SECTION V

QUALITY ANALYSIS

Quality analyses may be performed at several levels of detail, ranging from an explicit formulation of runoff quality for small subcatchments within a city to a broad representation of pollutant loads for an entire urbanized area, state or region. It has been necessary to consider the entire spectrum during the course of this research.

It is unfortunate that perhaps the only consistent remark about urban runoff quality analysis in general is that data and results of previous studies are so remarkably inconsistent. As discussed in Volume III of this report, few studies have been made of characteristics of street litter, and they offer a wide range of values of concentrations and loads. Effluent data show a similar scatter. However, it is necessary that a decision be made regarding actual values for use in the analysis. This section will describe methods used for predicting runoff quality, data required for their use, and final results used in this study.

QUALITY PARAMETERS

Parameter Definitions

Urban runoff quality may be characterized by a variety of parameters, as documented in Volume III. However, the list is generally shortened for modeling purposes to those characteristic of solids, oxygen demand, health hazards and aquatic growth potential, as indicated in Table V-1, Typical Quality Parameters of Urban Runoff Models. It is discouraging that even at this juncture, a serious problem of definition of terms arises because of various possibilities for analyzing and reporting quality parameters. The assurance that analyses have been performed according to Standard Methods[1] is not enough information. For example, solids are sometimes reported as "residue" instead of solids, and "filterable residue" instead of "dissolved solids," because of the nature of the evaporation and filtration techniques utilized in the chemical analyses. Generally, "solids" and "residue" are synonymous, and "solids" will be used in this report. Another problem arises from the fact that pollutants may be in both soluble and insoluble forms. Some studies report concentrations of only the soluble portions of, say, BOD and PO_4, leading to unrealistically low values if the reader mistakenly thinks of them as total (soluble plus insoluble) concentrations.

TABLE V-1. TYPICAL QUALITY PARAMETERS OF URBAN RUNOFF MODELS

Quality Characteristic	Representative Quality Parameters
Solids	Surface "Dust and Dirt"
	Surface "Solids"
	Total Solids
	Suspended Solids
	Dissolved Solids
	Volatile Solids
	Settleable Solids
Oxygen Demand	BOD, COD
	Total Organic Carbon
	Organic N, NO_2, NH_3
Health Hazards	Total Coliforms
	Fecal Coliforms
Aquatic Growth Potential	Ortho-PO_4
	Total PO_4
	NO_2, NO_3, Total N

On the other hand, it is important to know the relative soluble-insoluble fractions of pollutants since this has a major impact upon treatability. That is, pollutants that appear as suspended solids are relatively easy to remove (e.g., by sedimentation) compared to those that are soluble.

To further complicate the picture, no clear relationship exists between data derived from studies of surface litter (gathered by sweeping, vacuuming, flushing) and those resulting from analysis of the runoff itself (e.g., samples of storm and combined sewage effluent sources). There is no study in which samples of both types have been gathered simultaneously. Hence, the relationship between the two is not well defined, and it is difficult to draw conclusions from all data considered together.

In this report, the solids relationship of Figure V-1, Relationships Among Solids Parameters, applies. Note that total solids (TS) is the sum of dissolved solids (DS) plus suspended solids (SS), and that total, dissolved and suspended solids may be separated into a volatile portion (generally considered the organic portion) and a fixed portion. Volatile solids (VS) will refer to a portion of total solids in this report, unless otherwise indicated. Settleable solids are some fraction of suspended solids. Note, finally, that an upper limit on the size of total solids reported is imposed by the size of the openings in the sampling equipment (e.g., a quarter-inch mesh screen).

Similar diagrams may be prepared for nitrogen and phosphorus, as shown in Figure V-2, Relationships Among Nitrogen Parameters, and Figure V-3, Relationships Among Phosphorus Parameters. For these parameters it is necessary to know whether concentrations are being reported of the element itself (e.g., phosphorus) or the ion (e.g., PO_4), although conversions can readily be made on the basis of the molecular weight of each. Regarding the nitrogen relationships, all concentrations should be reported in terms of N (i.e., NO_2-N, NO_3-N, NH_3-N) in order for mass balances to be performed easily.

Parameters for Assessment

For purposes of the nationwide assessment, five parameters will be used that are representative to some degree of the quality characteristics indicated in Table V-1. These are indicated in Table V-2, Quality Parameters Used in Nationwide Assessment.

Five-day BOD is used because of its broad acceptance and traditional role in water quality analysis. Its usefulness is severely impaired by the great difficulty in performing accurate and consistent laboratory analyses. For instance, there is no standard for laboratory comparison, and low-level values (e.g., 10 mg/l) are especially susceptible to errors of up to 100 percent. Moreover, studies have shown that results

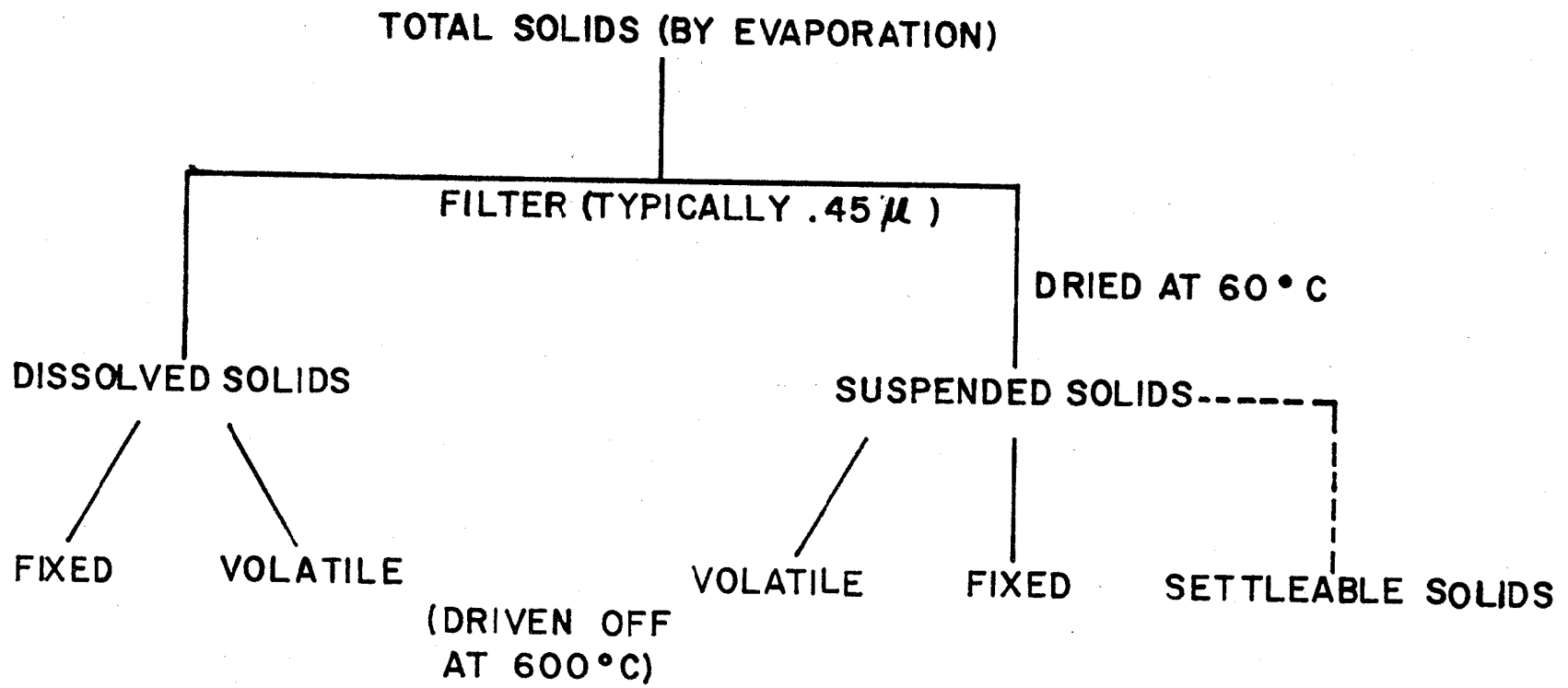

Figure V-1. Relationships Among Solids Parameters

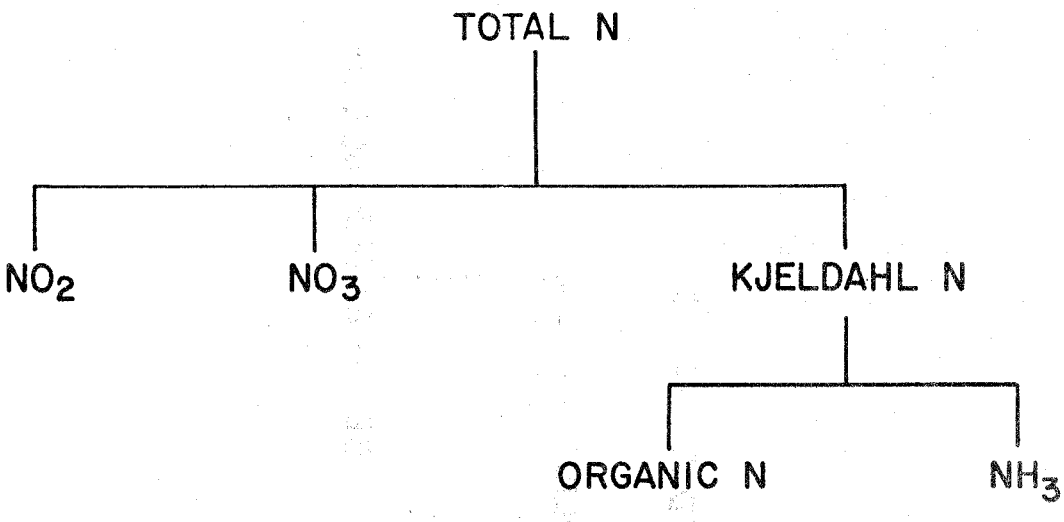

Figure V-2. Relationships Among Nitrogen Parameters.

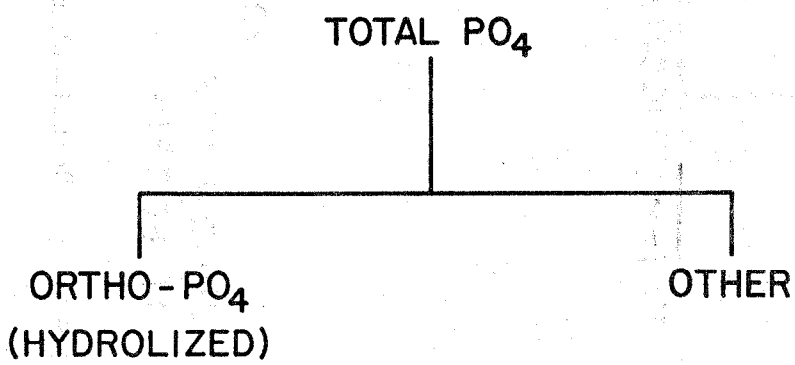

Figure V-3. Relationships Among Phosphorus Parameters.

TABLE V-2. QUALITY PARAMETERS USED IN NATIONWIDE ASSESSMENT

Note: All parameters (except suspended solids) are totals that include dissolved and insoluble portions, and are usually determined as in Standard Methods.[1] All are usually reported in concentration units of mg/l (equivalent to ppm).

Parameter	Abbreviation
1. Five-Day Biochemical Oxygen Demand	BOD_5 or BOD
2. Suspended Solids	SS
3. Volatile Solids (Total)	VS
4. Total Phosphate (as PO_4)	PO_4 or TPO_4
5. Total Nitrogen (as N)	N

are affected by the percent dilution and are generally not reproducible.[2] In addition, samples are affected by amounts of heavy metals and other parameters present. Use of COD and/or TOC avoids these problems for the most part, but their relationship with traditional stream sanitation analysis (i.e., prediction of dissolved oxygen) is unclear, and most people are used to thinking in terms of BOD. It is used in this study, realizing its limitations.

The other four parameters are used because of general acceptance and availability of data. It should be borne in mind that many options are available for modeling purposes, and the choice of parameters is somewhat arbitrary.

