PROCEDURE FOR ESTIMATING HOW FAR EFFLUENT WILL TRAVEL FROM A SURFACE DISCHARGING PRIVATE WASTEWATER TREATMENT SYSTEM

Illinois Soil Classifiers Association Interim Guidance – November, 2014

PURPOSE

On February 10, 2014, the US Environmental Protection Agency implemented a General Permit for New and Replacement Surface Discharging Wastewater Treatment Systems in Illinois. It was issued as National Pollutant Discharge Elimination System (NPDES) Permit No. ILG62.

The goal of this ISCA Interim Guidance is to establish a science-based procedure to address the requirements of ILG62 and determine whether surface discharged effluent would reach a "waters of US" as defined by the USEPA.

BACKGROUND INFORMATION

The US EPA presently has no established science-based method to determine whether surface discharge wastewater would reach Waters of the US, as defined by the USEPA and Army Corp of Engineers (ACOE).

DESIGN PROCESS

The existing tool used by NRCS and others to estimate runoff from a watershed is TR 55. Though this computer program is not designed for point source emissions, the criteria used in the program can be used to estimate how much soil area is required for effluent to be absorbed.

Three factors are used to estimate how far the effluent will move over the surface before it is absorbed by the soil. The factors are: Hydrologic Group; Type of Ground Cover and Soil Treatment (Coefficient Tables 1 [urban] or 2 [rural]).

Soils are classified by the USDA Natural Resource Conservation Service (National Engineering Handbook Part 630) into four Hydrologic Soil Groups based on the soil's runoff potential. The four Hydrologic Soils Groups are A, B, C and D. Where A's generally have the smallest runoff potential and D's the greatest.

Details of this classification can also be found in 'Urban Hydrology for Small Watersheds' published by the Engineering Division of the Natural Resource

Conservation Service, United States Department of Agriculture, Technical Release–55.

SPECIFICATIONS

Hydrologic Group Infiltration Rates (saturated hydraulic conductivity) from TR-55

Hydrologic group A: 0.3 inches/ hr. (use the minimum)

Hydrologic group B: 0.15-0.3 (use 0.22)

Hydrologic group C: 0.05-0.15 (use 0.1)

Hydrologic group D: 0-0.15 (use 0.025)

If the soil classifier has access to the area between the outlet and the "waters of US", investigate the area to determine the soil series and use the assigned hydrologic group for that series. Determine type (and density) of ground cover, and soil treatment. If site access is not available, the official USDA Web Soil Survey soil maps for the area are used to determine the Hydrologic Group. The average of the range is used to estimate the rate of infiltration.

Using the above infiltration rate data, and assuming 200gal./day/bedroom effluent (Illinois Department of Public Health Private Sewage Disposal Code Standard) and 231 cubic in./gallon (direct conversion), the square feet of soil surface needed to absorb the effluent under **ideal** soil and site conditions is as follows:

Sq. Ft. of soil surface required/ bedroom for each Hydrologic Group under ideal conditions (USDA-NRCS)

HG A: 40 sq. ft./bedroom

HG B: 61 sq. ft./bedroom

HG C: 134 sq. ft./bedroom

HG D: 534 sq. ft./bedroom

Example calculation – for above Hydrologic Group B:

1. 200 gal/day/bedroom (IDPH) x 231 cubic inches/gallon = 46,200 cubic inches/day/bedroom,

2. To convert from cu. In./day to standard in./hr.: 46,200 cu. In./day/BR x (1 day/24 hours) = 1,925 cubic inches/hour/BR

3. 1,925 cu. In./hr. divided by 0.22 in./hr. (USDA Hydrologic Group B infiltration rate from page 1) = 8,750 sq. in./BR

4. 8,750 sq. in./BR x (1 sq. ft./144 sq. in.) = 61 square feet/Bedroom

Slope also impacts infiltration vs. runoff, with multiplier factors applied as follows:

Nearly Level soils on 0-2 percent slopes = 1.0

Gently sloping soils on 2-7 percent slopes = 1.33

Sloping or steeper soils on 7+ percent slopes = 2.0

Table 1. (Runoff Coefficient Table – next page) shows runoff coefficients for estimating runoff in primarily urban settings, based on area description and character of the surface.

TABLE 1. Runoff Coefficient Table – Urban Settings

Runoff Coefficient Table

Area Description	Runoff Coefficient C
Business	
Downtown	0.70-0.95
Neighborhood	0.50-0.70
Residential	
Single-Family	0.30-0.50
Multiunits, detached	0.40-0.60
Multiunits, attached	0.60-0.75
Residential (suburban)	0.25-0.40
Apartment	0.50-0.70
Industrial	
Light	0.50-0.80
Heavy	0.60-0.90
Parks, cemeteries	0.10-0.25
Playgrounds	0.20-0.35
Railroad yard	0.20-0.35
Unimproved	0.10-0.30
Character of surface	**Runoff Coefficient C**
Pavement	
Asphaltic and concrete	0.70-0.95
Brick	0.70-0.85
Roofs	0.75-0.95
Lawns, sandy soil	
Flat, 2 percent	0.05-0.10
Average, 2-7 percent	0.10-0.15
Steep, 7 percent	0.15-0.20
Lawns, heavy soil	
Flat, 2 percent	0.13-0.17
Average, 2-7 percent	0.18-0.22
Steep, 7 percent	0.25-0.35

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coefficient (0.10) and increase the square feet needed for absorption based on the coefficient of crop and management of the fields down slope (ie. Row crops, conservation management (0.50) would require 5 times the square footage in Hydrologic Group A soils).

