TOWN OF CARRBORO

NORTH CAROLINA

TRANSMITTAL **STORMATER DIVISION**

DELIVERED VIA: ☐ *HAND* ☐ *MAIL* ☐ *FAX* ☒ *EMAIL*

To: **Stormwater Advisory Commission**
Environmental Advisory Board
Planning Board

From: **Randy Dodd, Stormwater Utility Manager**

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Date: **January 29, 2021**

Subject: **LUO Stormwater Volume Control Provision**

Background and Summary

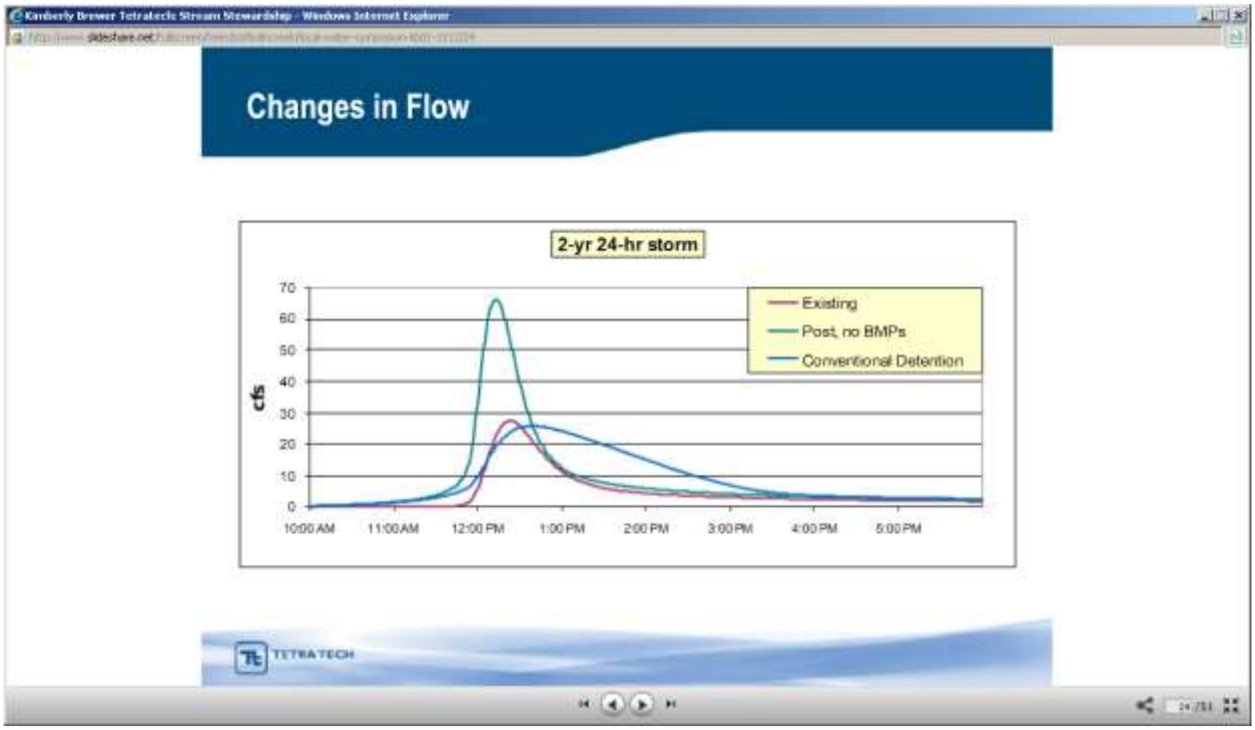
The Town's Land Use Ordinance (LUO) includes provisions for stormwater management to address peak runoff for flood mitigation, drawdown rates, water quality (treatment of the 1" storm event), and other stormwater management aspects. In addition, the Town amended the ordinance in 2012, with minor changes in 2013, 2104, and 2020, to include explicit provisions regulating the total volume of stormwater runoff from a site. Information is presented in this memo in response to the ArtsCenter application and specific issues that have arisen related to compliance with the stormwater volume provisions in the LUO. These are relevant to both a requested LUO text amendment and the CUP application.