PREDICTIVE TECHNIQUES

Pollutant loads

The quality prediction techniques found in most urban runoff models (e.g., SWMM, STORM) rely upon generation of an initial surface load of pollutants. This load is usually expressed in units of lbs, lbs/acre, lbs/curb-mile, lbs/day-acre, or lbs/day-curb-mile (or equivalent metric units). Normalized loads are, of course, multiplied by a unit of area, dry days, etc., to produce an initial mass

of pollutants at the start of the storm. Pollutants are then "washed off" during the storm in an exponential fashion, in which the amount removed per time step is proportional to the amount present, the runoff rate, and other factors. See SWMM[3,4] and STORM[5,6] documentation for details of this methodology. The key factor in prediction of long-term (e.g., annual) pollutant loads from urban areas is, however, the surface loading rates themselves, and most of the following discussion will be devoted to them.

Surface loadings are usually predicted by one of two means: estimates based on surface accumulation data or estimates based on measurements of effluent concentrations and flows. As mentioned earlier, no one study has performed the analysis both ways, so comparisons are not easily accomplished. However, to attain the objective of this analysis, normalization of loading rates by some means that could be converted to total mass of pollutants upon multiplication by area, days and/or other appropriate parameters was necessary. As a result, both methods were utilized in the development that follows.

Surface Accumulation Methods

Both SWMM and STORM use this method for prediction of the total soluble mass of pollutants available at the beginning of a storm. It is based upon the following equation, given in US customary units

$$P_{i,j} = dd_i \cdot F_{i,j} \cdot G_{L,i} \cdot A_i \cdot N_D + P_o \qquad \text{(V-1)}$$

where $P_{i,j}$ = total soluble pounds of pollutant j on urban land use i at the beginning of the storm,

dd_i = pounds of accumulated dust and dirt on land use i (or "surface solids") per curb-mile per dry day,

$F_{i,j}$ = soluble pounds of pollutant j per pound of dust and dirt found on land use i,

$G_{L,i}$ = curb-miles per acre of land use i,

A_i = area of land use i, acres,

N_D = number of dry days since last storm, and

P_o = total soluble pounds of pollutant remaining on land use i at end of last storm.

The dust and dirt accumulation rate is often given in terms of pounds per day per 100 ft of curb instead of curb-miles, but the latter units are used here for ease in comparison with other portions of the report.

The parameter N_D is the number of dry days since the last storm, not the number of days since the last storm or street cleaning operation. This is due to the fact that, in most cases, the interarrival time between storms is less than the street cleaning interval. The latter generally ranges from one to two days to several months. Allowance for street sweeping is incorporated later in the report.

The parameters dd_i, $F_{i,j}$ and $G_{L,i}$ are functions of land use, i. The dust and dirt loadings, dd_i, and pollutant fractions, $F_{i,j}$, are usually based for the most part on the 1969 APWA Chicago data[7] and are shown in Table V-3, Parameters for Surface Pollutant Accumulation Used in SWMM and/or STORM. The extensive efforts documented in Volume III of this report allow the updating of all parameters of this table, as will be described subsequently.

The insoluble portion of pollutants is accounted for (in STORM and SWMM) by addition of a fraction of the solids concentration to predicted effluent concentration (of the soluble portion). For example, SWMM adds five percent of the SS concentration to the soluble BOD concentration to obtain total BOD, on the basis of calibration of the original SWMM in San Francisco. This is because of the reliance upon the 1969 APWA Chicago data in which only soluble fractions were reported. It is obvious that equation V-1 could be used to predict the total (soluble plus insoluble) mass of surface pollutant accumulation simply by a redefinition of terms (and use of appropriate revised numbers). This would facilitate quality calibration of the models and probably be as accurate considering the available data. Final surface pollutant loads derived subsequently will refer to total pounds of pollutants. The data presented in Volume III will be utilized subsequently to revise the dust and dirt loadings and pollutant fractions.

Starting with the Chicago study and followed subsequently by others, it has become customary to report data in terms of mass of pollutants per unit length of curb, under the assumption that the curbs and gutters represent the main source area for acquisition of pollutants by the storm runoff. In order to obtain loadings on a unit area basis, it is necessary to obtain the length of curb per area for each land use, thus defining the parameter G_L in equation V-1.

It is expected that G_L would be a function of land use, which in turn is a function of population density, PD. Curb length (taken as twice street length) was related to population density in the Washington, DC area by Graham et al.[8] Their data were augmented by data from other parts of the country as described in Volume III, resulting in

$$G_L = 0.0782 - 0.0668 \cdot 0.839^{PD_d} \qquad \text{(V-2)}$$

where G_L = curb-miles per area, mile/acre, and

PD_d = developed population density, persons/acre.

Table V-3. PARAMETERS FOR SURFACE POLLUTANT ACCUMULATION USED IN SWMM AND/OR STORM

Except as noted, values are for soluble portion and derived from the 1969 APWA Chicago study.[7]

Parameter	Units	Land Use				
		1. Single-family res.	2. Multi-family res.	3. Commercial	4. Industrial	5. Open[a]
Dust and dirt loading, dd_i	lb/day-curb-mile	40.0	121.0	174.0	243.0	79.2
	kg/day-curb-km	11.4	34.4	49.4	69.0	22.5
Pollutant fractions[b], $F_{i,j}$						
SS[a] (SWMM)		1.0	1.0	1.0	1.0	1.0
SS[a] (STORM)		0.111	0.08	0.17	0.067	0.111
Settleable Solids[c] (SWMM)		0.1	0.1	0.1	0.1	0.1
Settleable Solids[c] (STORM)		0.011	0.008	0.017	0.007	0.011
BOD_5		0.005	0.0036	0.0077	0.003	0.005
COD		0.04	0.04	0.039	0.04	0.02
Total PO_4		0.00005	0.00005	0.00007	0.00003	0.00001
Total N		0.00048	0.00061	0.00041	0.00043	0.00005
Grease[a]		0.001	0.001	0.001	0.001	0.001
Total Coliforms	MPN/g	1.3×10^6	2.7×10^6	1.7×10^6	1.0×10^6	0.00

[a]All values assumed.

[b]Fraction refers only to soluble fraction of dust and dirt (except for solids).

[c]All values assumed at 10% of value for SS.

Equation V-2 seems to work well for residential areas, but the curb length concept is troublesome when one is evaluating commercial, industrial or open areas. For example, what is the equivalent curb length of a shopping center? Data from other sources are compared in Table V-4, Measured Curb Lengths for Various Land Uses. An average of the Tulsa[9] and Ontario[23] data is used in the analysis. Specific data for residential areas are used in lieu of equation V-2, since the equation was developed to predict curb length as a function of population density averaged over all land uses. However, the equation may be used when considering an overall urban area.

To summarize, the surface accumulation methods are convenient for modeling purposes and illustrate the linkages between various causative factors. The key missing factor is a link between the surface loads and effluent loads that has been verified by measurements of both. Until this is accomplished, such a link must be hypothesized in its mathematical formulation, as done in SWMM and STORM. However, equation V-1 is used in developments that follow to relate loadings between different land uses and pollutants; hence, the reason for the previous developments. The other side of the coin, that is, results derivable from effluent data alone, will be discussed next.

Effluent Concentration Methods

Many studies in recent years have reported measured concentrations of pollutants in storm and combined sewer discharges. If the flow rate is also known, the mass flow pollutograph may be determined (e.g., lbs/min of BOD) and integrated to produce the total mass emission for the storm discharge. When distributed over the area of the catchment and divided by the number of preceding dry days, normalized loadings (e.g., mass-BOD/area-day) may be determined. Some studies report these values directly, while others report a lesser amount of information. In general, the surface loading may be deduced from a measured average concentration and assumed runoff quantity:

$$M = P \cdot C \cdot CR \cdot \rho \qquad \text{(V-3)}$$

where M = pollutant loading, mass/area-time,

P = precipitation, depth/time,

C = average concentration = mass of pollutant per mass of total sample,

CR = runoff coefficient, and

ρ = water density, mass/volume.

For an individual storm, preceded by N_D dry days, the total depth of precipitation, P_s, may be given. Then,

Table V-4. MEASURED CURB LENGTHS FOR VARIOUS LAND USES

	Location								
	Tulsa[9]			10 Ontario Cities[a]			Average of Two Locations for Use in Study		
	mile/acre	km/ha	100ft/acre	mile/acre	km/ha	100ft/acre	mile/acre	km/ha	100 ft/acre
Residential	0.076	0.30	4.0	0.042	0.17	2.2	0.059	0.23	3.1
Commercial	0.081	0.32	4.3	0.057	0.23	3.0	0.070	0.28	3.7
Industrial	0.042	0.17	2.2	0.025	0.099	1.3	0.034	0.13	1.8
Park	0.042	0.17	2.2	-	-	-	-	-	-
Open	0.016	0.063	0.85	0.015	0.059	0.79	0.023[b]	0.091[b]	1.2[b]
Institutional	-	-	-	0.030	0.12	1.60	-	-	-

[a]Average of unpublished data collected by University of Florida, 1975, Guelph, Kingston, Kitchener-Waterloo, Milton, St. Catharines, Sault Ste. Marie, Thunder Bay, West Toronto, Windsor.[23]

[b]Average of open plus park.

$$M = \frac{P_s \cdot C \cdot CR \cdot \rho}{N_D} \cdot \qquad \text{(V-4)}$$

For annual average computations it may be assumed that, on an average basis,

$$P_s = \frac{P}{n} \qquad \text{(V-5)}$$

and

$$N_D = \frac{365}{n} \qquad \text{(V-6)}$$

where P = average annual precipitation, depth/year,

P_s = average precipitation per storm, depth/storm,

N_D = average number of dry days between storms, and

n = average number of storms per year.

Equation V-3 may thus be used to compute average annual values since it results from substitution of equations V-5 and V-6 into equation V-4.

Equation V-3 may be converted to convenient units. For instance,

$$M\left(\frac{lb}{day\text{-}acre}\right) = P\left(\frac{in.}{yr}\right) \cdot C\left(\frac{lb}{10^6\ lb}\right) \cdot CR \cdot 62.4\left(\frac{lb}{ft^3}\right) \cdot \frac{43560}{acre}\ ft^2 \cdot \frac{ft}{12\ in.} \cdot \frac{yr}{365\ day}$$

or

$$M = 6.21 \times 10^{-4} \cdot P \cdot C \cdot CR \qquad \text{(V-7)}$$

where M = average surface loading, lb/day-acre,

P = annual precipitation, in./yr,

C = pollutant concentration in discharge, mg/l or ppm; and

CR = runoff coefficient, fraction.

Use of equation V-7 suffers from several difficulties. It is inherently an average, and is susceptible to the assumptions of equations V-5 and V-6. It requires the use of a flow weighted average concentration. Unfortunately, such values are seldom reported in the literature, if indeed any specification is made as to the types of "average" concentration presented. Runoff is

generated by the simplest of methods, that of a runoff coefficient with all of its well-documented errors.

On the other hand, measured concentrations do in fact represent the real amount of pollutants being discharged, and thus incorporate all of the unknown factors involved in trying to generate surface loads coupled with a wash-off and transport mechanism. These include such factors as dust fall, air pollution and several others not specifically addressed in this study. Furthermore, for purposes of the nationwide assessment performed in this study, very simple methods of runoff and quality generation must be employed. Hence, equation V-7 is consistent with other levels of analysis used in this research.

In the same manner that surface accumulations could be considered functions of population density and land use, so can surface loadings derived from effluent data. In particular, both the concentration and runoff coefficient are clearly such functions; the latter has been discussed in the previous section. In order to ascertain the functional relationship between the surface loadings and population density, available data for the residential areas for which population density is given have been tabulated. Derived surface loadings are given in Table V-5, Surface BOD Loadings for Residential Areas as Derived from Effluent Measurements. The cities included in the table all had data for residential areas for which population density was specified and from which surface loadings could be derived. The list is not meant to be exclusive but represents data that were readily available during the study.

