



# Cole and ASSOCIATES INCORPORATED

APPROVED  
1/28/08  
RKC

## Storm Water Management Report

### Sediment Trap H

### Preston Woods Phase III



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## Sediment Trap H – Universal Soil Loss Calculations

Soil Loss (Tons/ac/yr) = A = R x K x (LS) x C x P

R = Rainfall Erosion Index = 220 (from Fig. 17.13)

K = Soil Erodibility Factor = 0.28 (Silty Clay- Table 17.6)

$$LS = \text{Length - Slope Factor} = \left( \frac{L}{72.6} \right)^m \left( \frac{430x^2 + 30x + 0.43}{6.574} \right)$$

ADJ Factor

(0.58) Segment 1: L=330LF M=0.4, X=0.040

$$LS_1 = \left( \frac{330}{72.6} \right)^{0.4} \left( \frac{430(0.04)^2 + 30(0.04) + 0.43}{6.574} \right)$$

$$LS_1 = 0.65$$

(1.06) Segment 2: L=90LF M=0.3, X=0.020

$$LS_2 = \left( \frac{90}{72.6} \right)^{0.3} \left( \frac{430(0.02)^2 + 30(0.02) + 0.43}{6.574} \right)$$

$$LS_2 = 0.20$$

(1.37) Segment 3: L=22LF M=0.5, X=0.20

$$LS_3 = \left( \frac{22}{72.6} \right)^{0.5} \left( \frac{430(0.20)^2 + 30(0.20) + 0.43}{6.574} \right)$$

$$LS_3 = 1.98$$

$$LS = \left( \frac{(0.58)(0.65) + (1.06)(0.20) + (1.37)(1.98)}{3} \right)$$

$$LS = 1.10$$

C = Cover Factor = 1.0 (For Construction Sites-Table 17.9)

P = Erosion Control Practice Factor = 1.3 (Table 17.10)

$$A = (220)(0.28)(1.10)(1.0)(1.3)$$

$$= 88.09 \text{ Tons/ac/yr}$$

Unit Weight of Soil = 120 lbs/CF

Watershed Acreage = 2.16Acres

$$\begin{aligned}\text{Volume of Soil Lost} &= (88.09 \text{ Tons} / \text{ac} / \text{ty}) (2.16 \text{ ac}) \left( \frac{2000 \text{ lbs} / \text{ton}}{120 \text{ lbs} / \text{cf}} \right) \\ &= 3,171 \text{ cf/yr}\end{aligned}$$

$$\text{Max. Storage Elevation} = \frac{5,232 - 3,171}{5,232 - 2,574} = \frac{603 - x}{603 - 602}$$

$$x = 602.22$$



(AI Sill Elevation 606.00)

2-Year High Water Elevation =

$$H = \left( \frac{Q}{CL} \right)^{2/3}$$

$$H = \left( \frac{5.89}{(3.0)(12.67')} \right)^{2/3}$$

$$H = \left( \frac{5.89}{38.01} \right)^{2/3}$$

$$H = (0.16)^{2/3}$$

$$H = 0.30$$

2-Year High Water Elevation =

$$0.30 + 606.00 \text{ (AI Sill Elevation)}$$

2-Year High water Elevation =

$$606.30$$

10-Year Q = 8.90 cfs

10-Year High Water Elevation=

$$H = \left( \frac{Q}{CL} \right)^{2/3}$$

$$H = \left( \frac{8.90}{(3.0)(12.67')} \right)^{2/3}$$

$$H = \left( \frac{8.90}{38.01} \right)^{2/3}$$

$$H = (0.23)^{2/3}$$

$$H = 0.38$$

10-Year High Water Elevation =

$$0.38 + 606.00 \text{ (AI Sill Elevation)}$$

10-Year High water Elevation =

$$606.38$$

10-Year High water Elevation

$$= 606.38$$

Top of Basin

$$= 608.00$$

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Elevation (ft)	Planimeter (sq.in)	Area (sq.ft)	A1+A2+sqr(A1*A2) (sq.ft)	Volume (cu.ft)	Volume Sum (cu.ft)
600.00	-----	0	0	0	0
601.00	-----	1693	1693	564	564
602.00	-----	2343	6028	2009	2574
603.00	-----	2987	7975	2658	5232
604.00	-----	3829	10198	3399	8631
605.00	-----	4657	12709	4236	12868
606.00	-----	5733	15557	5186	18053
607.00	-----	7573	19895	6632	24685
608.00	-----	10364	26796	8932	33617

