Peak Flow Calculations (Permanent Basins)

Description

This section describes the purpose, basic formulas, minimum criteria, computation methods, and types of structures that are needed for stormwater detention calculations. Stormwater detention is a necessary component of most stormwater treatment BMPs and is required for most types of site development and redevelopment by local governments.

Data generated in the creation of a post-development hydrographs, computed volumes and discharges, and the detention basin routing shall be performed by a competent stormwater designer. Detention designs shall use the Chattanooga Intensity Duration Curve Charts as shown in TDOT Drainage Manual *IDF Curve, page 4A-2.*

Selection Criteria

Stormwater detention designers are expected to be familiar with detention computation methods such as the SCS Method outlined in TR-55 publication “Urban Hydrology for Small Watersheds”, the Rational or Modified Rational Method, and also the theory and practical application of detention routing. All hydrologic and hydraulic computations for stormwater detention facilities must be prepared and stamped by a registered engineer, licensed in the State of Tennessee. Design plans must show sufficient information to allow the builder to construct the detention structure and its Outlet Control Device correctly and to verify that the as-built facility will operate as designed and approved.

Stormwater detention is defined as limiting the peak discharge rate for the post-developed conditions to be no greater than the peak discharge rate for the pre-development conditions.

Since water quality is the centerpiece of stormwater treatment, stormwater shall not be discharged is such a way that any scouring of the receiving waters may occur.

The first flush volume is defined as the first 3/4–inch of direct stormwater runoff from the contributing drainage basin (See Section 3.3 1st Flush/Water Quality Requirement). The first flush volume must be captured and then released over a 96-hour period in such a way as to maintain acceptable stormwater quality.

The top of berm for the stormwater detention facility must be higher than the required computed water surface elevation by an amount equal to 1 foot plus the difference between the computed top of riser elevation and the adjusted top of riser elevation. Make sure to check with the local governmental jurisdiction about possible no-rise policies.

All detention or retention ponds will have a paved and/or hard surface (such as riprap) emergency overflow and the maximum water level in the pond shall be one (1) foot below any finished floor level of the facility.

Computational Software

Software computations submitted for review must include all necessary input data to reproduce the detention design including details as needed to illustrate the outlet structures. This should also include at a minimum the Stage/Discharge relationship Table for the Outlet Structure as well as the corresponding areas inside the detention pond. Computations should be organized and printed so that the results are easily referenced and located. Additional information may be required to verify software or programs that are not well-known. In all cases, the programs should be based on stormwater routing analysis theory.

Stormwater detention basins are designed in an iterative fashion. The basin volume and outlet structure configurations are chosen, and then the design is actually tested by detention hydrograph routing. The resultant peak flows and peak water surface elevations are then compared to see if post-developed peak flow values have been reduced to the required pre-developed peak flow values.

Spreadsheet Examples

Most types of hydrology software (such as HEC-1 and Haestad Pondpack TM) will have efficient methods of dealing with matrices and selecting the best computational interval. It is recommended that the design engineer should use commercially available software or public domain software.

Computing C and Tc

There are many acceptable methods of computing detention including such method as HEC-I, Haestad Pondpack TM, and Modified Rational Method (See Section 3.5 Acceptable Peak Flow and Detention Design Software).

Detention storage is based upon each computed volume having the associated discharge outlet value equal to pre-developed peak flow for the specified design storm. This is most easily done by sizing an orifice or weir at the appropriate invert elevation (or often several orifices). A carefully selected V-notch weir may satisfy more than one point on the required stage-storage-discharge curve.

Photo 2 Detention Pond

Maintenance

In many cases the permanent detention pond and/or basin will be used as the sedimentation pond during the construction phase of the project. Ponds and/or basins shall have permanent vehicle and equipment access for maintenance purposes. A maintenance and a transition plan (from sedimentation basin to permanent structure) shall be incorporated in the Stormwater Pollution Prevention Plan (SP3).

Conclusion

There are many commercially available programs for stormwater detention routing with various input requirements and a variety of spreadsheets. It is recommended that the stormwater designer should learn to use a commercially available program or a government public domain software to perform stormwater detention computations. It is important to perform detention routing to verify that the initial design estimates are adequate. Available detention space and configuration should be included into the project site at a very early stage in the design process.