The vast disparity among all the data may be seen in Figure V-4, Residential BOD Loadings vs Developed Population Density. Both separate stormwater and combined sewage loadings vary by over an order of magnitude. Unfortunately, the variation persists if normalized by dividing by annual precipitation (not shown). Three cities -- Atlanta, Bucyrus, and Durham -- produce very high results compared to the bulk of the data. The reason for this is primarily variation from strictly residential land use. In addition, the open channels in Durham had characteristics of open sewers. The values are so high as to be inconsistent with the rest of the data and are omitted from subsequent analysis. The remaining data still show considerable scatter, but will be utilized to derive required relationships.

LOADING PREDICTION FOR NATIONWIDE ASSESSMENT

Form of Equation

Surface pollutant loads generated by the pollutant load estimating equation will be assumed to "wash off" on an annual basis for purposes of the nationwide assessment. Hence, they must be representative of actual measured effluent loads. Moreover, they should be functionally related to causative factors in a reasonable manner. They are expected to be functions of land use and population density. In addition, the extensive presentation of Volume III showed geographical variations in,

Table V-5. SURFACE BOD LOADINGS FOR RESIDENTIAL AREAS AS DERIVED FROM EFFLUENT MEASUREMENTS

Note: Surface loadings are taken directly from the source if computed therein, or derived from mass emission (e.g., lbs/storm) data, if listed. Otherwise equation V-7 is used (for cities for which runoff coefficient and BOD concentration are listed).

City	Site or Station[a]	Sewer System	Catchment Area ac	(ha)	Annual Precip. in.	(cm)	Runoff Coef.	BOD Conc. mg/l	BOD Surface Loading lb/ac-day	(kg/ha - day)	Population Density Persons/ac	(persons/ha)	Reference
Tulsa	3	Separate	550	(223)	48	(122)			0.0381	(0.0428)	7.13	(17.61)	9
	5	"	507	(205)					0.0901	(0.1012)	8.93	(22.06)	
	7	"	197	(80)					0.0417	(0.0468)	11.55	(28.53)	
	8	"	211	(85)					0.0899	(0.1009)	11.37	(28.08)	
	9	"	64	(26)					0.0544	(0.0611)	13.67	(33.76)	
	11	"	815	(330)					0.0963	(0.1081)	9.57	(23.64)	
	13	"	212	(86)					0.0679	(0.0762)	2.36	(5.83)	
	15	"	74	(30)					0.0688	(0.0772)	11.22	(27.71)	
Bucyrus	8	Combined	179	(72)	35	(89)	0.39	120	1.017	(1.142)	11.7	(28.9)	10
	17	"	614	(249)			0.41	107	0.953	(1.070)	9.1	(22.5)	
	23	"	378	(153)			0.35	108	0.821	(0.922)	5.0	(12.4)	
Atlanta	Confed. Ave.	Combined	1129	(457)	48	(122)	0.31	210	1.94	(2.178)	10.9	(26.9)	11
	Blvd.	"	2421	(980)			0.42	84	1.05	(1.179)	16.6	(41.0)	
	McDan St.	"	968	(392)			0.42	286	3.58	(4.019)	13.2	(32.6)	
	Harlan	Separate	954	(386)			0.33	7	0.069	(0.077)	9.7	(24.0)	
	Casplan	"	517	(209)			0.56	20	0.334	(0.375)	7.3	(18.0)	
	Fed. Pris.	"	1498	(606)			0.31	26	0.240	(0.269)	4.8	(11.9)	
Roanoke	Trout Run	Separate	997	(404)	34	(86)			0.0363	(0.0408)	11.0	(27.2)	12
	Murray Run	"	909	(368)					0.0428	(0.0481)	6.6	(16.3)	
	24 St.	"	1034	(419)					0.0233	(0.0262)	9.7	(24.0)	
Milwaukee	Hawley Rd.	Combined	495	(200)	31	(79)	0.40	49	0.377	(0.423)	35.0	(86.5)	13
Wash. D.C.	Good Hope Run	Separate	265	(107)	41	(104)			0.063	(0.071)	37.6	(92.9)	14
	B4	Combined	105	(43)					0.247	(0.277)	43.6	(107.7)	
	C4	"	222	(90)					0.381	(0.428)	52.6	(129.9)	
Des Moines	S-1	Separate	315	(128)	31	(79)	0.10	48	0.093	(0.104)	7.4	(18.3)	15
	S-3	"	356	(144)			0.10	63	0.121	(0.136)	5.3	(13.1)	
	O-3	Combined	4050	(1640)			0.15	69	0.199	(0.223)	7.5	(18.5)	
	O-6	"	5600	(2267)			0.15	95	0.275	(0.309)	8.3	(20.5)	
	O-8	"	1350	(547)			0.15	68	0.197	(0.221)	10.9	(26.9)	
	O-8A	"	927	(375)			0.15	77	0.222	(0.249)	10.9	(26.9)	
Cincinnati	Mt. Washington	Separate	27	(11)	40	(102)			0.0904	(0.1015)	9.0	(22.2)	16
Durham	E-1	Separate	56	(23)	45	(114)	0.29[b]	25	0.202	(0.227)	14.9	(36.8)	17
	W-1	"	169	(68)			0.35[b]	61	0.596	(0.669)	2.6	(6.4)	
	W-2A	"	69	(28)			0.34[b]	38	0.361	(0.405)	11.0	(27.2)	
	W-2B	"	138	(56)			0.36[b]	51	0.513	(0.576)	13.4	(33.1)	
	N-1	"	183	(74)			0.36[b]	71	0.714	(0.802)	4.2	(10.4)	
Seattle	Low Dens.	Separate	c		36	(91)			0.04	(0.045)	11.0[d]	(27.2)	18
	Med. Dens.	"	c						0.07	(0.079)	22.0[d]	(54.3)	
	High Dens.	"	c						0.13	(0.146)	30.0[d]	(74.1)	
Windsor	Labadie Rd.	Separate	30	(12)	33	(84)			0.059	(0.066)	20.0	(49.4)	19

[a]Site or station as listed in source documentation.

[b]Value computed using imperviousness.

[c]Hypothetical area based on measured data.

[d]Assumed on basis of dwelling units per acre.

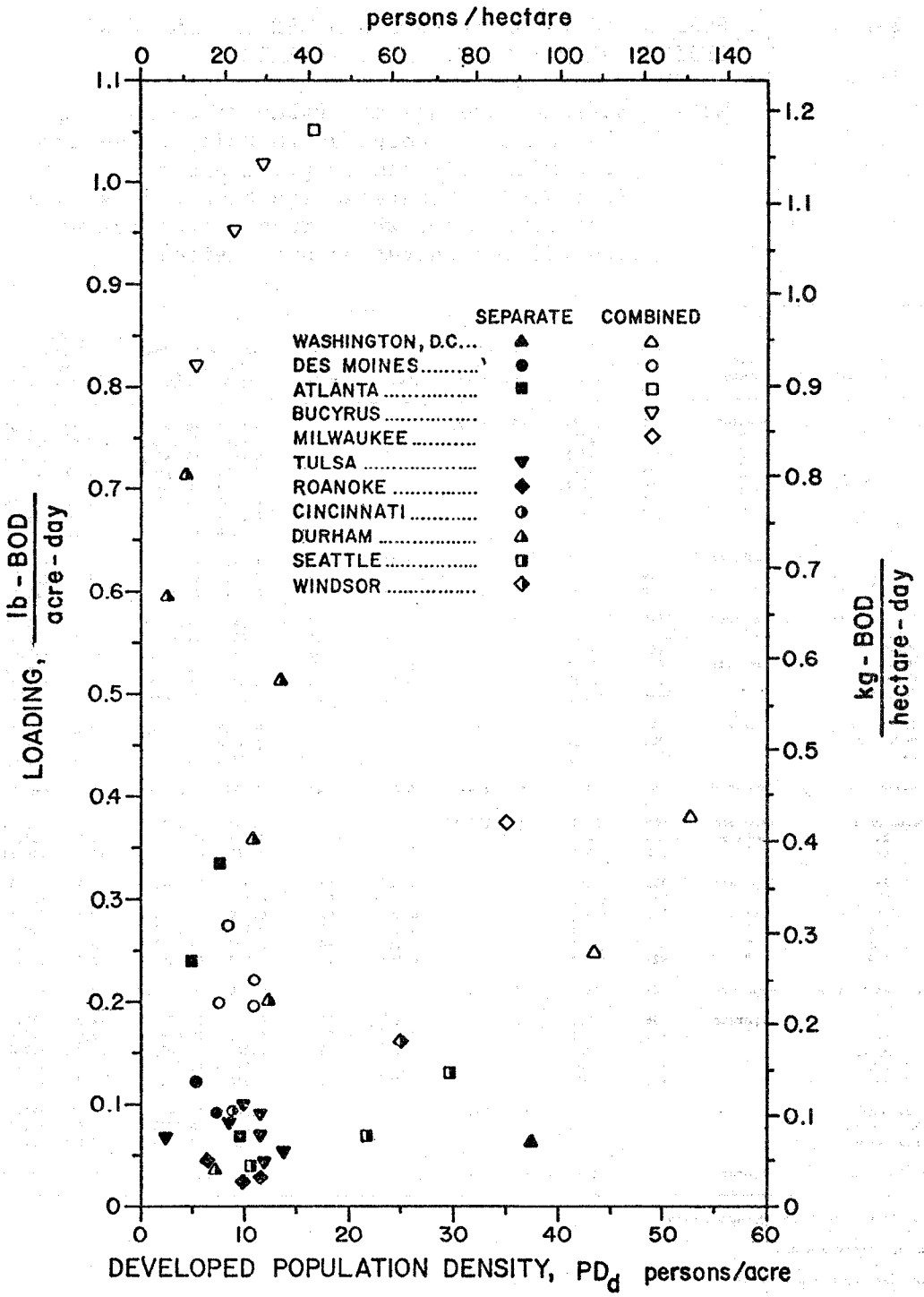

Figure V-4. Residential BOD Loadings vs Developed Population Density

Data are from Table V-5.

say, dust and dirt loadings, although it is not immediately obvious as to how these loadings differ in a commercial or industrial area from one point in the country to another. The key climatic parameter is precipitation, since the more precipitation that occurs, the more likely it is that pollutants will be washed off the surface and appear as effluent loads instead of being removed by other means such as street sweeping or wind. Total annual pollutant loads from storm runoff are lower in arid regions for this very reason.

These considerations led to the selection of a predictive equation in which the loading is proportional to precipitation, for all land uses.

It will also be proportional to a function of population density for residential areas which is intended to account for many other implicit factors such as age of area, imperviousness, runoff coefficient, etc., all of which are functions of population density. Lastly, it is also a function of street sweeping efficiency. This formulation may be easily applied to all parts of the country because precipitation and population density data are readily available. However, these parameters are about the only ones (other than areas) that are available, ruling out more complicated functions. The loading, M, will thus be represented functionally as:

$$M = \alpha \cdot f_1(P) \cdot f_2(PD_d) \cdot f_3(N_s) \qquad \text{(V-8)}$$

where the coefficient α and functions f_1, f_2, and f_3 are to be determined below and N_s is the street sweeping interval. The procedure to be followed will develop appropriate parameters for residential areas first, which will then be extended to other land uses.

Precipitation Function

If average BOD loadings for the cities of Table V-5 (omitting Atlanta, Bucyrus and Durham) are plotted versus annual precipitation (not shown), no clear relationship is indicated. Hence, the data will simply be averaged to obtain the factor α and $f_1(P)$ of equation V-8 for BOD. That is, it is assumed that the loadings are directly proportional to precipitation, such that zero precipitation generates zero stormwater pollution. This is supported by equation V-7. Hence,

$$f_1(P) = P \qquad \text{(V-9)}$$

and the parameter α is obtained as an average of the seven remaining cities of Table V-5 for which separate data are available. Thus, for BOD for residential areas,

$$\alpha = \frac{1}{7} \sum_{i=1}^{7} \frac{\text{loading}_i}{P_i} = \frac{1}{7} \sum_{i=1}^{7} \frac{M_i}{P_i} \tag{V-10}$$

$$= 0.80 \frac{\text{lb-BOD}}{\text{ac-in.}} = 0.35 \frac{\text{kg-BOD}}{\text{ha-cm}}$$

Annual average BOD loadings for residential areas are now predicted by

$$M = 0.80 \cdot P \cdot f_2(PD_d) \cdot f_3(N_s) \tag{V-11}$$

where M = annual average BOD loading for separate sewered, residential areas, lb-BOD/ac-yr,

P = annual precipitation, inches/year,

PD_d = developed population density, persons/acre, and

N_s = street sweeping interval, days.