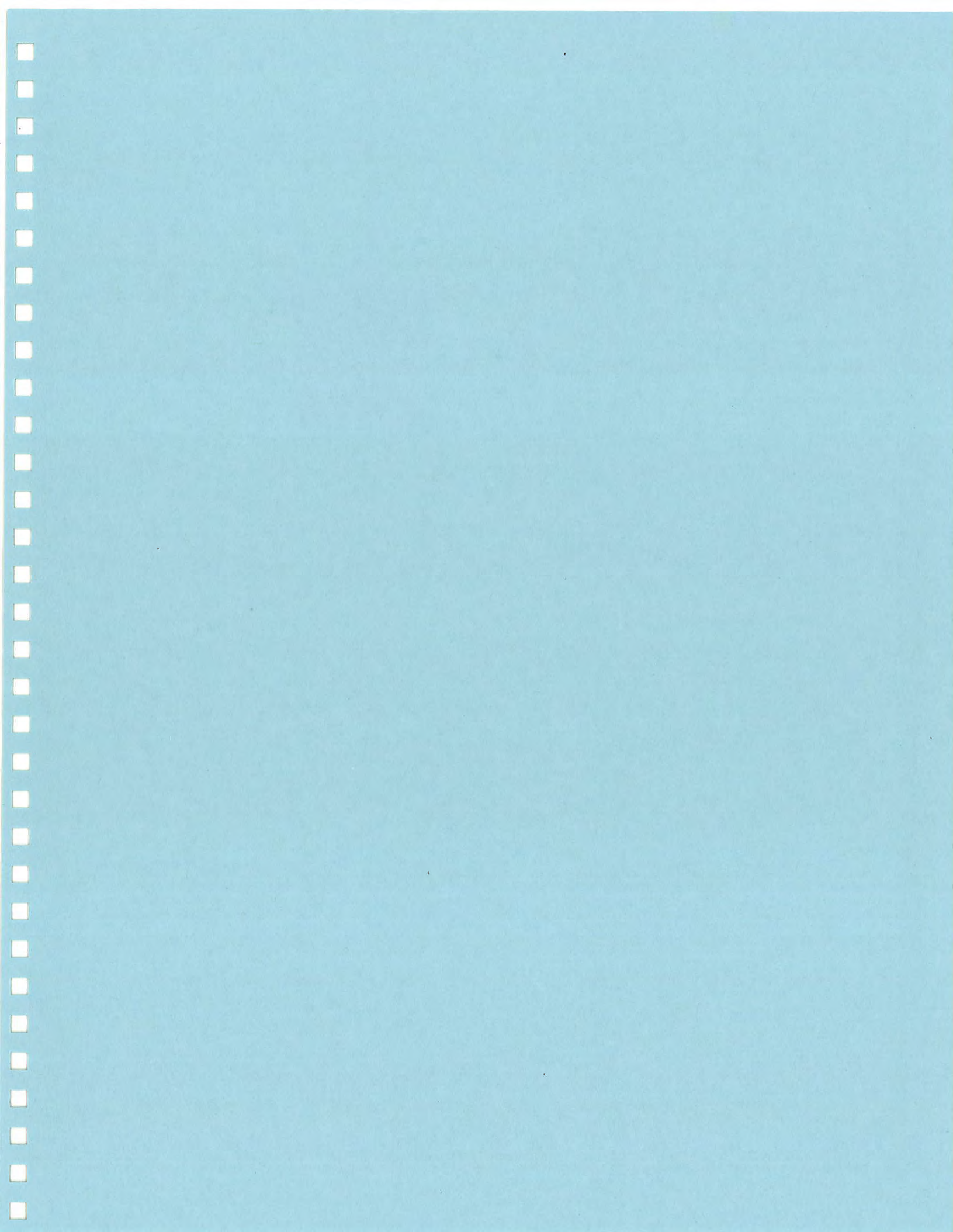
## POND VOLUME EQUATIONS

\* Incremental volume computed by the Conic Method for Reservoir Volumes.

$$\text{Volume} = (1/3) * (\text{EL2}-\text{EL1}) * (\text{Area1} + \text{Area2} + \text{sq.rt.}(\text{Area1}*\text{Area2}))$$

where: EL1, EL2 = Lower and upper elevations of the increment  
 Area1, Area2 = Areas computed for EL1, EL2, respectively  
 Volume = Incremental volume between EL1 and EL2