Information

Why is Total Stormwater Volume Control Important?

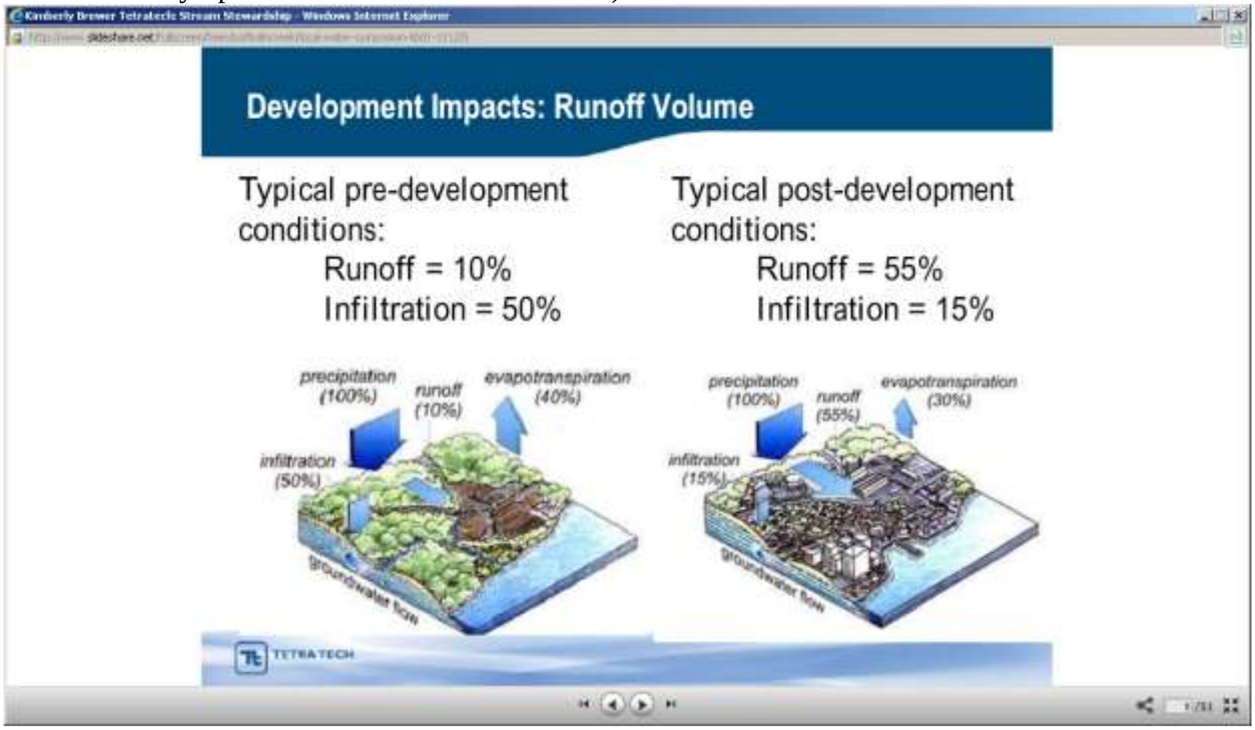
Carrboro's ordinance provisions address stormwater volume in that treatment of stormwater peak flow is required for the 1 through 25-year recurrence interval 24-hour design storms. In addition, water quality treatment is required for the first inch of rain during a storm event. Storm storage volume is required to be drawn down in 2 to 5 days after rain events to allow for capture of subsequent storms. These requirements provide water quantity control to minimize flooding and water quality treatment. Figure 1 graphically indicates how peak flow can be maintained after development, but with a substantial increase in the total volume of runoff relative to pre-development, which is reflected in the total area under the hydrograph curves.

Figure 1: Illustrative Pre and Post Hydrographs Indicating Runoff for Pre-Development and Post Development With and Without BMPs to address Peak Flow (Source: Kimberly Brewer, 2012 Local Creek Symposium at NC Botanical Garden)



A typical impact for a developing urban environment is illustrated in Figure 2. Historically, urban needs around transportation infrastructure and the built environment have resulted in dedication of significant portions of the landscape to intentionally impervious features. In addition, development can often compromise or reduce infiltration capacity through impacts on soil quality and permeability. In this typical higher density urban scenario, the proportions of rainfall that runs off and infiltrates are essentially reversed before and after development.

