City of Elizabethton

Commercial / Industrial Development
Stormwater BMP Guidance

This document is provided to assist developers/designers in properly selecting and sizing ***hydrodynamic structures***. These structures, also called ***"flow thru devices"***, are utilized to remove pollutants from stormwater runoff. A hydrodynamic device may be a stormwater quality best management practice (BMP) that is specifically required by the Development Committee to treat stormwater runoff. There are many commercially available hydrodynamic BMPs that provide water quality treatment (e.g., Crystalstream Technologies, Stormceptor, ADS, etc.). When required, the hydrodynamic structure should meet the **three minimum pollutant removal standards** listed below.

1. When utilized to treat stormwater runoff from land uses where hydrocarbons (e.g., gasoline, oil, petrochemicals, etc.) are a potential stormwater pollutant, the flow thru device must be of sufficient size to contain a hydrocarbon spill of 60 gallons within the structure. Hydrocarbons are potential pollutants for land uses such as gas stations, fueling facilities, vehicle repair facilities, etc.
2. The hydrodynamic structures must actively remove floatable debris in cases where debris is not previously intercepted by alternate measures.
3. All manufactured treatment devices must be able to safely overflow or bypass flows in excess of the stormwater quality design storm to downstream drainage systems. The capacity of the overflow or bypass must be sized in a manner that is consistent with the sizing of the remainder of the site's drainage system. All such flows must be conveyed in such a manner that trapped material, including floatables, is not resuspended and released. The designer must also check the capacity of the downstream conveyance system. All manufactured treatment devices must also have similar provisions to safely overflow or bypass runoff in the event of internal component clogging, blockage, and/or failure.

Additional policies regarding the selection and use of hydrodynamic BMPs in the City of Elizabethton are as follows.

- Proprietary hydrodynamic BMPs or technologies will be approved by the City on a case-by-case basis.
- The ability of the hydrodynamic BMP to meet the three minimum standards presented above must be verified by an independent third party, in accordance with the following monitoring criteria. Judgments of the standards shall be made by the City after review of applicable information submitted by the site designer.
- If the performance ability of the BMP cannot be verified, the BMP will not be approved. A poor

performance record, high failure rate, or unacceptably high maintenance requirements are all valid justifications for not allowing the use of a proprietary system or device.

- When a hydrodynamic device is proposed by the developer but not required by the Development Committee, it is the responsibility of the developer to provide the City with sufficient information to justify the use of the device.
- The BMP or technology must have documented procedures for inspection and maintenance (which are the sole responsibility of the owner), including the collection and removal of pollutants or debris.

The following monitoring criteria should be met for research/studies to support the use of a proprietary device:

- Water quality treatment performance must be monitored for a minimum of fifteen (15) storm events.
- Water quality treatment performance research/monitoring must be conducted in the field, as opposed to laboratory testing. Although local data is preferred, data from other areas can be accepted as long as the design reasonably accounts for local hydrologic conditions.
- Field monitoring must be conducted using standard protocols which require proportional sampling both upstream and downstream of the device. The City may require the use of testing protocols, such as those defined by "Stormwater Best Management Practices Demonstration Tier II Protocol for Interstate Reciprocity" as developed under the Environmental Council of States (ECOS) and Technology Acceptance and Reciprocity Partnership (TARP), and the U.S. Environmental Protection Agency Environmental Technology Verification (ETV) Program.
- Pollutant concentrations reported for the device must be flow-weighted.
- The proprietary system or device must have been utilized in place for at least one year prior to the time of monitoring.

In order to properly size a hydrodynamic structure, a volumetric runoff coefficient (Rv) for the site must be determined. Rv is defined as:

$$Rv = 0.015 + 0.0092(I)$$

where:

I = percent of impervious cover (%)

The volumetric runoff coefficient is then combined with the average 85th percentile annual rainfall event to attain the water quality peak runoff volume, as shown in the equation below. The 85th percentile annual rainfall in the City of Elizabethton is approximately 1.1 inches. This approach treats the runoff from 85% of the rainfall events that occur in an average year.

$$Qwv = 1.1Rv$$

where:

Q_{wv} = the water quality treatment volume (inches).

Knowing Q_{wv}, the water quality treatment peak discharge (Q_{wq}) can then be calculated to size the hydrodynamic structure. The following procedure shall be used to estimate Q_{wq}.