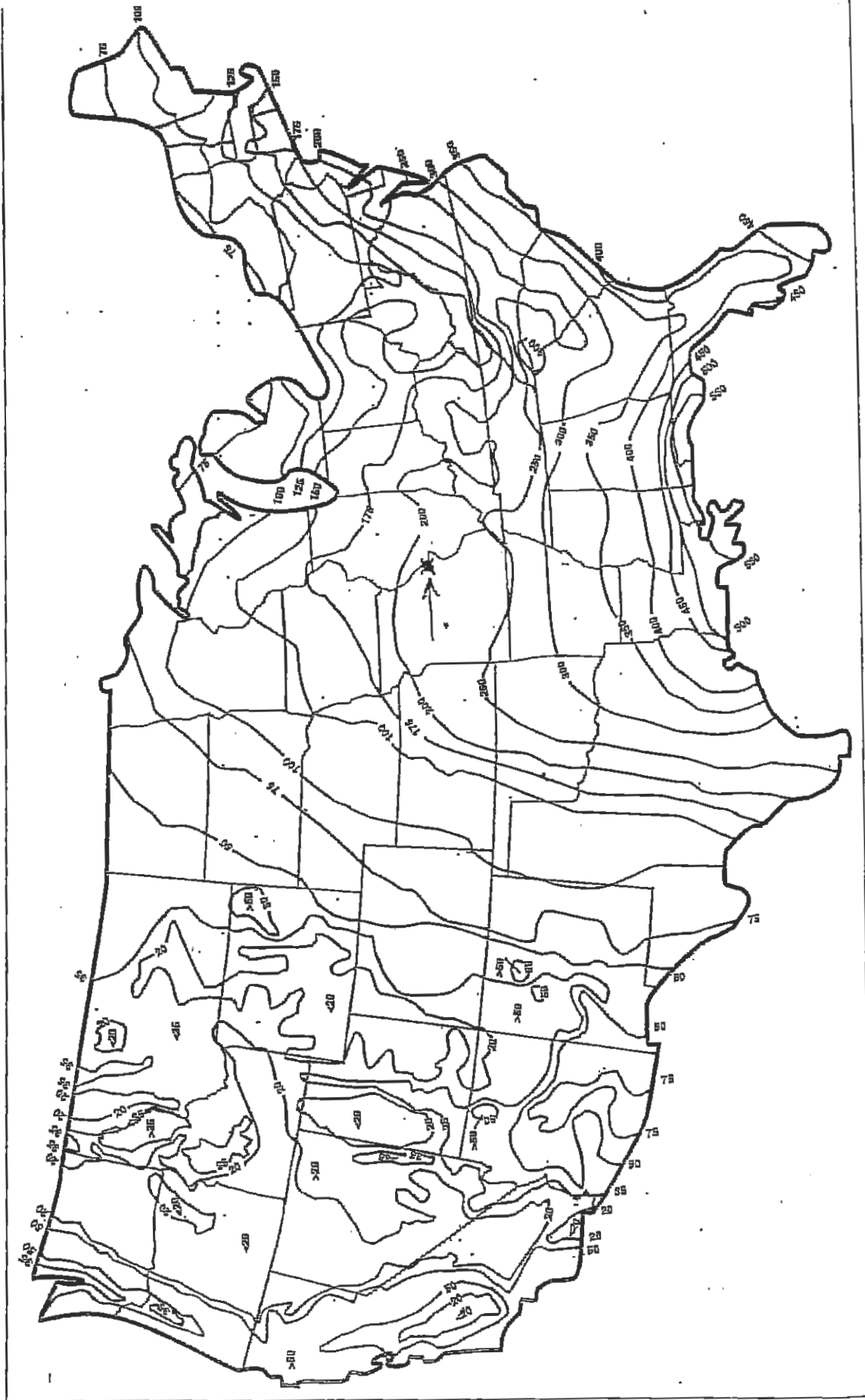


FIGURE 17.13 Average annual values of the R factor. (Source: USDA, SCS 1977.)



TABLE 17.6 K Values for Generalized Soils

## K VALUES FOR TOPSOIL

TEXTURE OF SURFACE LAYER	ESTIMATED K VALUE
Clay, clay loam, loam, silty clay	.32
Fine sandy loam, loamy very fine sand, sandy loam	.24
Loamy fine sand, loamy sand	.17
Sand	.15
Silt loam, silty clay loam, very fine sand loam	.37

Source: Soil Conservation Service, *Water Management and Sediment Control for Urbanizing Areas*, Columbus, Ohio, 1978.

## K VALUES FOR SUBSOIL

GENERALIZED SOIL CATEGORY (TEXTURE OF MATERIALS)	ESTIMATED K VALUE OF EXPOSED SUBSOIL MATERIAL
A. Outwash soils	
Sand	.17
Loamy sand	.24
Sandy loam	.43
Gravel, fine to moderate fine subsoil	.24
Gravel, medium to moderate coarse subsoil	.49
B. Lacustrine soils	
Silt loam and very fine sandy loam	.37
Silty clay loam	.28
Clay and silty clay	.28 ←
C. Glacial till	
Loam, fine to moderate fine subsoil	.32
Loam, medium subsoil	.37
Clay loam	.32
Clay and silty clay	.28
D. Loess	.37
E. Residual	
Sandstone	.49
Siltstone, nonchannery	.43
Siltstone, channery	.32
Acid clay shale	.28
Calcareous clay shale or limestone residuum	.24

Source: Soil Conservation Service, *Water Management and Sediment Control for Urbanizing Areas*, Columbus, Ohio, 1978.

