TOWN OF CARRBORO

NORTH CAROLINA

TRANSMITTAL PLANNING DEPARTMENT

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

To: **Mayor and Board of Aldermen**
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Date: **March 12, 2014**

Subject: **Update on Stormwater Volume Control for New Development**

Background and Summary

The Town's Land Use Ordinance (LUO) includes provisions for stormwater management to address peak runoff, water quality (as measured by total suspended solids and nitrogen and phosphorus), drawdown rates, and other stormwater management aspects. In addition, the Town amended the ordinance in 2012 to include explicit provisions regulating the total volume of stormwater runoff from a site. The Town adopted a technical amendment in 2013 to include updated State provisions for recognizing the impact of permeable pavement on stormwater volume. Increases in the total volume of runoff associated with new development results in environmental impacts such as decreased groundwater recharge and increased stream channel instability/erosion. Information is presented in this memo to provide an update on staff experience in implementing the total stormwater runoff volume provision.

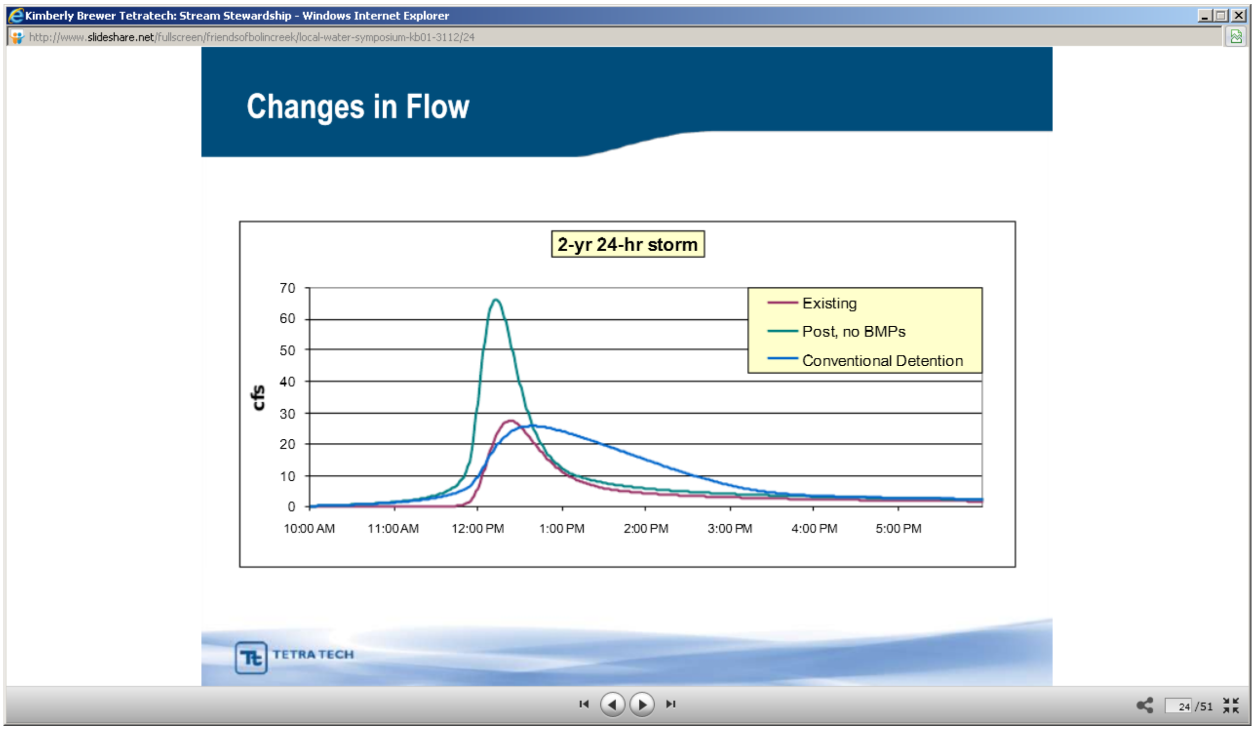
Information

Why is Total Stormwater Volume Control Important?