For combined areas, the equation will be identical, except that a parameter β will be employed instead of α in order to distinguish between combined and separate areas. For BOD for residential areas, the value of β is computed using average values for Des Moines, Milwaukee and Washington, DC from Table V-5

$$\beta = \frac{1}{3} \sum_{i=1}^{3} \frac{\text{loading}_i}{P_i} = \frac{1}{3} \sum_{i=1}^{3} \frac{M_i}{P_i} \tag{V-12}$$

$$= 3.3 \frac{\text{lb-BOD}}{\text{ac-in.}} = 1.5 \frac{\text{kg-BOD}}{\text{ha-cm}}$$

Annual BOD loadings for residential areas served by combined sewers are thus,

$$M = 3.3 \cdot P \cdot f_2(PD_d) \cdot f_3(N_s) \tag{V-13}$$

where parameters are as previously defined.

It may be seen that for the same population density and precipitation, combined BOD loadings are 3.3/0.80 = 4.12 times higher than separate loadings. This agrees with an independent survey of available data by Lager and Smith[20] in which average BOD concentrations in combined sewage of 115 mg/l are 3.83 times greater than the average BOD concentration of 30 mg/l in separate sewers. The difference in loadings is due mainly to residual matter left in conduits between storms since simple mixing of storm water and dry-weather flow, or differences in population density between separate and combined sewer areas will not explain the fourfold variation in concentrations and loadings.

Population Function

The data of Table V-5 and Figure V-4 incorporate all the available information about the relationship of BOD loadings with population density implied by equations V-7 and V-8. In order to extend the data base slightly further, it will be assumed that combined area loadings increase with population density, PD_d, in the same manner as do separate area loadings. The data base can then be extended slightly by normalizing by the average loadings for separate and combined areas. Omitting the data from Atlanta, Bucyrus and Durham, Table V-6, Normalized BOD Loading Data, may be prepared. Finally, the data of Table V-6 may be plotted, as shown in Figure V-5, Normalized BOD Loadings vs Developed Population Density. A point has been added that represents the loading in open space of 0.00982 lb-BOD/ac-day (0.0110 kg-BOD/ha-day) where presumably the population density is zero. (The derivation of this value is shown later.)

Inspection of Figure V-5 shows such scatter that no statistically significant relationship is likely to be derived from the data. Rather, an argument must be made upon the expected form of the functional relationship, and the data used only to obtain a calibration. This relationship is expected to be similar to those developed earlier for imperviousness and curb length, namely increasing rapidly at low population densities and leveling off at high ones.

The concentration of stormwater pollutants is M/AR, or

$$\frac{M}{AR} = \frac{\alpha P[f_2(PD_d)]}{K[0.15 + 0.75\ I]P} \qquad \text{(V-14)}$$

where $$I = 0.096\ PD_d^{(0.573-0.0391\ \log_{10} PD_d)}, \text{ or} \qquad \text{(V-15a)}$$

$$I \approx 0.096\ PD_d^{0.54} \qquad \text{(V-15b)}$$

and K is a conversion factor, for example, the value that appears in equation V-7 in order to achieve units of mg/l. Depression storage is omitted in the approximation of annual runoff. Thus,

$$\frac{M}{AR} = \frac{\alpha[f_2(PD_d)]}{K[0.15 + 0.072\ PD_d^{0.54}]}\ . \qquad \text{(V-16)}$$

Given that $f_2(PD_d)$ has a minimum where $PD_d = 0$, then a reasonable functional form for $f_2(PD_d)$ is

$$f_2(PD_d) = a + b\ PD_d^{\ m} \qquad \text{(V-17)}$$

where $a = 0.142$ = value at $PD_d = 0$ (from open space value),

Table V-6. NORMALIZED BOD LOADING DATA

Note: Values obtained from Table V-5, omitting data from Atlanta, Bucyrus and Durham.

	Average Loading lb-BOD / ac-day (kg-BOD / ha-day)	City	Loading / Ave. Loading	Population Density Persons/ac	(Persons/ha)
Separate Areas	0.0693 (0.0778)	Tulsa	0.550	7.13	(17.61)
			1.300	8.93	(22.06)
			0.060	11.55	(28.53)
			1.297	11.37	(28.08)
			0.785	13.67	(33.76)
			1.390	9.57	(23.64)
			0.980	2.36	(5.83)
			0.993	11.22	(27.71)
		Roanoke	0.524	11.0	(27.2)
			0.617	6.6	(16.3)
			0.336	9.7	(24.0)
		Wash. D.C.	0.909	37.6	(92.9)
		Des Moines	1.342	7.4	(18.3)
			1.746	5.3	(13.1)
		Cincinnati	1.305	9.0	(22.2)
		Seattle	0.577	11.0	(27.2)
			1.010	22.0	(54.3)
			1.876	30.0	(74.1)
		Windsor	0.851	20.0	(61.8)
Combined Areas	0.271	Wash. D.C.	0.911	43.6	(107.7)
			1.405	52.6	(129.9)
	(0.304)	Milwaukee	1.391	35.0	(86.5)
		Des Moines	0.734	7.5	(18.5)
			1.014	8.3	(20.5)
			0.727	10.9	(26.9)
			0.819	10.9	(26.9)

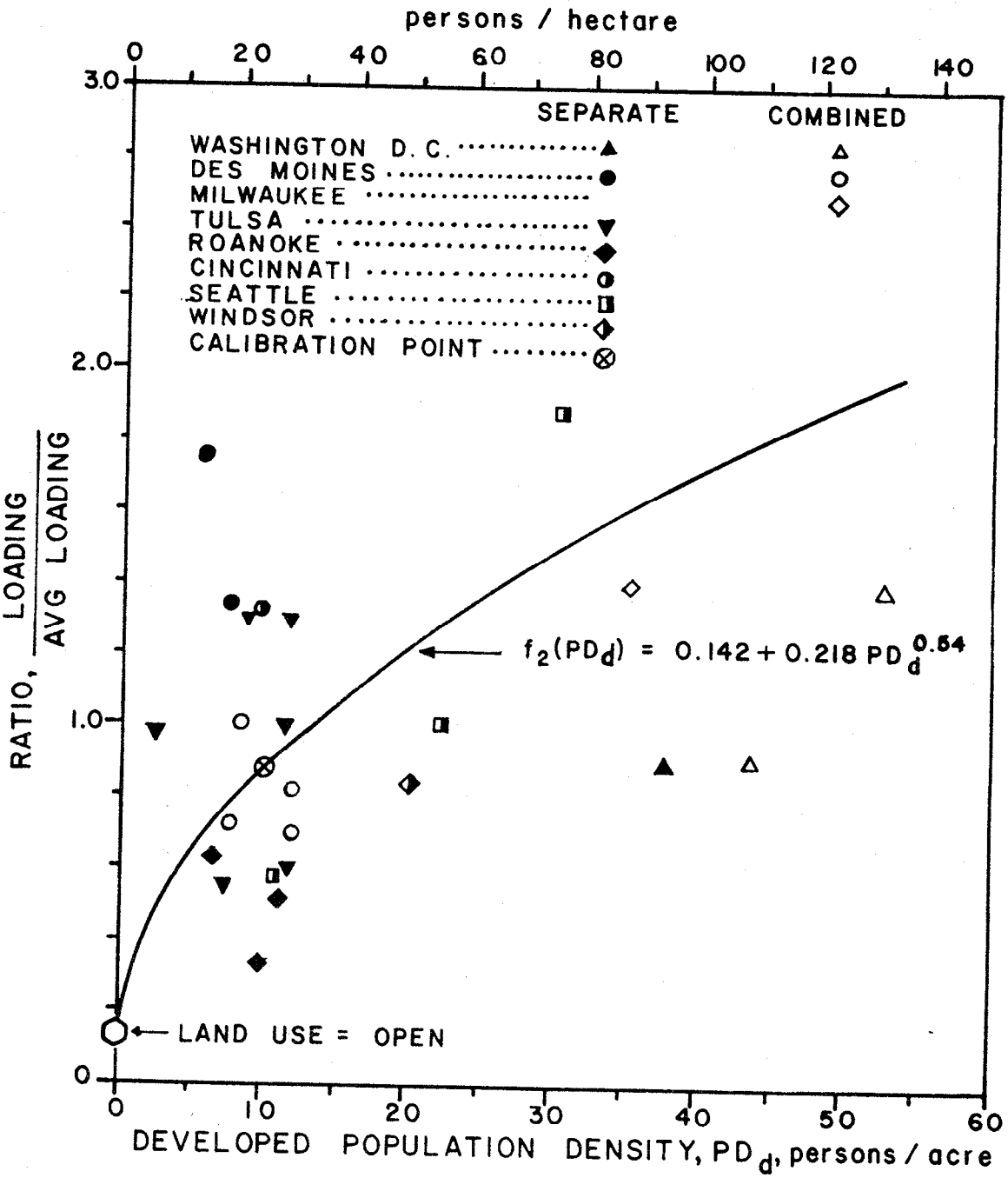

Figure V-5. Normalized BOD Loadings vs Developed Population Density. Data from Table V-6.

and developed population density will be used for consistency. Note that, depending on the assumed value of m, the concentration of storm water pollution will vary accordingly. Since no firm arguments can be made on the nature of the concentration function, it will be assumed that m is equal to the approximate exponent in the runoff equations or $m = 0.54$. Thus, $f_2(PD_d) = 0.142 + b\ PD_d^{0.54}$. Lastly, all data points with a PD_d ranging from 5 to 15 persons per acre (12 to 37 persons/ha) are averaged to obtain a calibrated value of $f_2(PD_d) = 0.895$ at 10 persons per acre (25 persons/ha). This range is chosen because data from most cities fall within it. Thus, the final equation is

$$f_2(PD_d) = 0.142 + 0.218\ PD_d^{0.54} \qquad \text{(V-18)}$$

where PD_d = developed population density, persons per acre.

The reasonableness of equation V-18 can be checked by estimating the variation in concentration as a function of population density. From equations V-11 and V-18, the annual BOD loading is

$$M = 0.80 \cdot P \cdot (0.142 + 0.218\ PD_d^{0.54}) \qquad \text{(V-19)}$$

and annual runoff, AR, using the approximate New Jersey[21] equation (equation V-15b) for imperviousness is:

$$AR = [0.15 + 0.75(0.096)PD_d^{0.54}] \cdot P \qquad \text{(V-20)}$$

Thus,

$$\frac{M}{AR} = \frac{0.113 + 0.174\ PD_d^{0.54}}{K[0.15 + 0.072\ PD_d^{0.54}]} \qquad \text{(V-21)}$$

Using K = 0.227 to convert to mg/l from the ratio of lbs/ac-yr per in./yr this ratio, which is plotted in Figure V-6, BOD Concentration Variation Using Estimating Equation, shows concentration increasing with population density which does seem reasonable. The range of average annual concentrations is lower than values shown in Table V-5 since it represents the average over the total residential area of a city. Unquestionably, the data base for estimating pollutant loads is very weak, and the resulting estimating equation, supported by such a weak foundation should be used with extreme caution.