and  $s_1 = 12$ ,  $s_2 = 10\%$ ,  $s_3 = 8\%$ , and  $s_4 = 5\%$  using equation (17.2). For example, a 12% slope is equivalent to  $6.8^\circ$  ( $\sin 6.8^\circ = .119$ ).

$$(LS)'_{12\%} = \left( \frac{600}{72.6} \right)^{0.5} \times \left( \frac{430(.119)^2 + 30(.119) + 0.43}{6.574} \right) = 4.4 \quad (17.4)$$

Similarly,  $(LS)_{10\%} = 3.5$ ,  $(LS)_{8\%} = 2.4$ , and  $(LS)_{5\%} = 1.4$ . From Table 17.7 the weighing factors are 0.50, 0.91, 1.18, and 1.40 and the effective LS is

$$(LS)_e = \frac{4.4(.50) + 3.5(.91) + 2.4(1.18) + 1.4(1.40)}{4} = 2.5 \quad (17.5)$$

**Chart Values for Successive Segments of a Slope Where the Slope-Length Exponent Equals 0.5.**

SEGMENT NO. (TOP TO BOTTOM)	NUMBER EQUAL-LENGTH SEGMENTS INTO WHICH THE SLOPE IS DIVIDED FOR EVALUATION OF LS				
	2	3	4	5	
1	0.71	0.58	0.50	0.45	
2	1.29	1.06	0.91	0.82	
3		1.37	1.18	1.06	
4			1.40	1.25	
5				1.42	

Source: Soil Conservation Service, *Water Management and Sediment Control for Urbanizing Areas*, Columbus, Ohio, 1978.

### Cover Factor (C)

The cover factor is the vegetative cover or the cropping management factor. It is an index of the type of ground cover and the condition of the soil over the area. Specifically, it is a ratio of the soil loss from a specific cover condition to the soil loss from a clean, tilled, fallow condition for the same soil, slope, and rainfall conditions. For denuded construction sites a C factor of 1 is appropriate. This condition is similar to the agricultural definition of continuous fallow, tilled up- and down-slope where  $C = 1$ . Table 17.8 shows typical C values for undisturbed land. Table 17.9 shows C values for various types of soil covers.

### Erosion Control Practice Factor (P)

The erosion control practice factor accounts for ground surface conditions that affect the runoff velocity. Specifically, P is defined as the ratio of soil loss with a given surface condition to soil loss with up-and-down-hill plowing. Such conditions would be contouring, terracing, roughening the soil, sediment basins, and control structures. Table 17.10 shows estimated P values that apply to construction areas.

### Limitations of USLE

The USLE is an empirical equation that was initially developed for agricultural applications. The USLE applies to relatively large homogeneous soil areas and is based on long-term averages of rainfall and soil losses from runoff directly on the slope. It does not estimate deposition, nor does it estimate sediment yield at a downstream location.

Morphological features of agricultural land are different from urbanized developing land. Agricultural land typically is characterized by relatively long, regular, gentle slopes whereas construction sites may have discontinuous and irregular land patterns. The land patterns are a combination of steep slopes, sharp breaks, excavation holes, and

average annual soil loss, the erosion from the relatively term denuding-stabilization sequence typical of a construction site may not be indicative of the value obtained from the USLE. Runoff from an area above a disturbed slope is not a factor in establishing the USLE, yet runoff from slope areas does occur on construction sites. Therefore, use of the USLE, especially for construction sites, requires the site area to be broken down into homogeneous areas. The USLE is applied to each individual area and the sum of the results is representative of the soil erosion estimate.

Use of the USLE provides an estimate of a site's erosion potential. Using the USLE to compare different practices at a construction site is appropriate; however, using the USLE to compare one construction site to another is not recommended. The equation does not account for deposition of sediment in the nonhomogeneous, irregular land forms of land development projects. Not all sediment eroded from a site can be classified as soil loss relative to the site boundaries. Some soil is redeposited on site from natural erosion.

A revised version of the USLE, the RUSLE, is now available as computer software. The RUSLE, while still using the same terms, incorporates data and additional theory describing hydrologic and erosion processes not included in the original USLE. The new data and additional theory allow for more refinement for evaluating the terms to suit specific site conditions. The computer format facilitates more complex calculations.

Another effort by the U.S. Department of Agriculture (USDA) in conjunction with the Agricultural Research Service (ARS), the Soil Conservation Service (SCS), and the Bureau of Land Management (BLM) has begun to develop erosion prediction technology to replace the USLE. The computer program resulting from this Water Erosion Prediction Project (WEPP) is expected to be available by the later part of the 1980s.