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. Recent benthic macroinvertebrate monitoring undertaken by the Town has indicated that Bolin Creek remains stressed, with signs of additional stress associated with decreased baseflow.

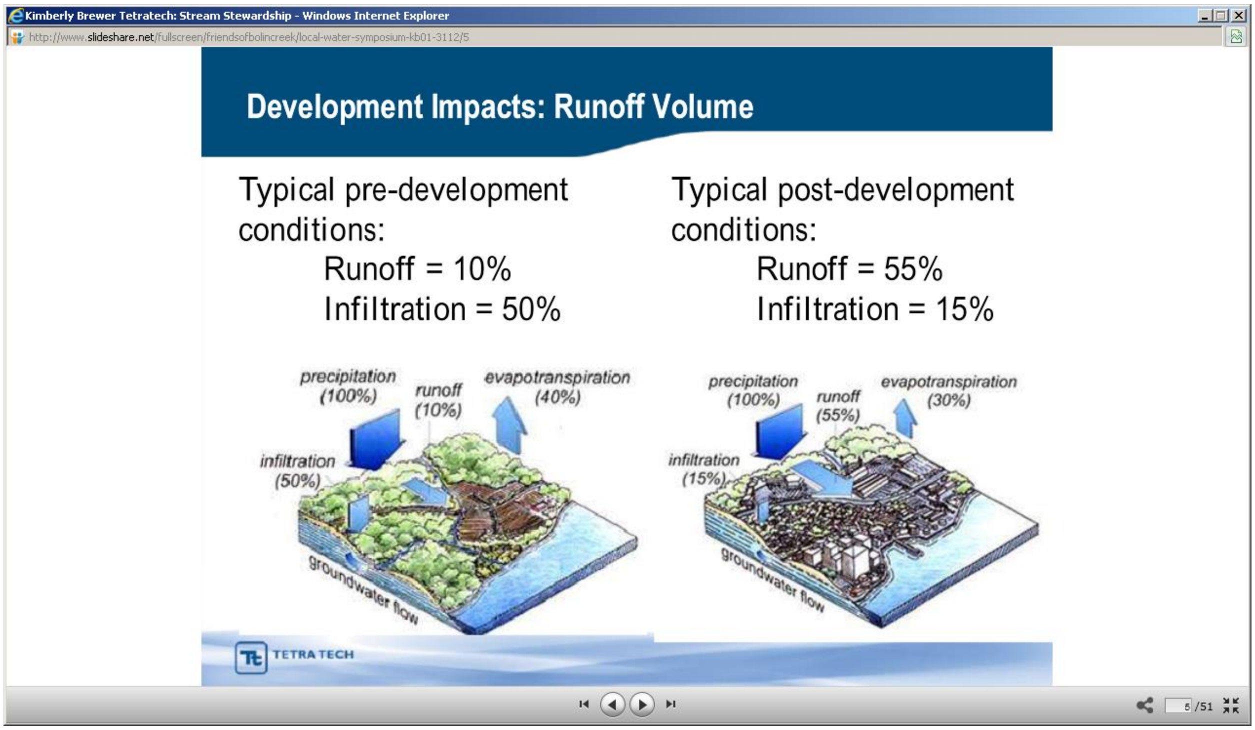
Carrboro's current ordinance provisions address stormwater volume in that treatment of stormwater peak flow is required for the 1 through 25-year recurrence interval 24-hour design storms. In addition, water quality treatment is required for the first inch of rain during a storm event. Storm storage 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. However, these requirements do not fully mitigate stormwater impacts associated with decreases in groundwater recharge and increases in streambank erosion. As stormwater is released in the hours and several days after a storm event, this runoff is not available to replenish groundwater supplies. In addition, controlling volume for flood protection does not provide maximum protection for stream banks since the critical flow for protecting stream banks (at and approaching "bankfull" flow) is not explicitly regulated. Practices that do not intentionally address the total volume of stormwater generated can therefore result in impacts to stream channels from more frequent flows at erosive levels. 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.