Figure 2: A Comparison of Pre and Post Runoff (Typical) (Source: (Source: Kimberly Brewer, 2012 Local Creek Symposium at NC Botanical Garden)



The concept of total stormwater volume control, also being referred to more and more as "runoff reduction" (synonyms or closely related concepts and terms include "Low Impact Development [LID]", "green infrastructure", "volume matching") marks an important philosophical milestone that has been helping define the next generation of stormwater design in recent years. Increases in the total volume of runoff associated with new development is associated with less infiltration and evapotranspiration. The intention of runoff reduction is that the benefits go beyond making sure the peak flow from the post construction condition does not exceed that from the pre-construction condition, and water quality improvement. If site and stormwater designs can successfully implement runoff reduction strategies, then they will also do a better job at replicating a more natural (or pre-development) hydrologic condition. In doing so, site level runoff reduction also can address: the duration and frequency of runoff impacts and velocity; groundwater recharge, and protection of stream channels. It is also an important tenet of planning for and improving the resilience to the changes in precipitation regimes that have been occurring and are anticipated to continue for the foreseeable future.

Runoff reduction to protect stream channels is of particular note. As stormwater stored on site for peak flow mitigation is released in the hours and several days after a storm event, stream banks can experience more erosive stress since the critical flow for protecting stream banks (at and approaching "bankfull" flow) is not explicitly regulated, and can actually occur for a longer duration when stormwater is stored on site and then gradually released. Detention based practices that do not intentionally address the total volume of stormwater generated can therefore potentially result in greater impacts to stream channels.

While the above provides an overall conceptual framework, in practical terms, the need for volume/runoff reduction have important local drivers. Importantly, both Bolin Creek and Morgan

Creek have been recognized by the North Carolina Division of Water Quality as impaired. Multiple studies undertaken by the State and the Bolin Creek Watershed Restoration Team have identified stormwater quantity as a significant stressor to local creeks. Benthic macroinvertebrate monitoring undertaken by the Town for over 15 years has indicated that the aquatic biota of Bolin Creek remain stressed, with stream channel/geomorphic instability and decreased baseflow being important stressors. The geomorphic stress is particularly important to note since the traditional detention based approach to flood mitigation can actually result in longer duration streamflows at or near the bankfull flow which is the flow of maximum stress. Additionally, inclusion of a volume/runoff reduction regulatory approach can help mitigate nuisance flooding, which has been a significant and growing concern primarily driven by changes in precipitation regimes.

As part of a larger LUO stormwater review, staff have initiated and will be further considering additional potential LUO amendments in the coming months to strengthen the LUO stormwater provision and recognize both local resilience needs and the ongoing advances that are happening in the stormwater profession.

What Stormwater Management Approaches Are Available to Reduce Runoff?

One way of categorizing approaches to runoff reduction is as "nonstructural" versus "structural". A similar presentation is via approaches that are more planning oriented and more engineering oriented. Nonstructural/planning approaches attempt to reduce runoff via methods that minimize unnecessary or unwise disturbance that increases runoff whereas structural methods attempt to treat and manage runoff resulting from disturbance. Structural practices for years were known as "Best Management Practices" (BMPs), but the nomenclature has changed in the past several years and they are now known as "Stormwater Control Measures" (SCMs). The effectiveness of these practices in reducing overall runoff are being captured in guidance and planning tools for stormwater management, as depicted in the following table.