## 17.7 SEDIMENT TRAPPING FACILITIES

Sediment trapping facilities retain the eroded sediment from a site by impounding sediment-laden runoff long enough for the sediment to settle out. Trapping facilities vary depending on the estimated runoff draining into the facility, the volume of sediment, and whether they are temporary or permanent. The facilities typically are either sediment traps or sediment basins; the distinction depends on the size of the facility. Facilities with drainage areas of about 3 acres are sediment traps (consult local design standards for specific acreage). Larger trapping facilities, sediment basins, are frequently designed as permanent. The location and design of permanent sediment basins should be such that they easily convert to retention or detention basins after the project area is stabilized.

### Sediment Basins

Sediment basins operate by reducing the velocity and turbulence of the runoff to levels where the material

TABLE 17.8-B C Factors for Mechanically Prepared Woodland Sites

SOIL CONDITION<sup>2</sup> AND WEED COVER<sup>3</sup>

SITE PREPARATION	MULCH COVER <sup>1</sup>	EXCELLENT		GOOD		FAIR		POOR	
		NC	WC	NC	WC	NC	WC	NC	WC
	Percent								
Disked, raked, or bedded <sup>4</sup>	None	0.52	0.20	0.72	0.27	0.85	0.32	0.84	0.36
	10	.33	.15	.46	.20	.54	.24	.60	.28
	20	.24	.12	.34	.17	.40	.20	.44	.22
	40	.17	.11	.23	.14	.27	.17	.30	.19
	60	.11	.08	.15	.11	.18	.14	.20	.15
	80	.05	.04	.07	.06	.09	.08	.10	.09
Burned <sup>5</sup>	None	.25	.10	.26	.10	.31	.12	.45	.17
	10	.23	.10	.24	.10	.26	.11	.36	.16
	20	.19	.10	.19	.10	.21	.11	.27	.14
	40	.14	.09	.14	.09	.15	.09	.17	.11
	60	.08	.06	.09	.07	.10	.08	.11	.08
	80	.04	.04	.05	.04	.05	.04	.06	.05
Drum chopped <sup>5</sup>	None	.18	.07	.17	.07	.20	.08	.29	.11
	10	.15	.07	.16	.07	.17	.08	.23	.10
	20	.12	.06	.12	.06	.14	.07	.18	.09
	40	.09	.06	.09	.06	.10	.06	.11	.07
	60	.06	.05	.06	.05	.07	.05	.07	.05
	80	.03	.03	.03	.03	.03	.03	.04	.04

<sup>1</sup> Percentage of surface covered by residue in contact with the soil.

<sup>2</sup> Excellent soil condition—Highly stable soil aggregates in topsoil with fine tree roots and litter mixed in. Good—Moderately stable soil aggregates in topsoil or highly stable aggregates in subsoil (topsoil removed during raking), only traces of litter mixed in. Fair—Highly unstable soil aggregates in topsoil or moderately stable aggregates in subsoil, no litter mixed in. Poor—No topsoil, highly erodible soil aggregates in subsoil, no litter mixed in.

<sup>3</sup> NC—No live vegetation. WC—75% cover of grass and weeds having an average drop fall height of 20 in. For intermediate percentages of cover, interpolate between columns.

<sup>4</sup> Modify the listed C values as follows to account for effects of surface roughness and aging. First year after treatment multiply listed C values by .40 for rough surface (depressions > 8 in); by .65 for moderately rough; and by .90 for smooth depressions (< 2 in). For 1–4 years after treatment multiply listed factors by .7.

<sup>5</sup> For first 3 years; use C values as listed.

(Source: USDA, SCS 1977.)

TABLE 17.9 C Factor for Various Quantities of Mulch

MULCH ADEQUATELY CRIMPED INTO SOIL	C FACTOR
Bare area	1.00
¼ ton straw mulch per acre	.52
½ ton straw mulch per acre	.35
¾ ton straw mulch per acre	.24
1 ton straw mulch per acre	.18
1½ ton straw mulch per acre	.10
2 ton straw mulch per acre	.06
3 ton straw mulch per acre	.03
4 ton straw mulch per acre	.02

Source: Soil Conservation Service, Universal Soil-Loss Equation, Agronomy Note #50, Colorado SCS, 1977.

clity. Rainfall-runoff volumes and soil types are highly regionalized. Sizing a sediment basin depends on local municipalities' design standards, which are developed according to regional conditions. In some cases determining the basin's volume may be as uncomplicated as applying a single constant to the drainage area (e.g., 100 cy of required storage volume per drainage acre). This design parameter approximates an upper limit for the amount of sediment expected to be delivered to the facility for the design storm. The assumption here is that the design storm erodes a constant amount of sediment. This blanket value does not consider the soils or topographical features that vary from site to site nor the daily variations of the site conditions. In other cases, sizing the basin requires a detailed analysis of the soils and their particle size distribution. This information is then used with USLE or discrete particle settling theory to set the sediment basin size.