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 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", marks an important philosophical milestone that is helping define the next generation of stormwater design. The intention of runoff reduction is that the benefits go beyond flood protection and water quality improvement. If site and stormwater designs can successfully implement runoff reduction strategies, then they will do a better job at replicating a more natural (or pre-development) hydrologic condition. This goes beyond peak rate control to address total runoff volume, duration, velocity, frequency, groundwater recharge, and protection of stream channels. The field of stormwater management is actively involved in integrating the runoff reduction concept with stormwater requirements to create stormwater criteria that can be presented in a unified approach. This concept is also significantly challenging in areas such as Carrboro where the native soils are generally not as well drained as Coastal Plain or Sandhill soils and infiltration of stormwater is difficult to achieve.

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 have for years been known as “Best Management Practices” (BMPs). The effectiveness of these practices in reducing overall runoff is beginning to be captured in guidance and planning tools for stormwater management, as depicted in the following table.

Table 1 (Source: Hirschmann et al; NCSU & NCDENR, 2011)

Runoff Reduction % for various BMPs (relative to no treatment)		
Practice	**Virginia***	**JFLSAT** (NC Piedmont)**
Green Roof	*45 to 60%*	*50*
Rooftop Disconnection	*25 to 50%*	*NA*
Raintanks and Cisterns	*40%*	*User defined*
Permeable Pavement	*45 to 75%*	*0-90%*
Grass Channel	*10 to 20%*	*0*
Bioretention	*40 to 80%*	*35-50%*
Dry Swale	*40 to 60%*	
Wet Swale	*0*	
Infiltration	*50 to 90%*	*NA*
ED Pond	*0 to 15%*	*0*
Soil Amendments	*50 to 75%*	*NA*
Sheetflow to Open Space	*50 to 75%*	*40*
Filtering Practice	*0*	*5*
Constructed Wetland	*0*	*20*
Wet Pond	*0*	*10*

* Virginia statewide technical provisions
* Jordan/Falls Lake Stormwater Accounting Tool (JFLSAT) assumptions

The above table references a stormwater regulatory tool recently developed to support implementation of new development requirements in the Jordan Lake Rules. 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 or runoff reduction provisions in the Town’s ordinance and the timing in parallel with implementation of new development provisions for nitrogen and phosphorus per the Jordan Lake Rules that the rules allow for “offset payments”. Experience to date with the accounting tool 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. A final point regarding State approaches for stormwater regulation is that new State guidelines for permeable pavement were adopted in 2012 that result in additional volume control credits for this technique. Previously, the Jordan Lake Accounting Tool assumed no credit for volume control for permeable pavement. The new credits can result in up to 90% volume credit for the area treated by the permeable pavement, with 80-85% credit being likely for application in Carrboro. The credit is variable based on the soil type and whether the permeable pavement is designed as "infiltrating" or "detention".

Carrboro's Ordinance Provision for Stormwater Volume

"No impact" development given Carrboro's zoning and policies is not in a literal sense feasible when it comes to maintaining total runoff at predevelopment conditions; the ordinance attempts to provide a transparent performance standard for achieving "low impact" development, and is based on the principals and concepts discussed above. The ordinance explicitly quantifies the deviation in stormwater volume from the preexisting condition that is deemed acceptable, and uses the Jordan Lake Accounting Tool (in addition to curve numbers) to calculate annual (and not design event) stormwater volume. The JFLSAT uses the Simple Method (a standard runoff calculation method approved in the NCDWQ BMP Manual). 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 2: 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 Jordan Lake accounting tool (JFLSAT) and the application of the requirements to specific projects/designs. In addition and as mentioned above, NCDWQ had not yet established the JFLSAT credit for permeable pavement. 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 annual volume increase. In addition, utilizing the JFLSAT means that a separate set of calculations do not have to be completed to address the ordinance requirement. 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 BMP Manual 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. Note that while the thresholds are based on careful review, they are not seen as “absolute”. Staff envision that these thresholds can and should be reviewed as experience grows with implementing the Jordan Lake rules and using the accounting tool. The experience to date is discussed below.