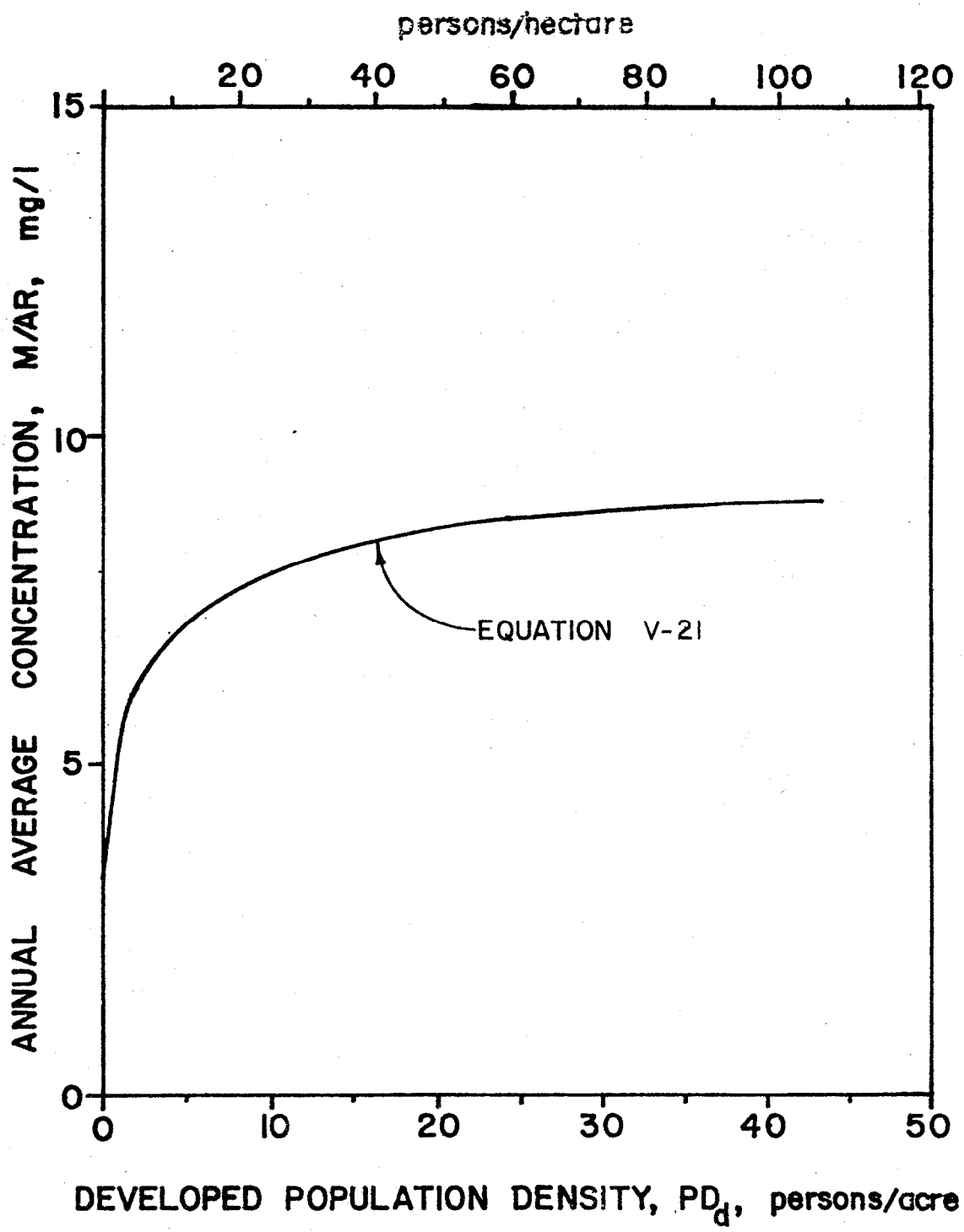

Figure V-6. BOD Concentration Variation Using Estimating Equation

Adjustment for Street Sweeping

In STORM, the computation of stormwater runoff quality parameters is dependent upon the analysis of the accumulation and washoff rate of the various pollutant loads. Related to the accumulation of pollutants is the frequency of street sweeping. If the number of days since the last runoff is less than the interval between street sweepings, the accumulation of pollutant j on land use i at the beginning of a storm is computed according to equation V-1. However, if the number of days without runoff is greater than the street sweeping interval, $P_{i,j}$ is computed as

$$P_{i,j} = P_o(1-\varepsilon)^n + N_s DD_i F_{i,j}[(1-\varepsilon)^n + (1-\varepsilon)^{n-1} + \ldots + (1-\varepsilon)] + DD_i F_{i,j}(N_D - nN_s) \quad \text{(V-22)}$$

where $P_{i,j}$ = total pounds of pollutant j on land use i at the beginning of the storm,

$F_{i,j}$ = pounds of pollutant j per pound of dust and dirt for land use i,

N_D = number of days without runoff since the last storm,

P_o = total pounds of pollutant j remaining on land use i at the end of the last storm,

DD_i = dust and dirt loading for land use i, lb/day = $dd_i \cdot G_{L,i} \cdot A_i$ from equation V-1,

N_s = number of days between street sweeping,

n = number of times the street was swept since the last storm, and

ε = street sweeping efficiency.

Note that total pounds of pollutant (not soluble only) are used in the equation, in keeping with the discussion following equation V-1.

Unfortunately, street sweeping frequencies and efficiencies are often not readily available for a study area. One can see that this is not a parameter to be taken lightly, especially when equation V-22 is used to compute pollutant accumulations. Nevertheless, it can be shown that, if the street sweeping interval is sufficiently large, it has no significant effect on pollutant accumulation and runoff quality. This is due to the fact that storms that occur within this interval will wash off the pollutants before they can build up and be removed by a sweeper.

The City of Des Moines, Iowa was chosen to demonstrate this contention. Des Moines is a moderately sized city with approximately 255,000 people and an annual average precipitation comparable to the national average. STORM was run using the precipitation record for the year 1968. Previously calibrated loading factors were also used. The street sweeping frequency was varied and the effect on the computation of annual average BOD and suspended solids concentration noted. The results are shown in Figure V-7, Effect of Street Sweeping Frequency on Annual BOD Concentration in Urban Stormwater Runoff - Des Moines, Iowa.

The results show that there is a point after which the magnitude of the street sweeping frequency has no effect on the computed values of average annual BOD and suspended solids concentrations. In this case, after approximately 20 days, STORM was insensitive to changes of the street sweeping interval. Thus,

$$f_3(N_s) = \gamma = \begin{cases} N_s/20 \text{ if } 0 \leq N_s \leq 20 \text{ days} \\ 1 \text{ otherwise} \end{cases} \qquad \text{(V-23)}$$

where γ = proportion of pollutant load remaining after street sweeping, and

N_s = street sweeping interval, days.

Due to insufficient data on street sweeping frequencies and associated control costs in the 248 urbanized areas, no adjustment was made in the calculated loadings to account for removal due to sweeping. Alternatively, γ was set equal to 1 for all cities.

Conversion for Alternate Land Uses and Pollutants

Different pollutants and land uses will generate different loadings for at least three reasons. First the dust and dirt loadings for different land uses differ. Second, the conversion factor of curb length per area is different for different land uses. Third, the pollutant fractions (as a fraction of dust and dirt) are different for different land uses. These factors are used to extend the equations developed for BOD for residential areas to similar equations for commercial, industrial and open land uses and for suspended solids, volatile solids, total PO_4 and total N.

It is assumed that fractions and ratios of pollutants as they appear in effluents will be the same as those determined from analysis of surface accumulation data. The parameters shown in Table V-7, Surface Loading and Pollutant Fraction Data, are used for conversion purposes. They are selected from the extensive survey material presented in Volume III. Where no data are available for pollutants as a fraction of surface dust and dirt, use is made (as a second choice) of similar

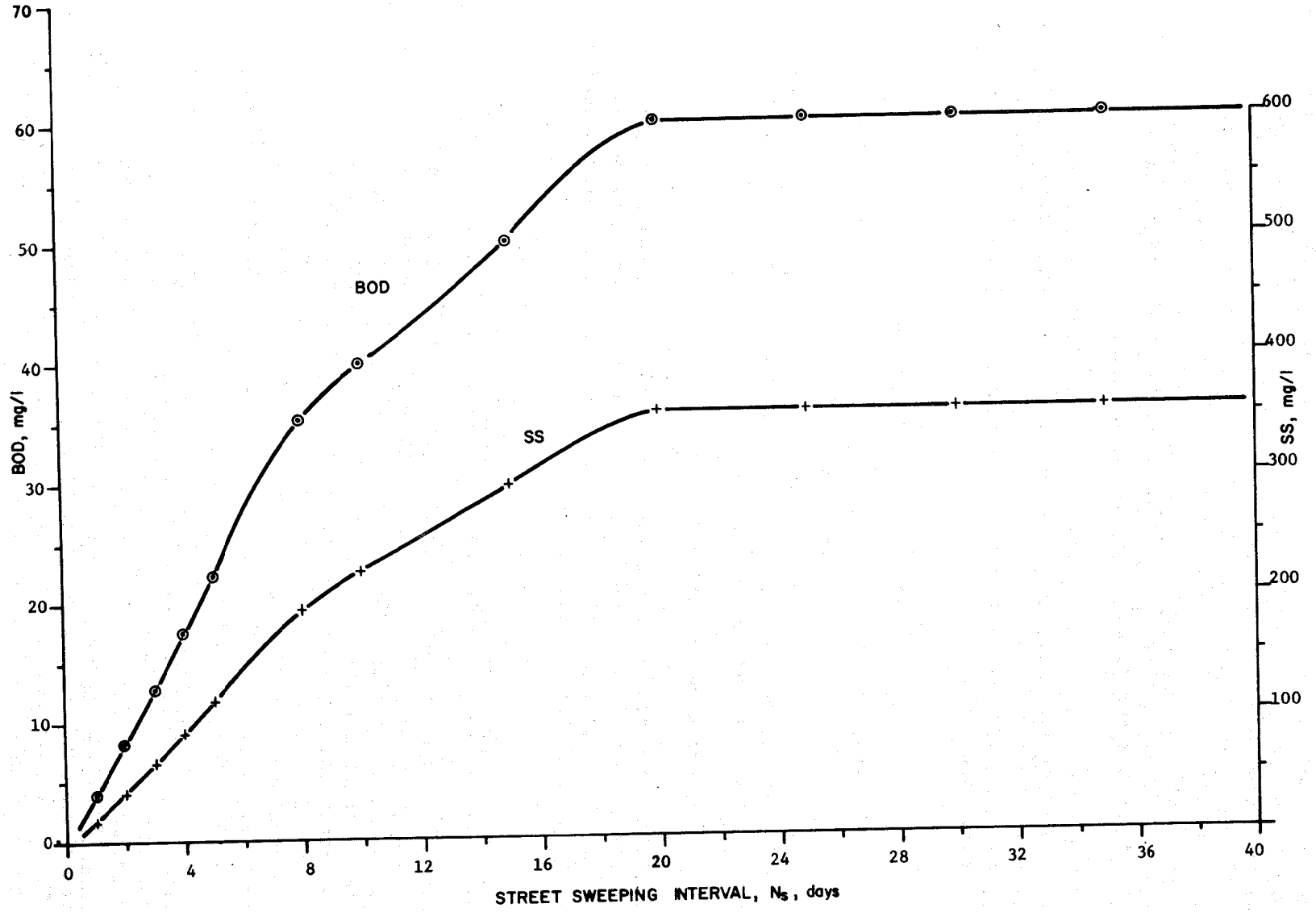

Figure V-7. Effect of Street Sweeping Frequency on Annual BOD Concentration in Urban Stormwater Runoff - Des Moines, Iowa. The variation of SS concentration is also shown.

Table V-7. SURFACE LOADING AND POLLUTANT FRACTION DATA

Except as noted, all data are from Volume III, Table: "Average Daily Dust and Dirt Accumulation and Related Pollutant Concentrations for Select Field Observations." Missing entries are not given in original table or not used in analysis.

	Residential						
	Single Family	Mult Family	Average	Commercial	Industrial	Open[a]	All Data
Dust and Dirt							
Accumulation dd_i $\frac{lb}{day\text{-}curb\ mile}$	62	113	87.5	166	319	50	159
$\frac{g}{day\text{-}curb\ mile}$	17	32	24.8	47	90	14.2	45
BOD - ppm of dd_i	5260	3370		7190	2920		
ppm of total solids (TS)[a]			29840	83800	25850	18990	
Total PO_4 - ppm of dd_i							170
ppm of TS[a]						1670	
Total N - ppm of dd_i							664[b]
ppm of TS[a]						10170[c]	
Suspended Solids-ppm of TS[a]			609200	582300	619500	453200	
Volatile Solids-ppm of TS[a]			353000	367700	306100	437500	

[a]Values taken from Volume III, Table: "Mean Pollutant Concentrations for Total Solids and Street Solids Accumulations."
[b]Sum of K-N plus NO_3-N.
[c]Value of organic - N only.

data developed for pollutants as a fraction of total solids (TS).