Figure 1 Hydrograph for Storage Estimation

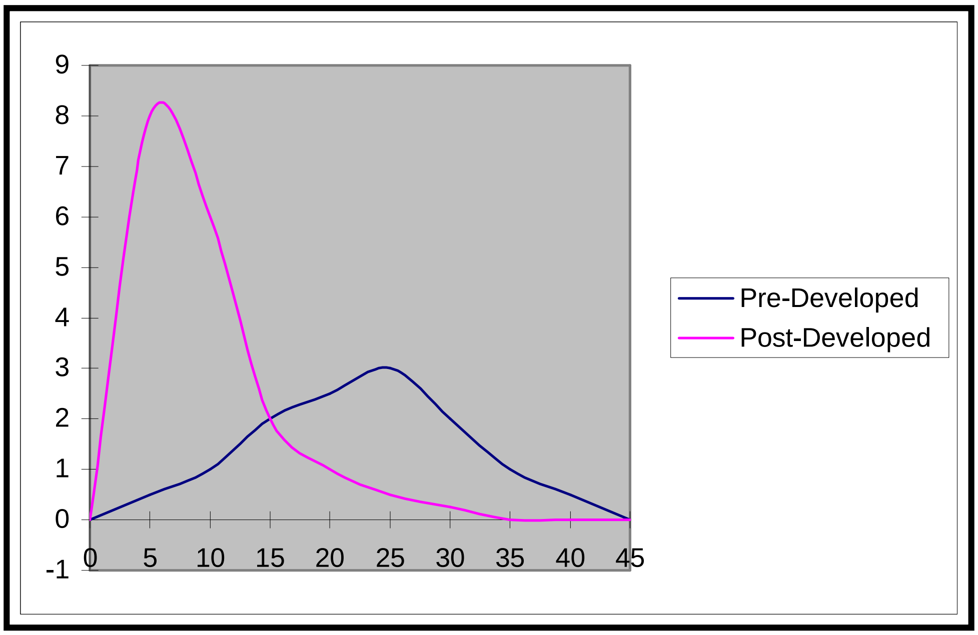
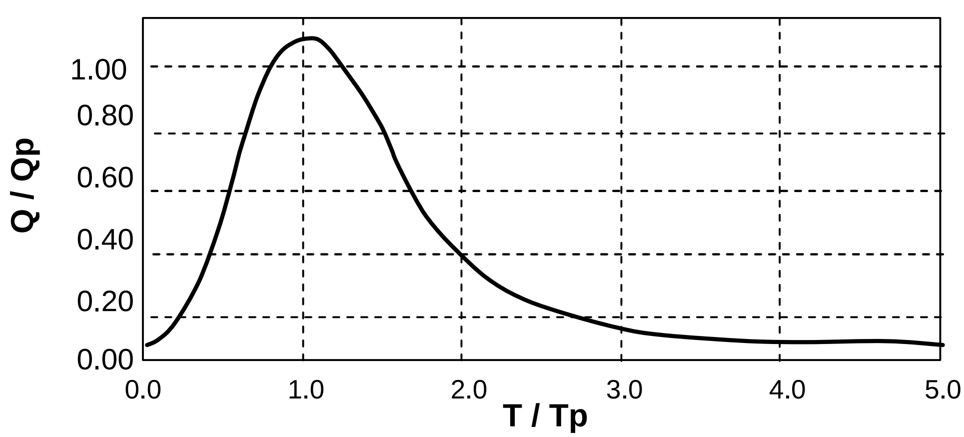


Figure 2 NRCS Unit Hydrograph



NRCS Unit Hydrograph

Figure 4
Co-Efficient of Runoff – "C"

Description of Area		Runoff Co-Efficient		
Business	Downtown	0.85	to	0.95
	Neighborhood	0.70	to	0.85
Residential	Single-Family	0.40	to	0.50
	Multi-Units (detached)	0.45	to	0.60
	Multi-Units (attached)	0.60	to	0.75
	Residential (suburban)	0.30	to	0.50
	Apartments	0.50	to	0.75
Industrial	Light	0.50	to	0.80
	Heavy	0.60	to	0.95
Other	Parks, cemetaries	0.15	to	0.30
	Playgrounds	0.20	to	0.35
	Railroad yard	0.20	to	0.35
	Unimproved	0.10	to	0.30
	Undisturbed Forest	0.02	to	0.25
Character of Surface		**Runoff Co-Efficient**		
Pavement	Asphalt	0.80	to	0.95
	Brick	0.70	to	0.85
	Concrete	0.70	to	0.94
Other	Roofs	0.80	to	0.95
Lawns	Flat, 2%	0.15	to	0.30
	Average, 2-7%	0.20	to	0.30
	Steep, 7-20%	0.25	to	0.45

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