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**TABLE 17.10 Erosion Control Practice Factor P for Construction Sites (Parks, 1973)**

Surface Condition With No Cover	Factor P
1. Compact, smooth, scraped with bulldozer or scraper up and down hill	1.30 ←
2. Same as above, except raked with bulldozer root, raked up and down hill	1.20
3. Compact, smooth, scraped with bulldozer root, raked across the slope	1.20
4. Same as above, except raked with bulldozer root, raked across the slope	0.90
5. Loose, as in a disked plow layer	1.00
6. Rough irregular surface, equipment tracks in all directions	0.90
7. Loose with rough surface greater than 12-inch depth	0.80
8. Loose with smooth surface greater than 12-inch depth	0.90
<b>Structures</b>	
1. Small sediment basins:	
0.04 basin/acre	0.50
0.06 basin/acre	0.30
2. Downstream sediment basins with chemical flocculants	0.10
without chemical flocculants	0.20
3. Erosion control structures	
normal-rate usage	0.50
high-rate usage	0.40
4. Strip building	0.75

(Source: SWMM Users Manual which references *Use of the Universal Soil Loss Equation as a Design Standard*, ASCE Water Resources Engineering Meetings, Washington, D.C. 1973. Reprinted with permission from ASCE.)

### Discrete Particle Settling Theory

A discrete particle is one that does not change in size, shape, or weight as it settles. Discrete particle settling theory describes the settling behavior of particles in an ideal basin in quiescent water. Particle settling in such ideal conditions depends only on fluid properties and particle characteristics. Interaction between particles is assumed to be negligible.

A particle settling in a quiescent fluid accelerates under the influence of gravity until the driving force of gravity is balanced by the resisting drag force. At this point the particle's terminal velocity is a maximum and remains constant during the remainder of the falling distance. The terminal

settling velocity,  $v_s$ , for a spherical particle is

$$v_s = \sqrt{\frac{4g(\rho_p - \rho_w)d_p^3}{3C_D\rho_w}} \quad (17.6)$$

where  $\rho_p$  = density of the spherical particle ( $\text{kg/m}^3$ ),  $\rho_w$  = density of water ( $\text{kg/m}^3$ ),  $g$  = acceleration due to gravity ( $\text{m/s}^2$ ),  $C_D$  = coefficient of drag for the particle and  $d_p$  = diameter of the particle (m).

The drag coefficient  $C_D$  is approximated by

$$C_D = \frac{24}{N_R} \quad \text{for} \quad N_R < 1 \quad (17.7)$$

$$C_D = \frac{24}{N_R} + \frac{3}{N_R} + 0.34 \quad \text{for} \quad N_R \geq 1$$

where  $N_R$ , the dimensionless Reynolds number, is

$$N_R = \frac{v_s d_p \rho_w}{\mu} \quad (17.8)$$

with  $\mu$  = the absolute viscosity of water. Note that when  $N_R$  is less than 1, the settling velocity for a sphere reduces to

$$v_s = \frac{g(\rho_p - \rho_w)d_p^2}{18\mu} \quad (17.9)$$

which is Stoke's Law for the settling velocity of a sphere in laminar flow. This can be reduced to

$$v_s = 2.8d_p^2 \quad (17.10)$$

where  $v_s$  is in feet per second and  $d_p$  is in millimeters, assuming the specific gravity of the particle = 2.75 and a water temperature of 70°F.

An idealized rectangular settling basin (figure 17.14) consists of four zones: the inlet zone, the removal zone, the outlet zone, and the settling zone. The length  $L$  is the distance between the inlet and outlet zones,  $H$  is the depth of the settling zone, and  $W$  is the basin width. Under such idealized conditions the incoming flow  $Q_i$  is steady and constant for the width of the basin. Particles in the incoming flow move horizontally through the basin with a horizontal velocity  $v_h = Q_i/(WH)$ . The vertical velocity component is the settling velocity,  $v_s$ .