Table 1: Volume Reduction Associated with SCMs from NC Stormwater Credit Manual (attributable to evaporation and infiltration; variability related to soil hydrologic groups)

Practice	**NC Credit Document**[1]
Permeable Pavement (infiltrating, A-C soils)	*100%*
Infiltration	*100%*
Bioretention per MDC	*14-90%*
Silva Cell per MDC	*14-90%*
Green Roof	*60%*
Disconnected Impervious Surface	*30-65%*
Rainwater Harvesting	*Custom/user defined*
Level spreader-filter strip	*15-60%*
Stormwater Wetland	*25-40%*
Treatment swale	*10-40%*
Wet Pond	*10-25%*
Dry pond	*0-10%*
Sand Filter (closed)	*0%*

https://files.nc.gov/ncdeq/Energy%20Mineral%20and%20Land%20Resources/Stormwater/BMP%20Manual/SSW-SCM-Credit-Doc-20170807.pdf

Table 2: NC Credit Manual Assessment of Stormwater Control Measures

SCM Type	Protection of Streambanks	Protection of Stream Temp.	Removal of Bacteria	% TN Removal[1]	% TP Removal[1]
Bioretention	Excellent	Good	Excellent	35-65[2]	45-60[2]
Infiltration	Excellent	Excellent	Excellent	84	84
Permeable Pavement (infiltration)	Excellent	Excellent	Excellent	84	84
Permeable Pavement (detention)	Fair	Good	Good	30	30
Wet Pond	Fair	Poor	Fair	30	30
Stormwater Wetland	Good	Fair	Good	44	40
Sand Filter	Poor	Fair	Good	35	45
Rainwater Harvesting	Excellent	Excellent	Good	Variable[3]	Variable[3]
Green Roof	Good	Good	Good	30	30
DIS	Good	Good	Good	30	35
LS-FS	Poor	Poor	Poor	30	35
Pollutant removal Swale (wet)	Fair	Fair	Poor	30	30
Pollutant removal Swale (dry)	Poor	Fair	Poor	10	10
Dry Pond	Poor	Poor	Poor	10	10
StormFilter	Poor	Fair	Fair	50	70

<u>Carrboro's Ordinance Provision for Stormwater Volume</u>

While reasonable and possible for certain types of development on certain sites, "No impact" development from a stormwater perspective given Carrboro's zoning, policies, and soils is not in a literal sense broadly practical or feasible when it comes to maintaining total runoff at predevelopment conditions; the ordinance stormwater volume provision attempts to provide a transparent performance standard for achieving "lower impact" development, and is based on the principals and concepts discussed above. The ordinance explicitly quantifies the allowable deviation in stormwater volume from the preexisting condition, and uses the NCDEQ approved SNAP Tool (in addition to curve numbers) to calculate the annual (and not design storm) stormwater volume. The ordinance specifically states that the post-development total annual stormwater runoff volume shall not exceed the predevelopment volume by more than the limits set forth in the following table.

Table 3: Carrboro's Allowable Increase in Stormwater Volume

Preexisting Composite Curve Number*	**Maximum allowable increase in annual stormwater runoff volume**
>= 78	50%
70-78	100%
64-70	200%
<=64	400%

*see appendix for more information on the composite curve number

The ordinance provision assesses compliance during the pre-development/permitting stage based on a composite curve number for the development site using the runoff curve number method described in USDA Technical NRCS Technical Release 55, Urban Hydrology for Small Watersheds (June, 1986) (see appendix for more information on curve number calculation).

On June 26, 2012 the Board of Aldermen adopted these new volume control provisions to the stormwater management requirements in Section 15-263 of the Land Use Ordinance (LUO) to regulate the total volume of stormwater runoff from a site. At that time, it was noted that refinements may be warranted as staff and others gained experience with the application of the requirements to specific projects/designs. In early 2013, staff received information from the NCDWQ regarding State guidance on stormwater volume control credits for permeable pavement, and prepared a draft ordinance update recognizing the credits which was approved in February, 2013. At that time, staff also changed the development submittal checklist to require applicants to conduct some field work, in particular, soils testing and a determination of the water table height, prior to land use permit approval.

The intent of the stormwater volume ordinance is to establish a specific "not to exceed" maximum allowable annual volume increase. In addition, utilizing the SNAP tool means that a separate set of calculations do not have to be completed to address the ordinance requirement, since this tool is used for nutrient requirements. The thresholds for % increase have been set based on judgment from application of the tool for sites with development applications. The minimum curve number value (64) included in the table is based on the NCDWQ Manual guidance available at the time the ordinance was adopted which states "if the composite CN is equal to or below 64, assume that there is no runoff resulting from either the 1 or 1½ inch storm". Other threshold values are based on review of the information in the appendix.