1. Using Q_{wv}, a corresponding Curve Number (CN) is computed utilizing the following equation:

$$CN = 1000 / \left[10 + 5P + 10Q_{wv} - 10\left(Q_{wv}^{\;2} + 1.25(Q_{wv})P\right)^{1/2} \right]$$

where:

CN = SCS curve number;
P = rainfall, (1.1 inches);
Q_{wv} = water quality volume, in inches (1.1Rv)

2. Once a CN is computed, the time of concentration (t_c) is computed. The time of concentration must be computed for the developed site assuming impervious surface conditions using standard SCS methods. A t_c that is unreasonably long for a developed site will not be accepted.
3. Using the computed CN, t_c and the drainage area (A), in square miles; the water quality peak discharge (Q_{wq}) is computed using a slight modification to the Simplified SCS Peak Runoff Rate Estimation technique described in steps a through c. Use the Type II rainfall distribution for this method.
   1. read the initial abstraction (I_a) value from Table 1, compute I_a/P;
   2. read the unit peak discharge (q_u) for appropriate t_c from Figure 1; and
   3. using Q_{wv}, compute the peak discharge (Q_{wq})

$$Q_{wq} = q_u * A * Q_{wv}$$

where:

Q_{wq} = the water quality peak discharge (cfs)
q_u = the unit peak discharge (cfs/mi²/inch)
A = drainage area (mi^2)
Q_{wv} = water quality volume, inches (1.1R_v)

4. Use Q_{wq} to properly size the hydrodynamic device for the development.

The example on page 6 presents a calculation of Q_{wq} for a 50 acre development.

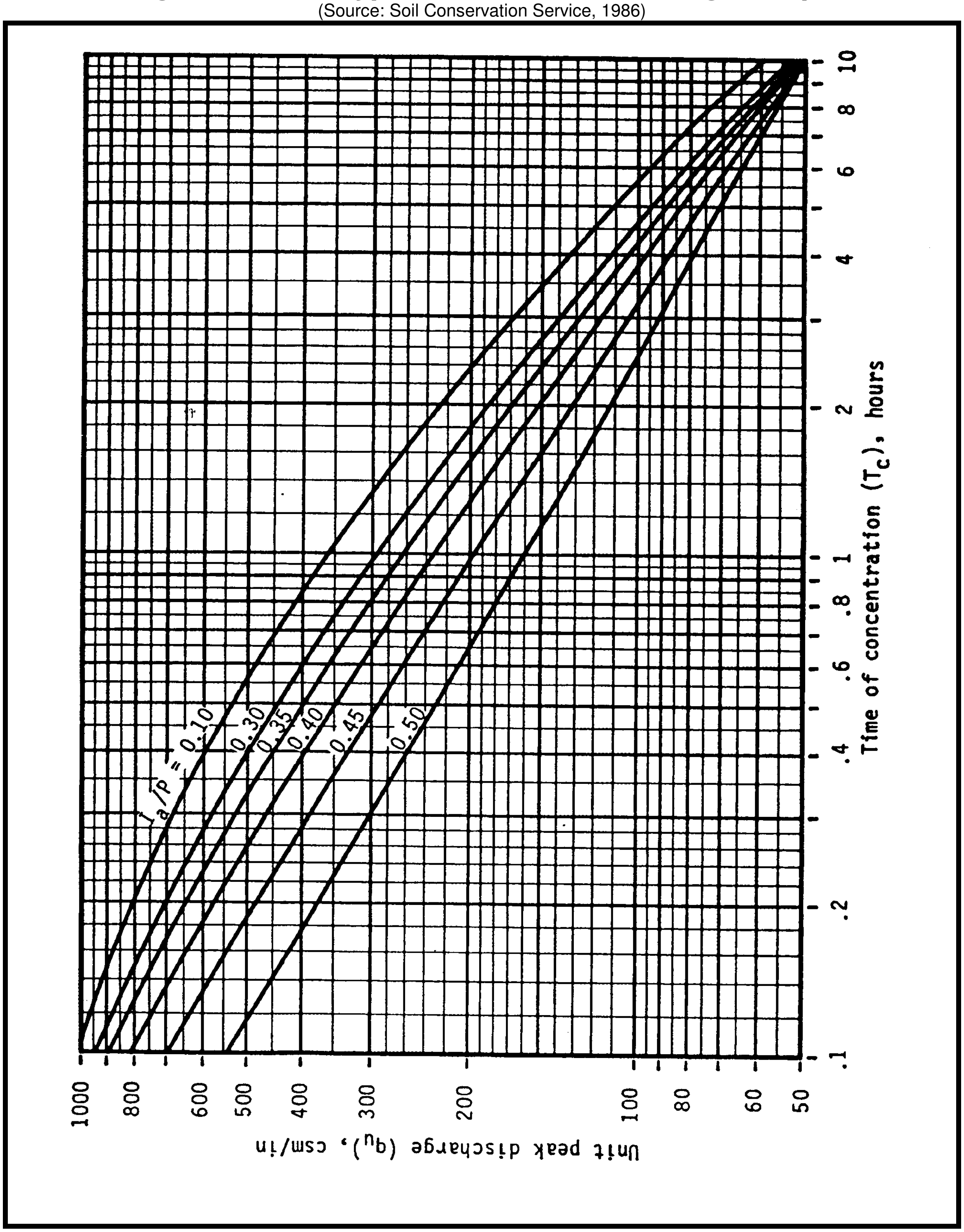
Table 1. Initial Abstraction (I_a) Values for Runoff Curve Numbers