Experience From Applying the JFLSAT and Volume Control Ordinance Requirements

How any given development application considers volume/runoff reduction depends on the site and the applicant’s design goals. Over time, it is likely that a combination of approaches will be employed for many projects that include additional and/or larger stormwater structural measures, greater reliance on structural practices that are more beneficial for runoff reduction, greater utilization of rainwater harvesting and reuse, and in general greater employment of LID principals and practices and reduction in impervious surfaces during the planning and design. Table 2 presents stormwater volume calculations for the 4 permitted projects and 4 other sites for which the accounting tool has been applied to study stormwater volume and the ordinance provision (Table 2).

Table 3: Annual Runoff Volume Change from Recent 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 BMPs)	**% change**	**Monitored % change**[2] (developed portion only)	**Compliant with Ordinance**
Pacifica	92,012	342,639	272%	408%/ 946%	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 (Charter School)	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
Lloyd Property	413,466	1,433,451	247%		TBD[4]

1 from JFLSAT applications
2 (Line, WRRI, 2012) (values reported for each of two stations. *Note that these values are not appropriate for a regulatory interpretation since they do not represent the entire site*.)
3 applicant submitted CUP plans and calculations indicating that stormwater reuse for toilet flushing and irrigation would be employed in addition to BMPs shown on plans and accounted for in JFLSAT.
4 Preliminary calculation; review in process.

It appears from this analysis that all of the applications/projects and associated stormwater management plans for which the JFLSAT has been applied appear to be in compliance with the ordinance, with the following qualifications.

1) The Pacifica project (built) would probably comply with this requirement as designed based on JFLSAT tool runs.
2) The Claremont South application would have warranted modification to comply with the stormwater volume ordinance via additional and/or different structural and/or nonstructural stormwater practices. Additional analysis is necessary to see if this requirement could have been met with stormwater management modifications alone or if some changes to other aspects of the site plan would have also been required.
3) The Family Dollar application would have had significant challenges in complying with this requirement. A fundamentally different site plan with less disturbance would likely have been warranted for this site to comply with this requirement. Additional/different runoff reduction stormwater management measures would also probably have to be employed, since a sand filter and detention are not effective in runoff reduction/total volume control.
4) The Lloyd Property application and calculations are still being reviewed.

In summary, experience with the stormwater volume provision of the ordinance has indicated that the provision (relative to other sections of the ordinance):

1. Has resulted in stormwater plans at the CUP stage that demonstrate compliance for all sites reviewed subsequent to the ordinance adoption.

2. Has resulted in stormwater management plans with additional stormwater management/Low Impact Development features for most sites.

3. Requires the most changes to stormwater management plans for currently undeveloped sites with very high intensity/percent impervious planned new development.

Recommendation

Staff recommend that the Board receive the staff report.

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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.