One aspect of Carrboro's ordinance and State regulatory requirements under the Jordan Lake Rules is also relevant. The SNAP tool was developed to support implementation of new development requirements in the Jordan Lake Rules and for other Nutrient Sensitive Water. While its use focuses on regulation of nitrogen and phosphorus, the calculation for nutrient loading (in lb/ac/yr) requires the calculation of total annual runoff volume. It is noteworthy in implementing the stormwater volume provisions per the Jordan Rules and in the Town's ordinances that the rules allow for "offset payments". Experience to date with the SNAP tool and its predecessors indicates that compliance with the Town's existing water quality treatment provisions for total suspended solids are resulting in many new developments being able comply with the new Jordan Lake nutrient rules simply via an offset payment with little or no additional onsite treatment beyond what is required in the ordinance for TSS treatment. This underscores that the volume control/runoff reduction component in the ordinance provides additional protection for local waterways not provided via the Jordan Lake new development provisions.

Experience from Applying Volume Control Ordinance Requirements

How any given development application considers volume/runoff reduction depends on the site and the applicant's design goals. A combination of approaches have been employed and are anticipated going forward that include additional and/or larger stormwater structural measures, greater reliance on structural practices that are more beneficial for runoff reduction, and in general greater consideration of LID principles and practices during the planning and design. Table 3 presents stormwater volume calculations for the permitted projects and other sites for which the accounting tool has been applied to study stormwater volume and the ordinance provision.

Table 3: Annual Runoff Volume Change from Previous and Current Land Use Permit Applications

	Annual runoff (cubic feet) [1]			
Project (chronological) *(underline: land use permit issued; italics: provision did not apply at time of permit review)*	**Pre-development**	**Post-development** (with SCMs)	**% change**	**Compliant with Ordinance**
Pacifica	92,012	342,639	272%	Probably
Claremont South	358,883	2,112,505	489%	No
Family Dollar	8,416	101,541	1170%	No
CVS	147,705	179,000	34%	Yes
Claremont Phase 5	124,553	320,778	158%	Yes
Shelton Station[3]	67,278	100,430	49%	Yes
West Carr Street Apts.	65,622	77,384	18%	Yes
Hilton Inn	86,764	86,332	0%	Yes
South Green	406,868	257,182	-37%	Yes
Burgundy Lane	59,675	268,287	350%	Yes
Lloyd Property	413,466	1,433,451	247%	Yes
Chan Live Work	9,313	25,091	169%	Yes
Inara Court	10,645	22,722	113%	Yes
Sanderway	73,492	295,006	301%	Yes
CASA	16,777	83,738	399%	Yes
Kentfield	57,214	287,504	403%	Yes

From this analysis, it can be concluded that the volume provisions:

1. Have resulted in stormwater plans for approved permits that demonstrate compliance for all sites permitted to date subsequent to the ordinance adoption.

2. Has resulted in stormwater management plans with additional stormwater management/Low Impact Development features, or at least SCM enhancements for some sites.

Recommendation

Staff recommend that the Advisory Boards receive the staff memo and review and provide recommendations for the draft amendment prior to the public hearing scheduled for February 23rd.

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Appendix: Curve Number Reference Information

Table 2-2a Runoff curve numbers for urban areas [1]

Cover description: Cover type and hydrologic condition	Average percent impervious area [2]	Curve numbers for hydrologic soil group: A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

1 Average runoff condition, and $I_a = 0.2S$.

2 The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

3 CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

4 Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

5 Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Source: NRCS, 1986

Figure 2-3 Composite CN with connected impervious area.