The BOD data are first converted to other land uses using equation V-1 as indicated below, and using i = residential (res) land use as the reference:

$$\alpha(i,BOD) = \alpha(res,BOD) \cdot \frac{dd_i}{dd_{res}} \cdot \frac{G_{L,i}}{G_{L,res}} \cdot \frac{F_{i,BOD}}{F_{res,BOD}} \qquad \text{(V-24)}$$

where dd_i = dust and dirt accumulation on land use i, lb/day-curb mile,

$G_{L,i}$ = curb miles per acre for land use i from Table V-4, and

$F_{i,BOD}$ = fraction of dust and dirt that is BOD on land use i.

For example, the parameter α for BOD for commercial land use for separate areas is

$$\alpha(com,BOD) = 0.80 \cdot \frac{166 \times 7190}{353465} \cdot \frac{0.070}{0.059}$$

$$= 3.2 \frac{\text{lb-BOD}}{\text{ac-in.}} = 1.4 \frac{\text{kg-BOD}}{\text{ha-cm}} \qquad \text{(V-25)}$$

where the number 353,465 is the average product of $dd_i \cdot F_{i,j}$ for j = BOD and i = single and multi-family residential and is equal to

$$\frac{62 \times 5260 + 113 \times 3370}{2} .$$

After determination of BOD for each land use, i, other quality parameters, j, are computed on the basis of relative values of the fractions, $F_{i,j}$. Thus,

$$\alpha(i,j) = \alpha(i,BOD) \frac{F_{i,j}}{F_{i,BOD}} . \qquad \text{(V-26)}$$

For example, the parameter α for total PO_4 in commercial areas is

$$\alpha(com,PO_4) = 3.2 \times \frac{170}{7190} = 0.076 \frac{\text{lb-}PO_4}{\text{ac-in.}} \qquad \text{(V-27)}$$

$$= 0.034 \frac{\text{kg-}PO_4}{\text{ha-cm}} .$$

For total nitrogen, N, in residential areas the calculation is similar but includes the average product of $dd_i \cdot F_{i,j}$,

$$\alpha(\text{res},N) = \frac{0.80 \cdot 664 \cdot (62 + 113)/2}{353{,}465} = 0.13 \frac{\text{lb-N}}{\text{ac-in.}} \qquad \text{(V-28)}$$

$$= 0.058 \frac{\text{kg-N}}{\text{ha-cm}}$$

For open land use and for suspended solids and volatile solids no data are available for fractions of dust and dirt, so fractions of total solids are used for values of F in the ratios. For example, for suspended solids in commercial areas,

$$\alpha(\text{com},SS) = 3.2 \times \frac{582{,}300}{83{,}800} = 22 \frac{\text{lb-SS}}{\text{ac-in.}} \qquad \text{(V-29)}$$

$$= 9.8 \frac{\text{kg-SS}}{\text{ha-cm}} .$$

Computations for combined areas are carried out in the same manner to calculate the β parameters. The final result is shown in Table V-8, Pollutant Loading Factors for Nationwide Assessment. Use of the same adjustment factors for combined and separate areas leads to the same ratio $\beta/\alpha = 4.12$ for all entries in the table. The assumption is probably not too bad, although some studies have shown higher ratios of volatile solids to suspended solids, for example, in combined sewage than in storm runoff alone.[22]

The BOD loadings are compared to dry-weather flow loadings in Table V-9, Comparison of BOD Loadings, for residential land use. Storm and combined runoff can be seen to be comparable to treatment plant effluent, although on a city-wide basis they would be greater because of higher loadings for commercial and industrial areas. Of course, BOD loads in both storm and combined sewage are in addition to the dry-weather flow loads since the usual BOD load for the latter of 0.17 lb/person-day (0.08 kg/person-day) is based upon measurements of flows actually received at treatment plants. The data from which the loadings shown in Table V-8 were derived reflect discharges over and above those received by the plants.

TABULATION OF NATIONWIDE BOD LOADS

In order to minimize the volume of material presented for each city in the assessment, only BOD loadings were tabulated. The equations indicated in Table V-8 may easily be used to calculate loadings of any of the desired parameters, given the precipitation and population density of the area of interest. As described in Section III, land use variations are determined by first computing the fraction of undeveloped land in the urbanized area. The remaining land has a constant distribution

Table V-8. POLLUTANT LOADING FACTORS FOR NATIONWIDE ASSESSMENT

The following equations may be used to predict annual average loading rates as a function of land use, precipitation and population density.

Separate Areas: $M_s = \alpha(i,j) \cdot P \cdot f_2(PD_d) \cdot \gamma \frac{lb}{acre\text{-}yr}$

Combined Areas: $M_c = \beta(i,j) \cdot P \cdot f_2(PD_d) \cdot \gamma \frac{lb}{acre\text{-}yr}$

where
- M = pounds of pollutant j generated per acre of land use i per year,
- P = annual precipitation, inches per year,
- PD_d = developed population density, persons per acre,
- α, β = factors given in table below,
- γ = street sweeping effectiveness factor, and
- $f_2(PD_d)$ = population density function.

Land Uses:
- i = 1 Residential
- i = 2 Commercial
- i = 3 Industrial
- i = 4 Other Developed, e.g., parks, cemeteries, schools (assume $PD_d = 0$)

Pollutants:
- j = 1 BOD_5, Total
- j = 2 Suspended Solids (SS)
- j = 3 Volatile Solids, Total (VS)
- j = 4 Total PO_4 (as PO_4)
- j = 5 Total N

Population Function:
- i = 1 $f_2(PD_d) = 0.142 + 0.218 \cdot PD_d^{0.54}$
- i = 2,3 $f_2(PD_d) = 1.0$
- i = 4 $f_2(PD_d) = 0.142$

Factors α and β for Equations: Separate factors, α, and combined factors, β, have units lb/acre-in. To convert to kg/ha-cm, multiply by 0.442.

		Pollutant, j				
	Land Use, i	1. BOD_5	2. SS	3. VS	4. PO_4	5. N
Separate Areas, α	1. Residential	0.799	16.3	9.45	0.0336	0.131
	2. Commercial	3.20	22.2	14.0	0.0757	0.296
	3. Industrial	1.21	29.1	14.3	0.0705	0.277
	4. Other	0.113	2.70	2.6	0.00994	0.0605
Combined Areas, β	1. Residential	3.29	67.2	38.9	0.139	0.540
	2. Commercial	13.2	91.8	57.9	0.312	1.22
	3. Industrial	5.00	120.0	59.2	0.291	1.14
	4. Other	0.467	11.1	10.8	0.0411	0.250

Street Sweeping: Factor γ is a function of street sweeping interval, N_s, (days):

$$\gamma = \begin{cases} N_s/20 & \text{if } 0 \le N_s \le 20 \text{ days} \\ 1.0 & \text{if } N_s > 20 \text{ days} \end{cases}$$

Table V-9. COMPARISON OF BOD LOADINGS

Assume residential land use; PD_d = 10 persons/acre (24.7 persons/ha), P = 30 in./yr (76 cm/yr), and γ = 1.

	lb/ac-yr	kg/ha-yr
Separate Areas	21	24
Combined Areas	88	99
Dry Weather	621	697
DWF at 85% Treatment[a]	93	105

[a]Assuming 0.17 lb-BOD/persons-day (0.08 kg-BOD/person-day).

of land uses, and can be used to weight the pollutant loading factors to give an average over all land uses as follows:

$$\overline{M} = P \sum_{i=1}^{4} w_i \cdot \alpha(i,j) \cdot f_{2_i}(PD_d) \cdot \gamma. \qquad \text{(V-30)}$$

The land use distribution fractions, w_i, are given below from Table III-3:

i	Land Use	Fraction, w_i
1	Residential	0.584
2	Commercial	0.086
3	Industrial	0.148
4	Open	0.182
		1.000

When equation V-30 is applied to BOD loadings for separate areas, the result is

$$\overline{M} = 0.42 \cdot P \cdot (0.142 + 0.218\ PD_d^{0.54}) + 0.46P \qquad \text{(V-31)}$$

where $\overline{M}$ = average annual BOD loadings over four land uses, lb-BOD/ac-yr,

P = annual precipitation, in./yr, and

PD_d = developed population density, persons/acre.

For application to combined areas, the result is

$$\overline{M} = 1.73 \cdot P \cdot (0.142 + 0.218\ PD_d^{0.54}) + 1.9P. \qquad \text{(V-32)}$$

These composite equations may easily be applied over the selected areas. The results are shown for combined, storm (separate), unsewered (using loadings for separate areas) and total land areas in Table V-10, Wet-Weather BOD Loadings. BOD loadings are the only ones computed for the sake of brevity. Values for other pollutants may be easily calculated using Table V-8 and equation V-30.

Dry-weather flow loadings are computed simply on the basis of population density assuming average annual BOD generation of 0.17 lb/person-day (0.08 kg/person-day). Thus, BOD loadings are

$$M_{Dw} = 62.1\ PD_d \qquad \text{(V-33)}$$

where M_{Dw} = average annual dry-weather flow BOD loading, lb-BOD/ac-yr.

In combined sewers, deposition during dry-weather flow can amount to as much as ten percent of the value of equation V-33, on an annual basis.[24] This could properly be subtracted from equation V-33 when used in combined sewered areas since equation V-32 implicitly includes this deposition. However, this refinement was not included in the assessment.

Values calculated using equation V-33 are presented in Table V-11, Dry-Weather BOD Loadings. As would be expected, the most heavily urbanized areas, USEPA regions 2 and 3, have the highest wet- and dry-weather BOD loadings. It may be also noted that for the same population density, areas with a large component of combined sewers produce higher loads.

TABLE V-10 WET-WEATHER BOD LOADINGS

EPA REG	STATE ID	URBANIZED AREA	TN/YR ANNL. PRECP	WET-WEATHER BOD (LBS/ACRE-YEAR) COMB	STORM	UNSEW	AVER
1	CT	BRIDGEPORT	42.0	151.7	36.9	30.8	47.1
1	CT	BRISTOL	43.0	0.0	38.7	30.4	33.5
1	CT	DANBURY	42.0	0.0	36.7	30.0	32.4
1	CT	HARTFORD	42.0	154.1	37.4	30.5	81.5
1	CT	MERIDEN	45.0	0.0	39.6	32.0	34.8
1	CT	NEW BRITAIN	43.0	0.0	37.0	32.3	35.1
1	CT	NEW HAVEN	45.0	161.4	39.2	33.4	82.5
1	CT	NORWALK	44.0	210.5	32.0	32.0	52.2
1	CT	STAMFORD	45.0	0.0	39.2	33.3	36.0
1	CT	WATERBURY	46.0	166.4	40.4	33.7	48.3
1	CT	OTHER URBAN AREAS	43.7	158.6	37.8	31.8	56.9
1	CT	AVE. FOR STATE	43.7	158.6	37.8	31.8	56.9
1	ME	LEWISTON	44.0	152.8	0.0	30.6	89.5
1	ME	PORTLAND	43.0	140.3	0.0	34.1	111.3
1	ME	OTHER URBAN AREAS	43.5	144.3	0.0	32.1	102.4
1	ME	AVE. FOR STATE	43.5	144.3	0.0	32.1	102.4
1	MA	BOSTON	43.0	164.3	39.9	30.3	44.5
1	MA	BROCKTON	45.0	0.0	39.5	33.1	36.1
1	MA	FALL RIVER	45.0	163.5	39.7	33.0	92.9
1	MA	FITCHBURG	46.0	165.9	40.3	32.8	54.4
1	MA	LAWRENCE	41.0	142.3	0.0	31.1	84.1
1	MA	LOWELL	40.0	148.4	36.0	28.7	64.3
1	MA	NEW BEDFORD	41.0	145.1	35.3	30.8	103.4
1	MA	PITTSFIELD	44.0	0.0	38.8	31.3	34.0
1	MA	SPRINGFIELD	45.0	147.8	0.0	35.9	91.2
1	MA	WORCESTER	46.0	177.0	39.4	34.2	46.7
1	MA	OTHER URBAN AREAS	43.6	152.9	39.7	31.6	56.9
1	MA	AVE. FOR STATE	43.6	152.9	39.7	31.6	56.9
1	NH	MANCHESTER	40.0	138.5	0.0	29.5	93.7
1	NH	NASHUA	42.0	136.8	0.0	33.2	94.3
1	NH	OTHER URBAN AREAS	41.0	137.8	0.0	31.0	94.0
1	NH	AVE. FOR STATE	41.0	137.8	0.0	31.0	94.0
1	RI	PROVIDENCE	40.0	152.9	34.6	28.8	59.1
1	RI	OTHER URBAN AREAS	40.0	152.9	34.6	28.8	59.1
1	RI	AVE. FOR STATE	40.0	152.9	34.6	28.8	59.1
1	VT	URBAN AREAS	35.0	117.7	0.0	27.9	68.5
1	VT	AVE. FOR STATE	35.0	117.7	0.0	27.9	68.5
1		AVE. FOR REGION 1	41.1	149.6	38.7	31.3	62.2
2	NJ	ATLANTIC CITY	42.0	0.0	37.8	29.6	32.8
2	NJ	NEW YORK CITY METRO	43.0	199.1	39.5	30.0	35.3
2	NJ	PHILADELPHIA METRO	43.0	148.2	0.0	27.8	144.9
2	NJ	TRENTON	42.0	0.0	36.1	31.6	35.0
2	NJ	VINELAND	44.0	0.0	37.4	31.9	33.8
2	NJ	AVE. FOR STATE	42.8	160.1	39.2	30.1	38.2
2	NY	ALBANY	38.0	141.3	34.3	27.2	67.7
2	NY	BINGHAMPTON	36.0	123.2	0.0	27.1	103.6
2	NY	BUFFALO	36.0	139.5	29.7	26.5	70.2
2	NY	NEW YORK CITY	43.0	243.5	46.2	0.0	134.1
2	NY	ROCHESTER	32.0	124.1	30.1	22.5	47.6
2	NY	SYRACUSE	38.0	136.5	33.2	28.2	65.7
2	NY	UTICA	44.0	157.6	38.3	32.6	48.1
2	NY	OTHER URBAN AREAS	38.1	190.8	41.1	26.5	95.9
2	NY	AVE. FOR STATE	38.1	190.8	41.1	26.5	95.9
2		AVE. FOR REGION 2	40.5	187.8	40.1	29.2	64.4