TABLE 2: Table of Runoff Coefficients for the Rational Equation: Q=kCiA

	Hydrologic Soil Group			
Land Use, Crop, and Management	A	B	C	D
CULTIVATED, with crop rotations				
Row Crops, poor management	0.55	0.65	0.70	0.75
Row Crops, conservation mgmt	0.50	0.55	0.65	0.70
Small Grains, poor management	0.35	.40	0.45	0.50
Small Grains, conservation mgmt	0.20	.022	0.25	0.30
Meadow	0.30	0.35	0.40	0.45
PASTURE, permanent w/moderate grazing	0.10	0.20	0.25	0.30
WOODS, permanent, mature, no grazing	0.06	0.13	0.16	0.20
Urban Residential				
30 percent of area impervious	0.30	0.40	0.45	0.50
70 percent of area impervious	0.50	0.60	0.70	0.80

Hydrologic Soil Group Descriptions

A -- Well-drained sand and gravel; high permeability.
B -- Moderate to well-drained; moderately fine to moderately coarse texture; moderate permeability.
C -- Poor to moderately well-drained; moderately fine to fine texture; slow permeability.
D -- Poorly drained, clay soils with high swelling potential, permanent high water table, claypan, or shallow soils over nearly impervious layer(s).

- This table was obtained from http://pasture.ecn.purdue.edu/~engelb/abe526/Runoff/C_table.html

Formula Summary to determine distance effluent is likely to travel

Formula Components:

1. Hydrologic Soil Group sq ft/bedroom (from page 1)
2. Slope Group Factor (from page 1)
3. Table 1 or 2 (ground cover/land use/management) Runoff Coefficient Factor

FORMULA FOR DETERMINING EFFLUENT TRAVEL BEFORE ABSORPTION INTO SOIL:

(Hydrologic Group Sq. Ft./Bedroom) X (Slope Group Factor) X (Table 1 or 2 Runoff Coefficient *(x/.20) Factor) = Total Distance required for effluent absorption.

* Pasture, permanent w/ moderate grazing is considered the ideal vegetative cover. The multiplier would be 1.0. For other options in Table 2, the multiplier would equal X (the appropriate number for the selected crop cover from Table 2) divided by .20 (the ideal).

Example site factors: Hydrologic Group B = 61 Sq. Ft./bedroom (page 1)

Slope of 5% = 1.33 multiplier (see slope group factors on p. 2)

Table 2 Coefficient (x) Factor for a row crop field (cultivated, w/ crop rotation) = .55

Incorporating the above example in the formula :

(61 sq. ft./bedroom) x (1.33) x (.55/.20) = 223.1075 square feet / bedroom required to absorb the expected effluent output.

OTHER CONSIDERATIONS:

The density of vegetative cover of the options listed in Table 2 should also be documented. The table numbers are for the standard vegetative density for each of the land use, crop, and management options listed. If, for instance, the identified cover is 25% less than the expected standard for the identified options, then the formula result (square footage needed for effluent absorption) should be increased by 125%.

Greater concentrations of runoff would be expected on concave slopes than on convex slopes. If the effluent discharge is on or extends into a concave slope, first determine the square footage of area needed per bedroom according to the standard formula below, then convert the square footage determined by formula components 1, 2, and 3 to linear feet (1 sq. ft. = 1 linear foot) .

If the landscape between the effluent discharge point and the downstream beginning point of Waters of the US contains both convex and concave slopes, the percentage of each should be estimated. Then the above equation can be run for each of the two slope segments, then added together to determine the square footage.

Also, during periods when the ground is frozen, the effluent would not be absorbed into the soil as readily. During heavy rain events under these conditions, the effluent would require additional soil surface to be absorbed.

To encourage sheet flow (rather than concentrated output from a single discharge pipe), discharge outlets should be equipped with a distribution system of multiple ports. Such multiple ports may be in the form of gated pipes, level spreaders, baffles, sprinklers, or other dispersing methods. These may be accompanied by land shaping or leveling in order to maximize sheet flow.

The goal is to estimate, using the available science, whether the effluent will reach a “waters of US”. The following document provides the official criteria for determinations of **“WATERS OF US”**

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References

Illinois Department of Public Health Private Sewage Disposal Licensing Act and Code, Part 905

Illinois Soil Classifiers Association: https://www.illinoissoils.org/

United States Army Corps of Engineers
Jurisdictional Determination Form
Instructional Guidebook

http://www.usace.army.mil/Portals/2/docs/civilworks/regulatory/cwa_guide/jd_guidebook_051207final.pdf

USDA – Natural Resources Conservation Service web link for Engineers List of Hydrologic Soil Groups for Illinois soil series =
https://prod.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs141p2_029054.pdf

United States Department of Agriculture Natural Resources Conservation Service National Engineering Handbook Part 630

United States Department of Agriculture Natural Resources Conservation Service Engineering Division Technical Release – 55 “Urban Hydrology for Small Watersheds”

United States Department of Agriculture Web Soil Survey: source of soil maps and data at www.websoilsurvey.sc.egov.usda.gov/App/HomePage.htm