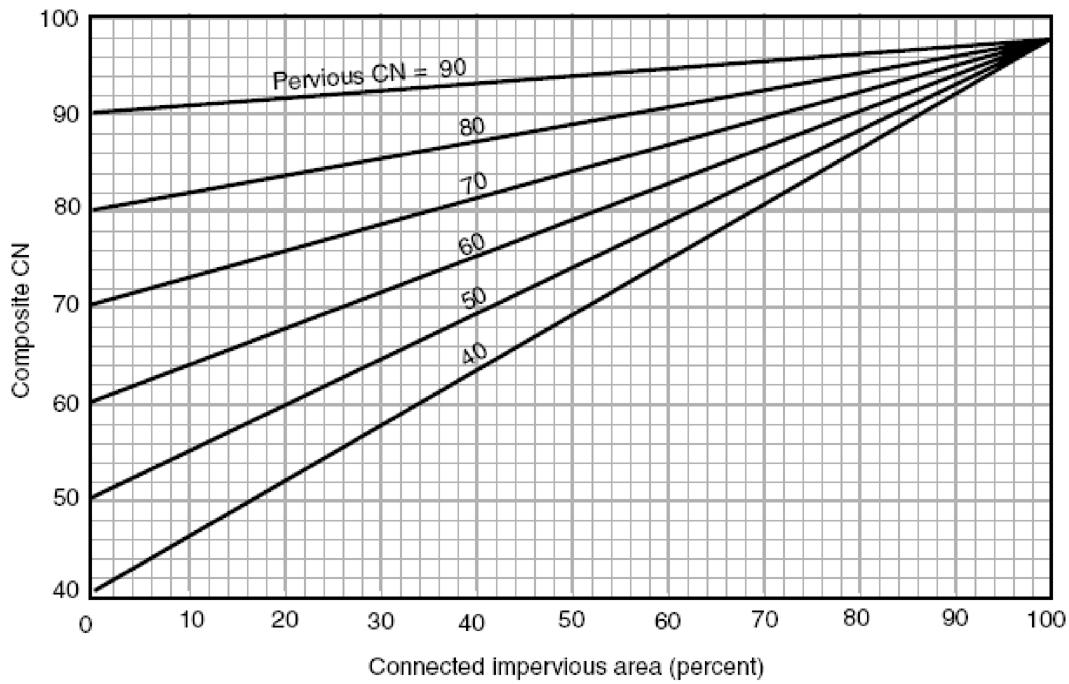
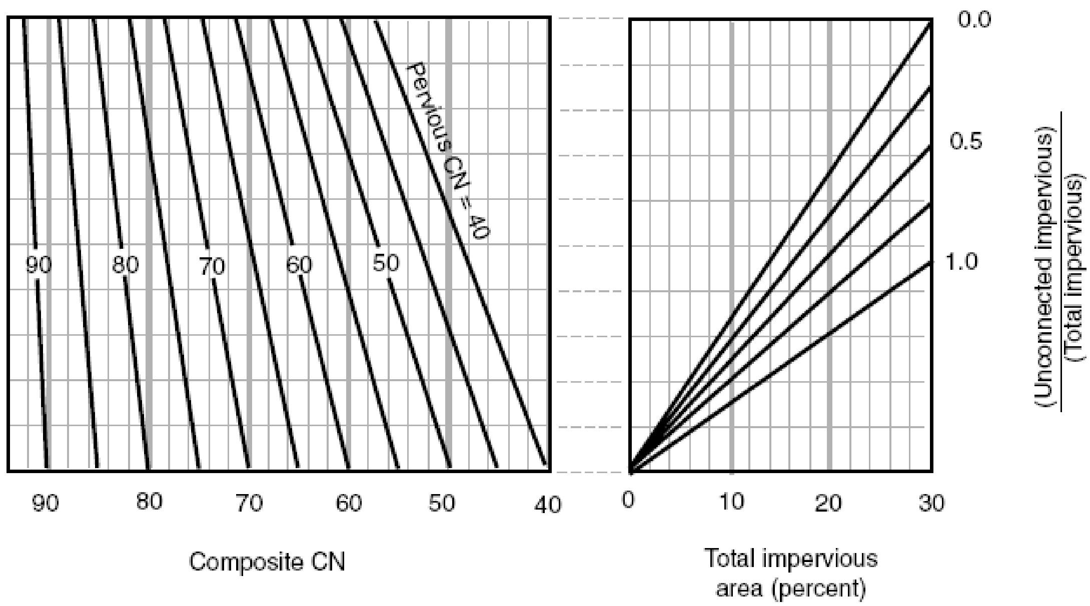


Figure 2-4 Composite CN with unconnected impervious areas and total impervious area less than 30%



Source: NRCS, 1986