APPENDIX E - HSPF Pervious Land Parameters for SMRHM

Pervious Land Hydrology (PWATER) Parameters

The HSPF hydrology parameters of PWATER are divided into four sections, titled PARM1-4. PARM1 is a series of checks to outline any monthly variability versus constant parameter values within the simulated algorithm; whereas, PARM2 and 3 are a series of climate, geology, topography, and vegetation parameters that require numerical values to be input.

PARM2 involves the basic geometry of the overland flow, the impact of groundwater recession, potential snow impact due to forest cover and the expected infiltration and soil moisture storage. The main parameters of groundwater recession are KVARY and AGWRC. The infiltration and soil moisture storage parameters are INFILT and LZSN.

PARM3 involves the impact of climate temperature during active snow conditions, a wide range of evaporation parameters due to the variability of the onsite soil and existing vegetation and subsurface losses due to groundwater recharge or the existing geology. The main evaporation parameters are INFEXP, INFILD, BASETP, and AGWETP. The parameter for subsurface loss is DEEPFR, which accounts for one of only three major losses from the PWATER water balance (i.e., in addition to evaporation, and lateral and stream outflows).

PARM4 involves the flow and hydrograph characteristics, the expectation of rain interception due to the inherent moisture storage capacity from existing vegetation, land use and/or near surface soil conditions and evaporation due to the root zone of the soil profile. The main interception parameters are CEPSC and UZSN. The parameter for evaporation as a primary function of vegetation is LZETP.

PARM2

KVARY – A groundwater recession flow parameter used to describe non-linear groundwater recession rate (per inches) (initialize with reported values, then calibrate as needed). KVARY is usually one of the last PWATER parameters to be adjusted; it is used when the observed groundwater recession demonstrates a seasonal variability with a faster recession (i.e., higher slope and lower AGWRC values) during wet periods, and the opposite during dry periods. Value ranges are shown in Table A-4. Values that are representative of the conditions in South Orange County have been selected for the SOCHM. Plotting daily flows with a logarithmic scale helps to elucidate the slope of the flow recession.

AGWRC – A groundwater recession rate, or ratio of current groundwater discharge to that from 24 hours earlier (when KVARY is zero) (per day) (estimate, then calibrate).

The overall watershed recession rate is a complex function of watershed conditions, including climate, topography, soils, and land use. Hydrograph separation techniques can be used to estimate the recession rate from observed daily flow data (such as plotting on a logarithmic scale).

INFILT – Index to mean soil infiltration rate (in/hr); (estimate, then calibrate).   In HSPF, INFILT is the parameter that effectively controls the overall division of the available moisture from precipitation (after interception) into surface runoff. Since INFILT is not a maximum rate nor an infiltration capacity term, its values are normally much less than published infiltration rates, percolation rates (from soil percolation tests), or permeability rates from the literature. INFILT is primarily a function of soil characteristics, and value ranges have been related to SCS hydrologic soil groups (Donigian and Davis, 1978, p.61, variable INFIL) as follows (**Table 8**):

Table 8 - SCS Hydrologic Soil Group Characteristics

SCS Hydrologic Soil Group	INFILT Estimate		Runoff Potential
	(in/hr)	(mm/hr)	
A	0.4 – 1.0	10.0 – 25.0	Low
B	0.1 – 0.4	2.5 – 10.0	Moderate
C	0.05 – 0.1	1.25 – 2.5	Moderate to High
D	0.01 – 0.05	0.25 – 1.25	High

An alternate estimation method that has not been validated is derived from the premise that the combination of infiltration and interflow in HSPF represents the infiltration commonly modeled in the literature (e.g., Viessman et al., 1989, Chapter 4). With this assumption, the value of 2.0*INFILT*INTFW should approximate the average measured soil infiltration rate at saturation, or mean permeability.

LZSN – Lower zone nominal soil moisture storage (inches).   LZSN is related to both precipitation patterns and soil characteristics in the region. Viessman, et al, 1989, provide initial estimates for LZSN in the Stanford Watershed Model (SWM-IV, predecessor model to HSPF) as one-quarter of the mean annual rainfall plus four inches for arid and semiarid regions, or one-eighth annual mean rainfall plus four inches for coastal, humid, or subhumid climates.

