_{p10}, Q_{p25}, and/or Q_{p100} may be waived by the Director of Engineering and Public Works (the Director) if adequate overbank flood protection and/or extreme flood protection is suitably provided by a downstream or shared off-site stormwater facility, or if engineering studies determine that installing the required stormwater facilities would not be in the best interest of Knox County. However, a waiver of such controls does not eliminate the requirement to comply with the water quality and channel protection standards defined in the Ordinance and in this Stormwater Management Manual.
 - The developer can coordinate with Knox County Engineering (and other state/federal agencies as appropriate) to determine other acceptable approaches to reduce the peak discharges (and, therefore the flow elevation) through the channel (e.g., conveyance improvements) for all design storm events.
 - The property owner can obtain a flow easement from downstream property owners through the zone of influence where the post-development peak discharges are higher than pre-development peak discharges.

Example 3-9. Ten Percent Rule Example

The figure below illustrates the concept of the ten-percent rule for two sites in a watershed.



Site A is a development of 10 acres, all draining to a wet ED stormwater pond. The overbank flooding and extreme flood portions of the design are going to incorporate the ten-percent rule. Looking downstream at each tributary in turn, it is determined that the analysis should end at the tributary marked “80 acres.” The 100-acre (10%) point is in between the 80-acre and 120-acre tributary junction points.

The assumption is that if there is no peak flow increase at the 80-acre point then there will be no increase through the next stream reach downstream through the 10% point (100 acres) to the 120-acre point. The designer constructs a simple HEC-1 (HEC-HMS) model of the 80-acre areas using single existing condition sub-watersheds for each tributary. Key detention structures existing in other tributaries must be modeled. An approximate curve number is used since the *actual* peak flow is not the key for initial analysis; only the increase or decrease is important. The accuracy in curve number determination is not as significant as an accurate estimate of the time of concentration. Since flooding is an issue downstream, the pond is designed (through several iterations) until the peak flow does not increase at junction points downstream to the 80-acre point.

Site B is located downstream at the point where the total drainage area is 190 acres. The site itself is only 6 acres. The first tributary junction downstream from the 10% point is the junction of the site outlet with the stream. The total 190 acres is modeled as one basin with care taken to estimate the time of concentration for input into the TR-20 model of the watershed. The model shows that a detention facility, in this case, will actually increase the peak flow in the stream.