Appendix 10-A

Optional Recharge Volume Approach

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10-A.0. INTRODUCTION

The most widely applied recharge and/or volume reduction sizing criterion is the recharge volume approach. The objective of the criteria is to mimic the average annual recharge rate for the prevailing hydrologic soil group(s) present at a development site. Therefore, the recharge volume is calculated as a function of annual pre-development recharge for a given soil group, average annual rainfall volume, and the amount of impervious cover at a site. The recharge volume is considered to be part of the total water quality volume provided at a development site and, therefore, does not require additional stormwater BMPs when water quality treatment is also required ***(see below)***. Additionally, recharge can be achieved by a range of BMP types, including infiltration, bioretention, filtration, impervious disconnection, open space preservation, or some combination of these. Note, however, that the infiltration of polluted stormwater runoff is not always desirable or even possible at some development sites. Therefore, most communities qualify their recharge and/or infiltration requirements to reflect special site conditions, protect groundwater quality, and avoid common nuisance issues. For example, the local review authority may require:

- The pretreatment of stormwater runoff prior to infiltration in some land use categories, pollution source areas (e.g. parking lots, roadways), or geological zones (e.g., karst areas).
- That recharge be restricted or prohibited at specific industrial, commercial and transport-related operations designated as potential stormwater hotspots.
- That recharge be prohibited or otherwise restricted within the vicinity of wellhead protection areas, individual wells, structures, basins.
- That recharge be restricted or prohibited within certain geological zones, such areas adjacent to unstable or fill slopes.
- That recharge requirements may be reduced or waived for minor redevelopment projects.

10-A.1 HORSELY METHOD FOR DETERMINING RECHARGE VOLUMES

One suggested approach to determining recharge volumes is based on work done by Horsley (1996) and is currently implemented in states such as Maryland, Massachusetts, and Vermont. The design approach involves determining the average annual recharge rate based on the prevailing hydrologic soil group (HSG) present at the site from the USDA-Natural Resource Conservation Service (NRCS) Soil Surveys.

HSG is an NRCS designation given to different soil types to reflect their relative surface permeability and infiltrative capability. Group A soils have low runoff potential and high infiltration rates, even when thoroughly wetted. They consist chiefly of deep, well-drained to excessively-drained sands or gravels with high infiltration rates greater than 0.3 in/hr. Group A soils include sand, loamy sand, or sandy loam. Group B soils have moderate infiltration rates (0.15 - 0.30 in/hr) and consist chiefly of soils with fine to coarse textures, such as silt loam or loam. Group C soils have low infiltration rates (0.05 - 0.15 in/hr) and fine textures. They typically have a dense layer near the surface that impedes the downward movement of water. Group C soils include sandy clay loam. Group D soils have high runoff potential with very low infiltration rates (0.0 - 0.05 in/hr). These soils consist primarily of clay soils with high swelling potential, soils with permanently high water tables, soils with a claypan or clay layer at or near the surface, and shallow

soils over nearly impervious parent material. D soils include clay loam, silty clay loam, sandy clay, silty clay, or clay (*TR-55*, 1986).

Horsley recommended the following pre-development recharge volumes to be assigned based on NRCS soil types for humid climates receiving approximately 44 inches of annual average precipitation.

Hydrologic Soil Group Annual Recharge

A – 18 inches/year
B – 12 inches/year
C – 6 inches/year
D – 3 inches/year

Average annual rainfall varies in Virginia from approximately 34 inches per year in Rockingham and Shenandoah Counties to 48 inches in the Hampton Roads region. The State Climatology Office at the University of Virginia has determined that Virginia's overall average annual rainfall amount is 42.7 inches, based on rainfall records from 1895-1998. Therefore, the Horsley recommendation is appropriate for application in Virginia.

The objective of the criterion is to mimic the average annual recharge rate for the prevailing hydrologic soil group(s) present at the development site. Therefore, the recharge volume can be determined as a function of annual pre-development recharge for a given soil group, average annual rainfall volume, and amount of impervious cover at a site. Being a function of site impervious cover, the criterion provides incentive to planners and developers to reduce site imperviousness. Based on this approach, Maryland, our closest state neighbor using this approach (based on an average annual rainfall there of 42 inches) developed the following recharge criteria:

Equation 10-A.1. Site Recharge Volume Requirement
(the percent volume method)

$$Re_v = [(S)(R_v)(A)] / 12$$

OR

Equation 10-A.2. Modified Site Recharge Volume Requirement
(the percent area method)

$$Re_v = (S)(Ai)$$

Where

R_v = 0.05 + 0.009 (I), where I is the percent of impervious cover
A = the site area, in acres
Ai = the measured impervious cover
S = the soil-specific recharge factors, as follows:

HSG-A – 0.38 inches x impervious area
HSG-B – 0.26 inches x impervious area
HSG-C – 0.13 inches x impervious area
HSG-D – 0.07 inches x impervious area

The relationship between the Re_v and site imperviousness is shown in graphical form in **Figure 10-A.1**. The practical implication is that a fairly modest volume of infiltration is needed to maintain recharge rates for B, C and D soils, even if the site is highly impervious. The recharge volume is considered to be part of the total Treatment Volume (T_v) that must be provided at a site and can be achieved by various stormwater BMPs, either individually or in combination.