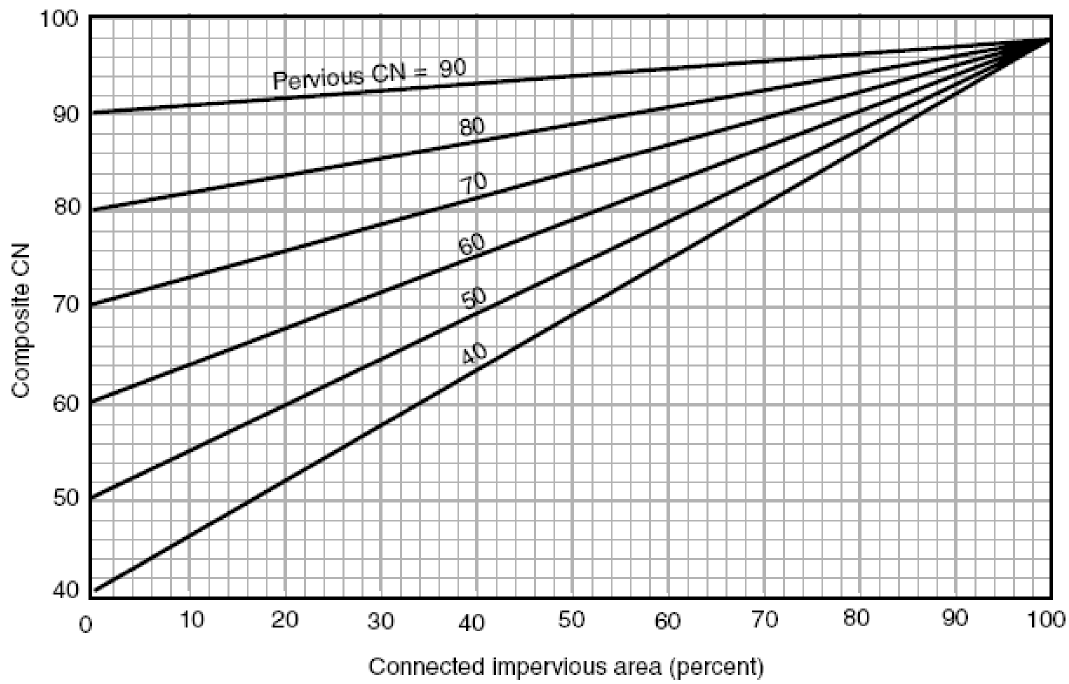
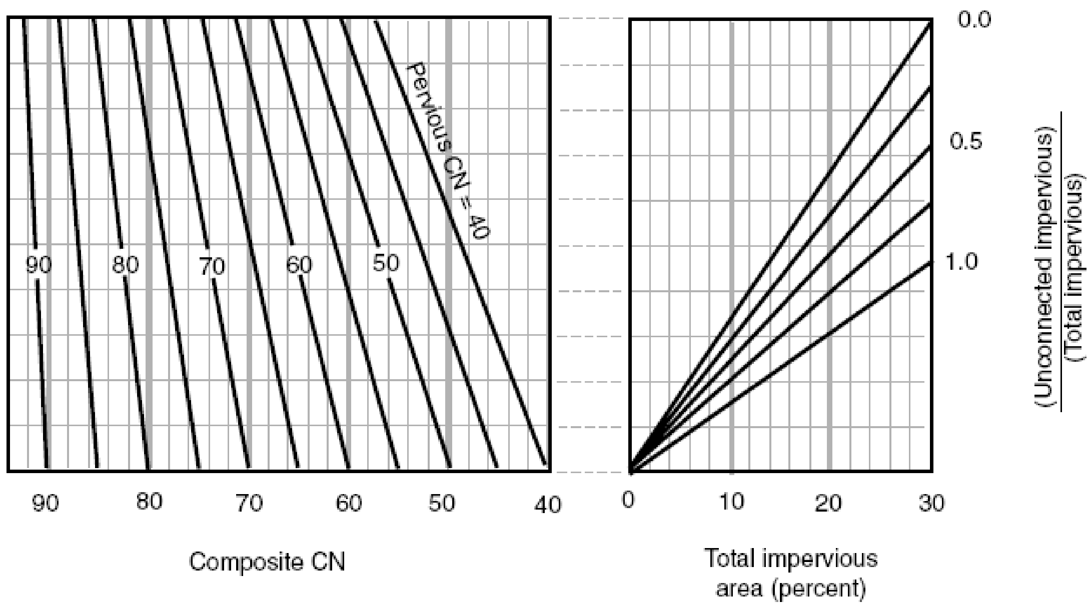


Figure 2-4 Composite CN with unconnected impervious areas and total impervious area less than 30%



Source: NRCS, 1986