PARM3

INFEXP – Exponent that determines how much a deviation from nominal lower zone storage affects the infiltration rate (HSPF Manual, p. 60).

Variations of the Stanford approach have used a POWER variable for this parameter; various values of POWER are included in Donigian and Davis (1978, p. 58). However, the vast majority of HSPF applications have used the default value of 2.0 for this exponent.

INFILD – Ratio of maximum and mean soil infiltration capacities.   In the Stanford approach, this parameter has always been set to 2.0, so that the maximum infiltration rate is twice the mean (i.e., input) value; when HSPF was developed, the INFILD parameter was included to allow investigation of this assumption. However, there has been very little research to support using a value other than 2.0.

DEEPFR - The fraction of infiltrating water which is lost to deep aquifers (i.e., inactive groundwater), with the remaining fraction (i.e., 1-DEEPFR) assigned to active groundwater storage that contributes baseflow to the stream.

It is also used to represent any other losses that may not be measured at the flow gauge used for calibration, such as flow around or under the gauge site. Watershed areas at high elevations, or in the upland portion of the watershed, are likely to lose more water to deep groundwater (i.e., groundwater that does not discharge within the area of the watershed), than areas at lower elevations or closer to the gauge.

BASETP – ET by riparian vegetation as active groundwater enters streambed; specified as a fraction of potential ET, which is fulfilled only as outflow exists.

If significant riparian vegetation is present in the watershed then non-zero values of BASETP are typically applied. If riparian vegetation is significant, a generic BASETP value of 0.2 is typically representative of the evapotranspiration conditions in the San Juan Hydrologic Unit. This value was established in conjunction with a satisfactory annual water balance.

AGWETP – Fraction of model segment (i.e., pervious land segment) that is subject to direct evaporation from groundwater storage, e.g., wetlands or marsh areas, where the groundwater surface is at or near the land surface, or in areas with phreatophytic vegetation drawing directly from groundwater. This is represented in the model as the fraction of remaining potential ET (i.e., after base ET, interception ET, and upper zone ET are satisfied), that can be met from active groundwater storage.

A value of 0.05 has been selected for inclusion into the SOCHM. This value was adjusted and calibrated in the Aliso Creek watershed HSPF model based on adjustment of the low flow simulation, and ultimately the annual water balance.

PARM4

CEPSC – Amount of rainfall, in inches, which is retained by vegetation, that never reaches the land surface, and is eventually evaporated (estimate, then calibrate). Typical guidance for CEPSC for selected land surfaces is provided in Donigian and Davis (1978, p. 54, variable EPXM) (**Table 9**).

Table 9 - CEPSC for Selected Land Surfaces

Land Cover	Maximum Interception (in)
Grassland	0.10
Cropland	0.10 – 0.25
Forest Cover, light	0.15
Forest Cover, heavy	0.20

LZETP – Index to lower zone evapotranspiration (unitless). LZETP is a coefficient to define the ET opportunity; it affects evapotranspiration from the lower zone, which represents the primary soil moisture storage and root zone of the soil profile. LZETP behaves much like a "crop coefficient" with values mostly in the range of 0.2 to 0.7; as such, it is primarily a function of vegetation. Typical and possible value ranges are shown in **Table 11**, and the following ranges for different vegetation are expected for the "maximum" value during the year (**Table 10**):

Table 10 - LZETP Value Ranges

Land Cover Type	Input Coefficient
Forest	0.6 – 0.8
Grassland 0.4	0.4 - 0.6
Row Crops 0.5	0.5 – 0.7
Barren 0.1	0.1 – 0.4
Wetlands 0.6	0.6 – 0.9

Table 11 - Typical permanent channel cross-section with benchmark locations and points of measurement – Rosgen (1996)