(Source: Soil Conservation Service, 1986)

Curve Number	I_a (in)	Curve Number	I_a (in)
40	3.000	70	0.857
41	2.878	71	0.817
42	2.762	72	0.778
43	2.651	73	0.740
44	2.545	74	0.703
45	2.444	75	0.667
46	2.348	76	0.632
47	2.255	77	0.597
48	2.167	78	0.564
49	2.082	79	0.532
50	2.000	80	0.500
51	1.922	81	0.469
52	1.846	82	0.439
53	1.774	83	0.410
54	1.704	84	0.381
55	1.636	85	0.353
56	1.571	86	0.326
57	1.509	87	0.299
58	1.448	88	0.273
59	1.390	89	0.247
60	1.333	90	0.222
61	1.279	91	0.198
62	1.226	92	0.174
63	1.175	93	0.151
64	1.125	94	0.128
65	1.077	95	0.105
66	1.030	96	0.083
67	0.985	97	0.062
68	0.941	98	0.041
69	0.899	-	

Figure 1. SCS Type II Unit Peak Discharge Graph

(Source: Soil Conservation Service, 1986)



Example   Calculation of the Water Quality Peak Flow

Given: A 50-acre wooded area is proposed for development, to result in a total impervious area of 18 acres.
t_c is computed as 0.34 hours (for developed conditions).

Using the given information, calculate the water quality peak flow.

Step 1: Calculate the volumetric runoff coefficient (Rv) for the site

$$Rv = 0.015 + (0.0092)(I) = 0.015 + (0.0092)(18/50 X 100\%) = 0.35$$

Calculate water quality treatment peak flow

Step 2. Compute peak runoff volume in inches, Q_{wv}:

$$Q_{wv} = 1.1 * 0.35 = 0.39 \, inches$$

Step 3: Compute curve number, storage, Initial abstraction (I_a) and I_a/P:

$$CN = 1000 / \left[10 + 5 * 1.1 + 10 * 0.39 - 10(0.39^2 + 1.25 * 0.39 * 1.1)^{1/2} \right]$$

t_c = 0.34 (computed for developed conditions)

$$S = 1000 / CN - 10 = 1000 / 90 - 10 = 1.11 \, inches$$
$$0.2S = I_a = 0.22 \, inches$$
$$I_a / P = 0.22 / 1.1 = 0.20$$

Step 5: Find q_u:

From Figure 3-7 for I_a/P = 0.20 q_u = 580 cfs/mi²/in

Step 6: Compute water quality treatment peak flow:

$$Q_{wq} = 580 * 50 / 640 * 0.39 = 17.67 \, cfs$$

References

Debo, Thomas N., and Andrew J. Reese. *Municipal Storm Water Management.* Lewis Publishers: CRC Press, Inc., Boca Raton, Florida, 1995.

Soil Conservation Service. *Urban Hydrology for Small Watersheds.* Technical Release 55, (TR-55), 1986.

Soil Conservation Service. *SCS National Engineering Handbook.* 1985.

Pitt, Robert. *Small Storm Hydrology.* Unpublished report. Department of Civil Engineering, University of Alabama at Birmingham, 1994.