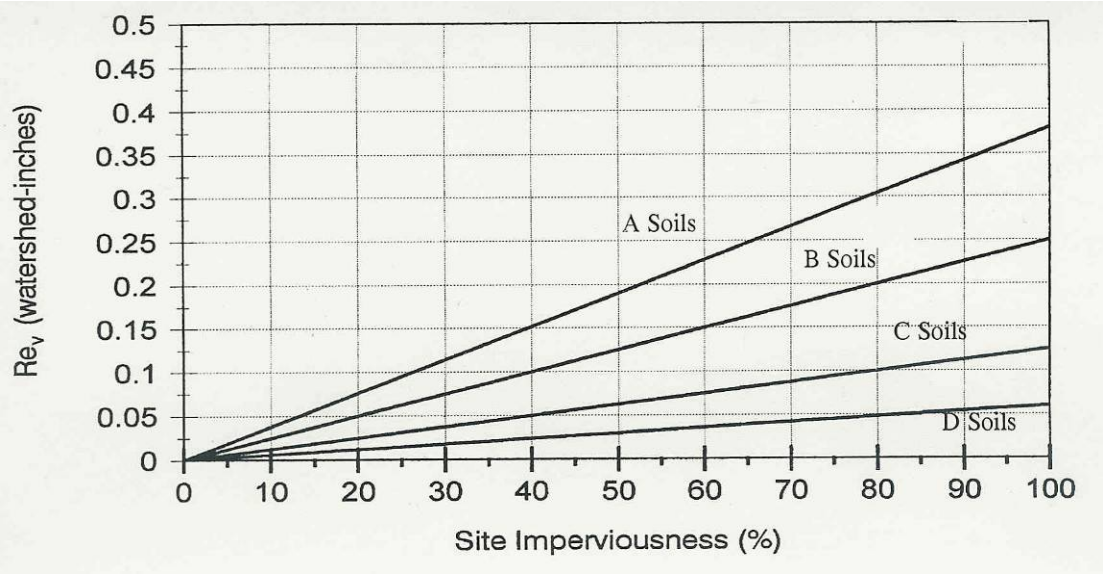

Figure 10-A.1. Relationship between Re_v and Site Impervious Cover

Drainage areas having no impervious cover and no proposed land disturbance during development may be excluded from the Re_v calculations. Designers are encouraged to use such areas as natural conservation areas and, potentially, to reforest them if they do not have forest cover.

10-A.1.1 Basis for Determining the Recharge Volume

- If more than one HSG is present at a site, a composite soil-specific recharge factor should be computed based on the proportion of total site area within each HSG. The recharge volume provided at the site should be directed toward the most permeable HSG available or toward an infiltration-type BMP, preferably incorporating amended soil or filtration media.

- The "percent volume" method is typically used to determine the Re_v requirement when structural practices are used to provide recharge. These practices must be able to provide seepage into the ground and may include infiltration and exfiltration structures (e.g., infiltration, bioretention, dry swales or sand filters with storage below the underdrain). Structures that require impermeable liners, intercept groundwater, or are designed for trapping sediment (e.g., forebays) should not be used for this purpose. In this method, the volume of runoff directed to the structural practices should meet or exceed the computed recharge volume.

- The "percent area" method is typically used to determine the Re_v requirement when non-structural practices are used. Under this method, the recharge requirement is evaluated by mapping the percent of impervious area that is effectively served by an acceptable non-structural practice and comparing it to the minimum recharge requirement. Acceptable non-structural practices include filter strips that treat rooftop or parking lot runoff, sheet flow discharge to stream buffers, and grass channels that treat roadway runoff.

- The recharge volume criteria should not apply to any portion of a site that is designated as a stormwater hotspot nor any project considered as redevelopment. In addition, the appropriate local review authority may alter or eliminate the recharge volume requirement if the site is situated on unsuitable soils (e.g., marine clays) or in an urban redevelopment area. In this situation, non-structural practices (percent area method) should be implemented and any remaining or untreated Re_v should be included in the treatment volume (T_v).

- If Re_v is treated by structural or non-structural practices separate and upstream of the T_v treatment, the T_v should be adjusted accordingly.

NOTE: The Re_v and the T_v are inclusive. Therefore, if a local government does choose to establish separate Groundwater Recharge criteria, the Re_v may be subtracted from the T_v when sizing the water quality BMP.

10-A.2 REFERENCES

Horsely, S. Memorandum dated July 10, 1996. *Methods for Calculating Pre and Post Development Recharge Rates*. Prepared for State of Massachusetts Stormwater Technical Advisory Group.