HSPF HYDROLOGY PARAMETERS AND VALUE RANGES

NAME	DEFINITION	UNITS	TYPICAL MIN	TYPICAL MAX	POSSIBLE MIN	POSSIBLE MAX	FUNCTION OF ...	COMMENT
PWAT - PARM2								
FOREST	Fraction forest cover	none	0.0	0.50	0.0	0.95	Forest cover	Only impact when SNOW is active
LZSN	Lower Zone Nominal Soil Moisture Storage	inches	3.0	8.0	2.0	15.0	Soils, climate	Calibration
INFILT	Index to Infiltration Capacity	in/hr	0.01	0.25	0.001	0.50	Soils, land use	Calibration, divides surface and subsurface flow
LSUR	Length of overland flow	feet	200	500	100	700	Topography	Estimate from high resolution topo maps or GIS
SLSUR	Slope of overland flow plane	ft/ft	0.01	0.15	0.001	0.30	Topography	Estimate from high resolution topo maps or GIS
KVARY	Variable groundwater recession	1/inches	0.0	3.0	0.0	5.0	Baseflow recession variation	Used when recession rate varies with GW levels
AGWRC	Base groundwater recession	none	0.92	0.99	0.85	0.999	Baseflow recession	Calibration
PWAT - PARM3								
PETMAX	Temp below which ET is reduced	deg. F	35.0	45.0	32.0	48.0	Climate, vegetation	Reduces ET near freezing, when SNOW is active
PETMIN	Temp below which ET is set to zero	deg. F	30.0	35.0	30.0	40.0	Climate, vegetation	Reduces ET near freezing, when SNOW is active
INFEXP	Exponent in infiltration equation	none	2.0	2.0	1.0	3.0	Soils variability	Usually default to 2.0
INFILD	Ratio of max/mean infiltration capacities	none	2.0	2.0	1.0	3.0	Soils variability	Usually default to 2.0
DEEPFR	Fraction of GW inflow to deep recharge	none	0.0	0.20	0.0	0.50	Geology, GW recharge	Accounts for subsurface losses
BASETP	Fraction of remaining ET from baseflow	none	0.0	0.05	0.0	0.20	Riparian vegetation	Direct ET from riparian vegetation
AGWETP	Fraction of remaining ET from active GW	none	0.0	0.05	0.0	0.20	Marsh/wetlands extent	Direct ET from shallow GW
PWAT - PARM4								
CEPSC	Interception storage capacity	inches	0.03	0.20	0.01	0.40	Vegetation type/density, land use	Monthly values usually used
UZSN	Upper zone nominal soil moisture storage	inches	0.10	1.0	0.05	2.0	Surface soil conditions, land use	Accounts for near surface retention
NSUR	Manning's n (roughness) for overland flow	none	0.15	0.35	0.05	0.50	Surface conditions, residue, etc.	Monthly values often used for croplands
INTFW	Interflow inflow parameter	none	1.0	3.0	1.0	10.0	Soils, topography, land use	Calibration, based on hydrograph separation
IRC	Interflow recession parameter	none	0.5	0.7	0.3	0.85	Soils, topography, land use	Often start with a value of 0.7, and then adjust
LZETP	Lower zone ET parameter	none	0.2	0.7	0.1	0.9	Vegetation type/density, root depth	Calibration

Source: U.S. EPA BASINS Technical Note 6

Model assumptions for stream reach infiltration rates were derived through calibration based on data collected within the reaches of Aliso Creek (11 stations) and Rose Creek (6 stations). In the model, infiltration rates vary by soil type. Stream infiltration was calibrated by adjusting a single infiltration value, which was varied for each soil type by factors established from literature ranges (U.S. EPA 2000) of infiltration rates specific to each soil type. The final resulting infiltration rates were 1.368 in/hr (Soil Group A), 0.698 in/hr (Soil Group B), 0.209 in/hr (Soil Group C) and 0.084 in/hr (Soil Group D). The infiltration rates for Soil Groups B, C, and D are within the infiltration range given in literature (Wanielisata et al. 1997). The result for Soil Group A is below the range given in Wanielisata et al. (1997); however, this result only represented one watershed in this TMDL study.