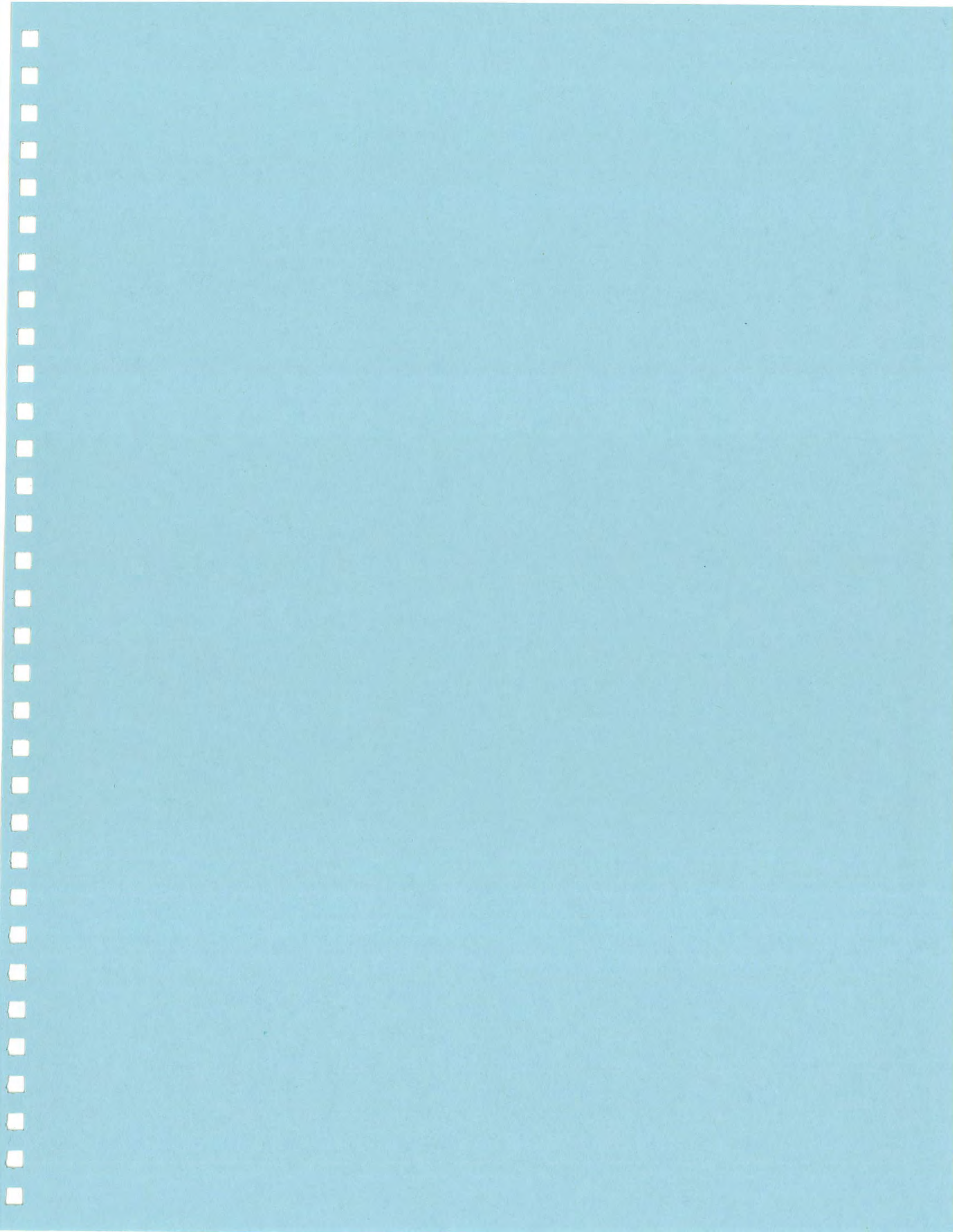
The design of an effective settling basin is such that an incoming particle travels the vertical height  $H$  and settles out before it travels the horizontal length  $L$  and is discharged. At or below the distance  $H$  the particle is in the settling zone and is considered removed from suspension. The time  $T_L$  for the particle to travel the horizontal length  $L$  of the basin is given as

