HMS-PrePro
Supplementary Information – Green & Ampt Method
Prepared By: Cynthia V. Castro

Green & Ampt Method

The Green and Ampt method is a simplification of the Richard's equation for describing water flow and infiltration through the soil (USACE, 2010[1]). In watershed modeling, the most sensitive set of values for describing the subbasin are the infiltration parameters (Smemoe et al, 2004[2]). Before the availability of soils data in digital format, the Green and Ampt method was used infrequently due to inherent difficulties in extracting useful soils information for a widespread area (Smemoe et al, 2004). With the advent of digital soils information, the Green and Ampt method has become more popular.

The Green and Ampt infiltration rate may be calculated by:

$$f_t = K + \frac{KS_w(\theta_s - \theta_i)}{F_t}$$

Where:

f_t = infiltration capacity (in/hr)

K = saturated hydraulic conductivity (permeability) (in/hr)

S_w = soil water suction (in)

θ_s = saturated water content

θ_i = initial water content

F_t = total accumulated infiltration (in)   (TxDOT, 2014[3])

Soil classifications may be used to derive the hydraulic conductivity (K), soil water suction (S_w), and the volumetric moisture deficit (S_e). The initial water content (θ_i) is estimated according to the relationship between the volumetric moisture deficit (θ_e) and the saturated water content (θ_s), such that:

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[1] USACE (2010). Hydrologic Modeling System HEC-HMS: User's Manual, Version 3.5. August 2010. US Army Corps of Engineers, Hydrologic Engineering Center.

[2] Smemoe, C.M., Nelson, E.J., and Zhao, B. (2004). Spatial averaging of land use and soil properties to develop the physically-based green and ampt parameters for HEC-1. *Environmental Modelling & Software*. 19(6): 525-535.

[3] TxDOT (2014). Hydraulic Design Manual. *Texas Department of Transportation*.

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$$\theta_i = S_e(1 - \theta_s)$$

Either the initial water content or the saturated water content is provided by the user. When modeling a specific storm magnitude, regional calibration studies may provide good estimates for the water content ratios. When modeling forecasted rain events, the current in-situ soil water content is useful. Without ongoing and thorough field measurements, an accurate estimation of θ_s and θ_i is problematic. Detailed field measurements for a large watershed are improbable within a short period of time. Given the high sensitivity of loss parameters on the overall hydrograph, rainfall-runoff modeling for forecasted rain events is challenging due to the difficulty in estimating soil water content.

In HMS-PrePro, the Green and Ampt parameters may be estimated from the soils data and a lookup table. At present, HMS-PrePro uses the hydrological soil group (HSG) classification to estimate effective porosity, suction, and hydraulic conductivity according to: http://www.water-research.net/Waterlibrary/Stormwater/greenamp.pdf. The USDA soil texture classifications are related to the HSG, where:

Soil Texture and Hydrological Soil Group

USDA Soil Texture Classification	HSG
Sand	A
Loam	B
Clay Loam	C
Clay	D

In HMS-PrePro, the dominant HSG for each subbasin is determined with *Zonal Statistics*. A lookup table is created that relates the soil parameter estimates to the HSG. Values for the effective porosity (S_e), soil water suction (S_w), and hydraulic conductivity (K) are appended to the subbasin attributes table and used to populate the HEC-HMS output file.

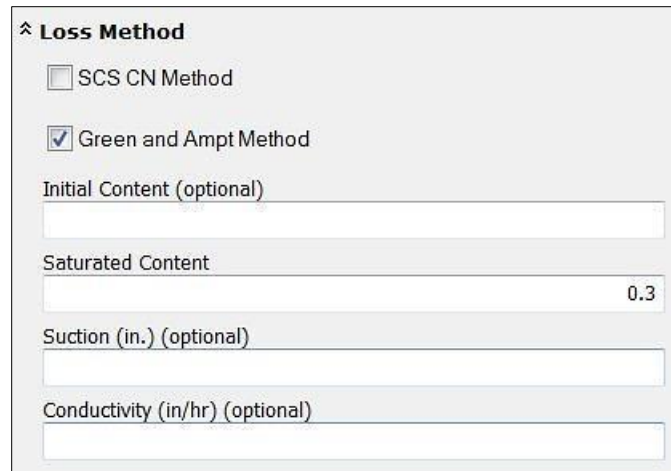| HSG	Porosity_Eff	Suction	Conductivity
A	0.417	1.95	9.276
B	0.436	3.5	0.52
C	0.389	8.22	0.079
D	0.385	12.45	0.024

HMS-PrePro Green & Ampt Lookup Table

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The user has the option of overriding the SSURGO estimates by specifying regional parameter values within the toolbox interface. In either scenario, the user should choose the saturated content ratio according to best practices from local knowledge and observed data.

Green and Ampt User-Input in HMS-PrePro