TABLE V-10 WET-WEATHER BOD LOADINGS

EPA REG	STATE ID	URBANIZED AREA	IN/YR ANNL. PRECP	WET-WEATHER BOD (LBS/ACRE-YEAR) COMB	STORM	UNSEW	AVER
3	DE	WILMINGTON	45.0	162.2	39.4	33.3	55.5
3	DE	OTHER URBAN AREAS	45.0	162.2	39.4	33.3	55.5
3	DE	AVE. FOR STATE	45.0	162.2	39.4	33.3	55.5
3	DC	WASHINGTON,D.C.	41.0	187.4	37.1	0.0	87.8
3	DC	AVE. FOR STATE	41.0	187.4	37.1	0.0	87.8
3	MD	BALTIMORE	43.0	0.0	38.3	31.7	36.3
3	MD	WASHINGTON DC METRO	41.0	0.0	36.8	29.8	33.6
3	MD	OTHER URBAN AREAS	42.0	0.0	38.0	31.0	35.6
3	MD	AVE. FOR STATE	42.0	0.0	38.0	31.0	35.6
3	PA	ALLENTOWN	44.0	162.0	39.4	32.0	37.0
3	PA	ALTOONA	44.0	155.8	37.9	33.1	57.4
3	PA	ERIE	38.0	135.5	32.6	28.6	56.0
3	PA	HARRISBURG	38.0	141.2	34.3	27.2	32.1
3	PA	JOHNSTOWN	45.0	155.3	37.7	34.8	59.6
3	PA	LANCASTER	43.0	151.8	36.9	32.5	75.1
3	PA	PHILADELPHIA	43.0	161.2	37.9	31.9	40.6
3	PA	PITTSBURGH	37.0	151.9	36.9	24.6	45.7
3	PA	READING	42.0	0.0	36.1	31.6	34.9
3	PA	SCRANTON	39.0	130.9	0.0	29.6	94.6
3	PA	WILKES-BARRE	39.0	140.0	34.0	28.8	54.2
3	PA	YORK	40.0	0.0	34.0	30.5	32.7
3	PA	OTHER URBAN AREAS	41.0	147.0	37.4	28.0	45.1
3	PA	AVE. FOR STATE	41.0	147.0	37.4	28.0	45.1
3	VA	LYNCHBERG	40.0	128.4	0.0	0.0	128.4
3	VA	NEWPORT NEWS	45.0	0.0	39.8	32.4	35.2
3	VA	NORFOLK	45.0	0.0	41.0	31.6	35.2
3	VA	PETERSBURG	43.0	0.0	39.3	30.2	33.8
3	VA	RICHMOND	44.0	159.6	38.8	32.3	74.0
3	VA	ROANOKE	42.0	148.6	36.1	31.6	35.0
3	VA	WASHINGTON DC METRO	41.0	157.1	37.1	0.0	39.1
3	VA	OTHER URBAN AREAS	42.9	147.8	38.3	31.8	45.8
3	VA	AVE. FOR STATE	42.9	147.8	38.3	31.8	45.8
3	WV	CHARLESTON	45.0	162.5	39.5	33.0	78.8
3	WV	HUNTINGTON	40.0	132.7	0.0	0.0	132.7
3	WV	STEUBENVILLE METRO	40.0	125.7	0.0	0.0	125.7
3	WV	WHEELING	39.0	134.7	32.7	30.2	97.1
3	WV	OTHER URBAN AREAS	41.0	137.6	38.6	32.3	104.1
3	WV	AVE. FOR STATE	41.0	137.6	38.6	32.3	104.1
3		AVE. FOR REGION 3	42.1	147.5	37.8	29.6	47.9

TABLE V-10 WET-WEATHER BOD LOADINGS

EPA RFG	STATE ID	URBANIZED AREA	IN/YR ANNL. PRECP	WET-WEATHER BOD (LBS/ACRE-YEAR) COMB	STORM	UNSEW	AVER.
4	AL	BIRMINGHAM	53.0	0.0	45.8	39.6	42.3
4	AL	GADSDEN	55.0	0.0	48.1	39.3	42.4
4	AL	HUNTSVILLE	52.0	0.0	45.6	36.8	40.0
4	AL	MOBILE	68.0	0.0	59.5	49.2	52.9
4	AL	MONTGOMERY	54.0	0.0	47.2	39.9	43.3
4	AL	TUSCALOOSA	53.0	0.0	44.3	41.2	42.0
4	AL	OTHER URBAN AREAS	55.8	0.0	48.7	41.6	44.4
4	AL	AVE. FOR STATE	55.8	0.0	48.7	41.6	44.4
4	FL	FT.LAUDERDALE	60.0	0.0	53.3	43.6	48.1
4	FL	GAINESVILLE	52.0	0.0	44.6	39.3	41.5
4	FL	JACKSONVILLE	53.0	0.0	46.4	37.7	41.1
4	FL	MIAMI	60.0	0.0	53.0	44.3	50.3
4	FL	ORLANDO	51.0	190.0	46.2	36.0	41.2
4	FL	PENSACOLA	63.0	0.0	55.5	46.0	50.2
4	FL	ST.PETERSBURG	55.0	0.0	49.7	39.4	44.1
4	FL	TALLAHASSEE	57.0	0.0	50.5	41.4	45.4
4	FL	TAMPA	52.0	0.0	47.6	36.7	41.3
4	FL	WEST PALM BEACH	62.0	0.0	54.2	45.5	49.0
4	FL	OTHER URBAN AREAS	56.5	190.0	51.0	40.8	45.9
4	FL	AVE. FOR STATE	56.5	190.0	51.0	40.8	45.9
4	GA	ALBANY	48.0	152.0	0.0	0.0	152.0
4	GA	ATLANTA	47.0	166.9	40.6	35.4	46.2
4	GA	AUGUSTA	39.0	129.2	0.0	31.4	79.6
4	GA	COLUMBUS	49.0	172.8	42.0	37.0	58.9
4	GA	MACON	44.0	0.0	38.4	32.5	35.1
4	GA	SAVANNAH	52.0	197.4	38.5	38.0	89.3
4	GA	OTHER URBAN AREAS	46.5	159.7	40.4	35.3	58.6
4	GA	AVE. FOR STATE	46.5	159.7	40.4	35.3	58.6
4	KY	HUNTINGTON METRO	40.0	141.0	34.3	30.3	43.4
4	KY	LEXINGTON	44.0	0.0	38.0	33.0	36.4
4	KY	LOUISVILLE	41.0	152.8	37.1	29.4	35.4
4	KY	OWENSBORO	44.0	155.7	37.8	33.1	114.4
4	KY	OTHER URBAN AREAS	42.3	153.2	37.2	30.0	39.8
4	KY	AVE. FOR STATE	42.3	153.2	37.2	30.0	39.8
4	MS	BILOXI	58.0	0.0	49.6	43.8	45.8
4	MS	JACKSON	51.0	0.0	44.4	37.8	40.8
4	MS	OTHER URBAN AREAS	54.5	0.0	46.2	40.5	42.9
4	MS	AVE. FOR STATE	54.5	0.0	46.2	40.5	42.9
4	NC	ASHEVILLE	48.0	0.0	43.1	33.9	37.4
4	NC	CHARLOTTE	43.0	0.0	36.8	32.5	34.5
4	NC	DURHAM	43.0	0.0	36.2	33.4	34.4
4	NC	FAYETTEVILLE	47.0	0.0	40.4	35.4	37.3
4	NC	GREENSBORO	42.0	0.0	37.0	30.7	33.4
4	NC	HIGHPOINT	46.0	0.0	38.2	35.8	36.4
4	NC	RALEIGH	46.0	0.0	40.1	34.4	36.4
4	NC	WILMINGTON	52.0	0.0	47.0	36.6	40.6
4	NC	WINSTON-SALEM	47.0	0.0	40.3	35.4	37.3
4	NC	OTHER URBAN AREAS	46.0	0.0	39.0	34.0	36.0
4	NC	AVE. FOR STATE	46.0	0.0	39.0	34.0	36.0
4	SC	CHARLESTON	47.0	0.0	40.2	35.6	37.5
4	SC	COLUMBIA	47.0	0.0	40.6	35.4	37.5
4	SC	GREENVILLE	46.0	0.0	39.5	34.7	36.6
4	SC	OTHER URBAN AREAS	46.7	0.0	40.2	35.3	37.2
4	SC	AVE. FOR STATE	46.7	0.0	40.2	35.3	37.2
4	TN	CHATTANOOGA	54.0	192.4	46.8	40.1	53.6
4	TN	KNOXVILLE	46.0	0.0	39.7	34.6	36.5
4	TN	MEMPHIS	48.0	0.0	43.4	34.5	38.8
4	TN	NASHVILLE	45.0	162.2	37.6	32.3	62.9
4	TN	OTHER URBAN AREAS	48.3	166.2	42.3	34.7	48.8
4	TN	AVE. FOR STATE	48.3	166.2	42.3	34.7	48.8
4		AVE. FOR REGION 4	49.6	161.0	44.9	37.2	45.5