$$T_L = \frac{L}{Q_i/(W \times H)} \quad (17.11)$$

The time to travel the height  $H$  is

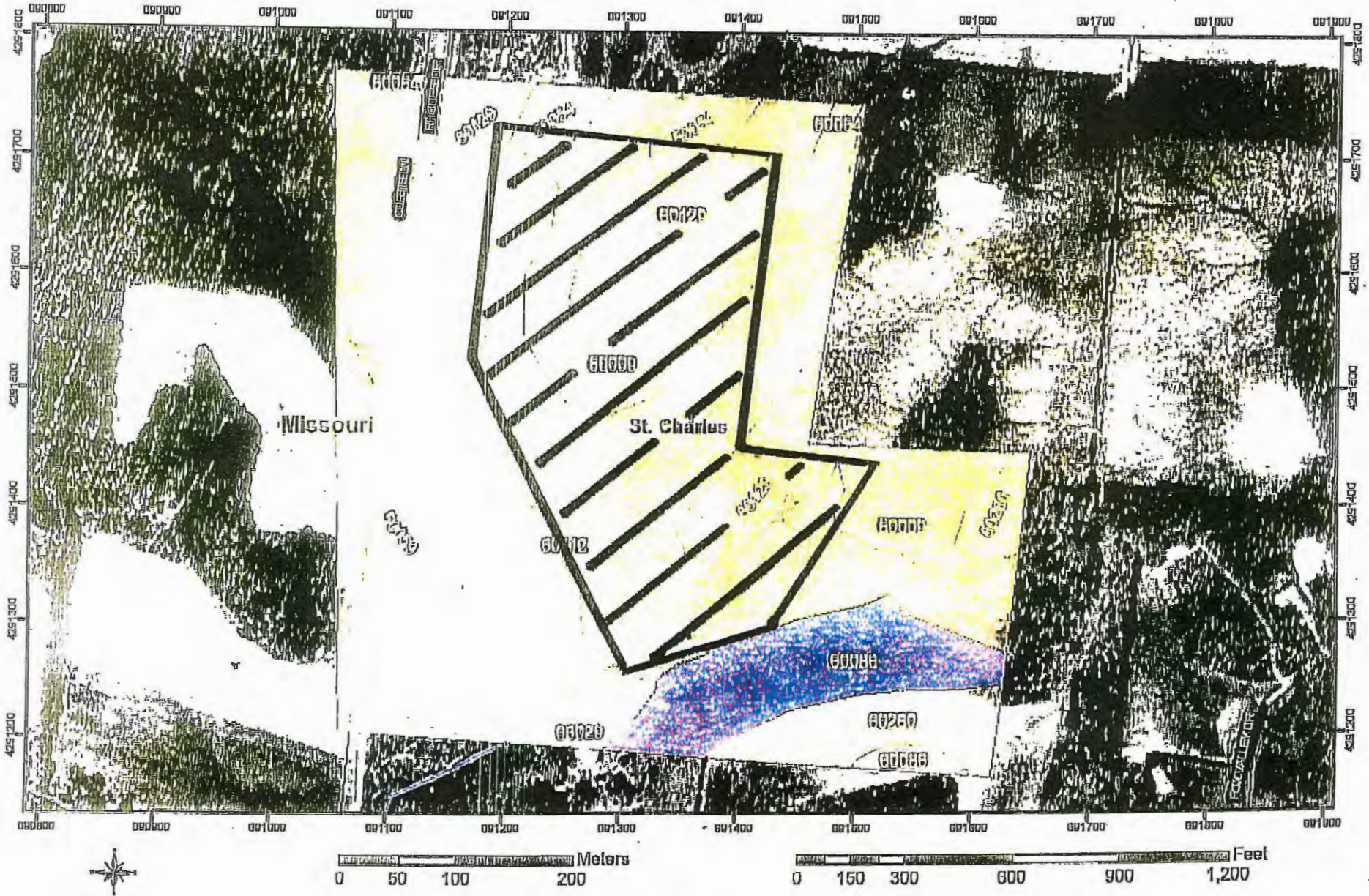
$$T_H = \frac{H}{v_s} \quad (17.12)$$







# HYDROLOGIC GROUP RATING FOR ST CHARLES COUNTY, MISSOURI













# HYDROLOGIC GROUP RATING FOR ST CHARLES COUNTY, MISSOURI










## MAP LEGEND

### Hydrologic Group

(Dominant Condition, &lt;math>\&lt;/math>)

-  A
-  A/D
-  B
-  B/D
-  C
-  C/D
-  D
-  Not rated or not available

Soil Map Units

-  Cities
-  Detailed Counties
-  Detailed States
-  Interstate Highways
-  Roads
-  Rails
-  Water
-  Hydrography
-  Oceans

## MAP INFORMATION

Source of Map: Natural Resources Conservation Service  
Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>

Coordinate System: UTM Zone 15

Soil Survey Area: St Charles County, Missouri  
Spatial Version of Data: 3  
Soil Map Compilation Scale: 1:24000

Map comprised of aerial images photographed on these dates:  
1995

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

## Tables - Hydrologic Group

## Summary by Map Unit - St Charles County, Missouri

Soil Survey Area Map Unit Symbol	Map Unit Name	Rating	Total Acres in AOI	Percent of AOI
50009	Keswick silt loam, 9 to 14 percent slopes, eroded	C	11.9	16.6
50054	Armster silt loam, 5 to 9 percent slopes	C	2.1	3.0
50059	Mexico silt loam, 1 to 4 percent slopes, eroded	D	1.5	2.1
60086	Crider silt loam, 9 to 14 percent slopes, eroded	B	6.0	8.4
60112	Goss gravelly silt loam, 14 to 45 percent slopes	C	35.4	49.6
60129	Hafton silt loam, 5 to 9 percent slopes	C	8.9	12.4
60260	Weller silt loam, 5 to 9 percent slopes	C	3.8	5.3
66029	Dockery silt loam, 0 to 2 percent slopes, occasionally flooded	C	1.8	2.6

## Description - Hydrologic Group

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are placed into four groups A, B, C, and D, and three dual classes, A/D, B/D, and C/D. Definitions of the classes are as follows:

The four hydrologic soil groups are:

**Group A.** Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

**Group B.** Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

**Group C.** Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

**Group D.** Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for

Hydrologic Group Rating

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undrained areas. Only soils that are rated D in their natural condition are assigned to dual classes.

## Parameter Summary - Hydrologic Group

Aggregation Method: Dominant Condition

Component Percent Cutoff:

Tie-break Rule: Lower