TABLE V-10 WET-WEATHER BOD LOADINGS

EPA REG	STATE ID	URBANIZED AREA	IN/YR ANNL. PRECP	WET-WEATHER BOD (LBS/ACRE-YEAR) COMB	STORM	UNSEW	AVER
5	IL	AURORA	34.0	0.0	30.7	24.4	27.2
5	IL	BLOOMINGTON	36.0	0.0	32.2	26.1	29.2
5	IL	CHAMPAIGN	37.0	0.0	32.7	27.5	31.7
5	IL	CHICAGO	33.0	136.1	24.2	23.9	70.6
5	IL	DAVENPORT METRO	34.0	117.0	28.4	26.5	66.9
5	IL	DECATUR	37.0	123.0	0.0	29.9	80.2
5	IL	JOLIET	33.0	0.0	29.1	24.2	26.5
5	IL	PEORIA	35.0	115.3	0.0	28.0	69.2
5	IL	ROCKFORD	36.0	0.0	32.6	25.8	29.0
5	IL	SPRINGFIELD	35.0	124.0	30.1	26.3	49.4
5	IL	OTHER URBAN AREAS	35.0	133.8	26.3	24.6	64.6
5	IL	AVE. FOR STATE	35.0	133.8	26.3	24.6	64.6
5	IN	ANDERSON	36.0	106.1	0.0	0.0	106.1
5	IN	CHICAGO METRO	33.0	122.6	29.8	23.7	53.3
5	IN	EVANSVILLE	41.0	138.6	0.0	0.0	138.6
5	IN	FORT WAYNE	34.0	126.6	30.8	24.4	57.6
5	IN	INDIANAPOLIS	40.0	147.1	35.7	28.0	67.0
5	IN	LAFAYETTE	35.0	131.0	23.0	0.0	89.4
5	IN	MUNCIE	39.0	134.4	32.7	30.2	76.9
5	IN	SOUTH BEND	36.0	120.8	0.0	28.8	82.6
5	IN	TERRA HAUTE	41.0	0.0	34.4	32.0	32.9
5	IN	OTHER URBAN AREAS	37.2	128.6	31.5	26.3	68.8
5	IN	AVE. FOR STATE	37.2	128.6	31.5	26.3	68.8
5	MI	ANN ARBOR	31.0	0.0	26.7	23.3	25.7
5	MI	BAY CITY	28.0	93.7	0.0	22.8	63.3
5	MI	DETROIT	31.0	116.8	27.0	22.5	63.3
5	MI	FLINT	30.0	107.7	26.2	22.3	26.8
5	MI	GRAND RAPIDS	31.0	114.1	27.7	22.2	34.0
5	MI	JACKSON	34.0	114.4	0.0	26.6	64.9
5	MI	KALAMAZOO	34.0	0.0	29.8	24.9	26.8
5	MI	LANSING	31.0	110.9	26.9	23.1	47.8
5	MI	MUSKEGON	32.0	0.0	28.4	23.0	25.1
5	MI	SAGINAW	28.0	94.5	0.0	23.0	72.5
5	MI	OTHER URBAN AREAS	31.0	114.5	27.1	22.7	55.0
5	MI	AVE. FOR STATE	31.0	114.5	27.1	22.7	55.0
5	MN	DULUTH	29.0	104.3	25.3	21.0	36.2
5	MN	FARGO METRO	21.0	72.4	17.6	16.3	52.9
5	MN	MINNEAPOLIS	25.0	90.6	22.0	17.9	29.7
5	MN	ROCHESTER	29.0	0.0	24.6	22.1	23.9
5	MN	OTHER URBAN AREAS	26.0	90.5	22.3	18.2	30.3
5	MN	AVE. FOR STATE	26.0	90.5	22.3	18.2	30.3
5	OH	AKRON	38.0	0.0	34.1	27.3	30.2
5	OH	CANTON	38.0	144.6	34.3	27.2	35.4
5	OH	CINCINNATI	34.0	118.8	28.9	25.9	80.4
5	OH	CLEVELAND	32.0	124.3	30.2	21.8	41.3
5	OH	COLUMBUS	36.0	137.5	33.4	25.3	41.8
5	OH	DAYTON	35.0	0.0	31.2	25.4	28.1
5	OH	HAMILTON	40.0	150.3	36.5	28.1	55.0
5	OH	LIMA	36.0	115.9	0.0	0.0	115.9
5	OH	LORAIN	35.0	184.2	30.7	25.2	27.9
5	OH	MANSFIELD	43.0	0.0	35.9	33.5	34.1
5	OH	SPRINGFIELD	40.0	137.7	33.5	31.0	108.6
5	OH	STEUBENVILLE	40.0	140.1	0.0	0.0	120.3
5	OH	TOLEDO	32.0	116.5	27.9	23.5	50.1
5	OH	YOUNGSTOWN	42.0	152.0	36.9	30.8	68.3
5	OH	OTHER URBAN AREAS	37.2	125.3	31.9	24.8	49.3
5	OH	AVE. FOR STATE	37.2	125.3	31.9	24.8	49.3
5	WI	APPLETON	29.0	108.3	26.3	20.8	34.9
5	WI	DULUTH METRO	29.0	0.0	24.6	21.1	22.3
5	WI	GREEN BAY	27.0	94.6	23.0	20.4	25.0
5	WI	KENOSHA	32.0	118.7	26.6	0.0	42.3
5	WI	LA CROSSE	31.0	109.5	26.6	23.4	30.2
5	WI	MADISON	31.0	0.0	27.8	22.3	24.8
5	WI	MILWAUKEE	28.0	118.2	21.6	21.4	32.9
5	WI	OSHKOSH	28.0	0.0	23.4	0.0	23.4
5	WI	RACINE	32.0	0.0	27.5	24.1	26.6
5	WI	OTHER URBAN AREAS	29.7	116.2	23.7	21.5	31.1
5	WI	AVE. FOR STATE	29.7	116.2	23.7	21.5	31.1
5		AVE. FOR REGION 5.	32.7	124.0	27.4	23.5	52.8

TABLE V-10 WET-WEATHER BOD LOADINGS

EPA REG	STATE ID	URBANIZED AREA	IN/YR ANNL. PRECP	WET-WEATHER BOD (LBS/ACRE-YEAR) COMB	STORM	UNSEW	AVER
6	AR	FORT SMITH	43.0	138.4	0.0	33.6	75.0
6	AR	LITTLE ROCK	49.0	0.0	42.6	37.9	39.1
6	AR	PINE BLUFF	52.0	0.0	44.2	39.7	42.0
6	AR	OTHER URBAN AREAS	48.0	138.4	43.2	37.2	48.1
6	AR	AVE. FOR STATE	48.0	138.4	43.2	37.2	48.1
6	LA	BATON ROUGE	60.0	0.0	52.4	44.5	48.3
6	LA	LAFAYETTE	59.0	0.0	50.2	45.0	47.9
6	LA	LAKE CHARLES	58.0	0.0	49.8	43.8	46.5
6	LA	MONROE	50.0	0.0	42.3	38.7	39.9
6	LA	NEW ORLEANS	64.0	0.0	61.9	0.0	61.9
6	LA	SHREVEPORT	45.0	0.0	38.5	34.1	36.0
6	LA	OTHER URBAN AREAS	56.0	0.0	55.1	40.0	49.9
6	LA	AVE. FOR STATE	56.0	0.0	55.1	40.0	49.9
6	NM	ALBUQUERQUE	9.0	0.0	7.9	6.6	7.2
6	NM	OTHER URBAN AREAS	9.0	0.0	7.9	6.6	7.2
6	NM	AVE. FOR STATE	9.0	0.0	7.9	6.6	7.2
6	OK	LAWTON	30.0	0.0	25.2	23.3	23.9
6	OK	OKLAHOMA CITY	31.0	0.0	27.8	21.8	24.0
6	OK	TULSA	37.0	0.0	32.8	26.6	29.1
6	OK	OTHER URBAN AREAS	32.7	0.0	29.4	23.6	25.8
6	OK	AVE. FOR STATE	32.7	0.0	29.4	23.6	25.8
6	TX	ABILENE	24.0	0.0	21.0	17.0	18.5
6	TX	AMARILLO	20.0	0.0	17.8	14.4	15.7
6	TX	AUSTIN	33.0	0.0	28.7	24.5	26.7
6	TX	BEAUMONT	54.0	198.1	48.1	38.1	68.1
6	TX	BROWNSVILLE	27.0	0.0	22.6	20.9	22.2
6	TX	BRYAN	39.0	0.0	34.8	27.5	30.2
6	TX	CORPUS CHRISTI	28.0	0.0	25.1	19.7	21.7
6	TX	DALLAS	35.0	0.0	31.4	24.2	27.2
6	TX	EL PASO	8.0	0.0	7.2	5.7	6.4
6	TX	FORT WORTH	30.0	0.0	26.9	21.1	23.3
6	TX	GALVESTON	43.0	205.2	0.0	32.4	47.1
6	TX	HARLINGEN	26.0	0.0	20.9	20.3	20.4
6	TX	HOUSTON	46.0	197.4	39.4	34.7	37.3
6	TX	LAREDO	19.0	0.0	16.2	14.5	15.5
6	TX	LUBBOCK	18.0	0.0	15.4	13.6	14.2
6	TX	MCALLEN	21.0	0.0	17.6	16.4	17.0
6	TX	MIDLAND	14.0	0.0	11.7	10.9	11.1
6	TX	ODESSA	14.0	0.0	11.9	10.7	11.4
6	TX	PORT ARTHUR	54.0	0.0	45.9	40.9	42.4
6	TX	SAN ANGELO	19.0	0.0	15.8	14.8	15.0
6	TX	SAN ANTONIO	28.0	0.0	25.3	20.1	22.6
6	TX	SHERMAN	39.0	0.0	31.8	30.4	30.7
6	TX	TEXARKANA	46.0	0.0	38.4	35.8	36.4
6	TX	TEXAS CITY	45.0	0.0	38.8	32.4	34.6
6	TX	TYLER	45.0	0.0	38.6	34.0	35.9
6	TX	WACO	32.0	0.0	28.1	22.8	24.7
6	TX	WICHITA FALL	29.0	0.0	24.4	22.5	23.2
6	TX	OTHER URBAN AREAS	31.0	200.1	29.7	24.3	27.5
6	TX	AVE. FOR STATE	31.0	200.1	29.7	24.3	27.5
6		AVE. FOR REGION 6	35.3	157.3	33.4	25.5	30.2

TABLE V-10 WET WEATHER BOD LOADINGS

EPA RFG	STATE ID	URBANIZED AREA	IN/YR ANNL. PRECP	WET-WEATHER BOD (LBS/ACRE-YEAR) COMB	STORM	UNSEW	AVER
7	IA	CEDAR RAPIDS	33.0	0.0	28.3	24.9	26.2
7	IA	DAVENPORT	34.0	121.8	29.6	24.7	27.8
7	IA	DES MOINES	31.0	139.1	23.5	22.4	37.2
7	IA	DUBUQUE	33.0	0.0	27.7	25.5	27.0
7	IA	SIOUX CITY	25.0	0.0	22.2	17.7	19.4
7	IA	WATERLOO	32.0	0.0	27.2	24.2	25.1
7	IA	OTHER URBAN AREAS	31.3	138.1	26.2	23.0	29.0
7	IA	AVE. FOR STATE	31.3	138.1	26.2	23.0	29.0
7	KS	KANSAS CITY METRO	34.0	121.6	29.6	25.3	46.4
7	KS	TOPEKA	34.0	122.3	29.7	25.1	48.0
7	KS	WICHITA	31.0	0.0	26.6	23.4	25.0
7	KS	OTHER URBAN AREAS	33.0	121.9	27.9	24.4	37.5
7	KS	AVE. FOR STATE	33.0	121.9	27.9	24.4	37.5
7	MO	COLUMBIA	37.0	0.0	32.6	26.3	28.6
7	MO	KANSAS CITY	34.0	127.6	26.4	25.7	45.5
7	MO	SPRINGFIELD	41.0	0.0	35.8	30.1	32.2
7	MO	ST.JOSEPH	35.0	107.7	0.0	0.0	107.7
7	MO	ST.LOUIS	37.0	127.0	0.0	30.7	86.3
7	MO	OTHER URBAN AREAS	36.8	125.2	29.2	28.5	70.3
7	MO	AVE. FOR STATE	36.8	125.2	29.2	28.5	70.3
7	NE	LINCOLN	27.0	0.0	23.9	19.7	21.7
7	NE	OMAHA	26.0	96.8	23.5	18.6	48.3
7	NE	OTHER URBAN AREAS	26.5	96.8	23.8	18.9	41.8
7	NE	AVE. FOR STATE	26.5	96.8	23.8	18.9	41.8
7		AVE. FOR REGION 7	31.9	121.7	27.0	25.0	50.2
8	CO	BOULDER	19.0	0.0	16.8	14.0	16.0
8	CO	COLORADO SPRINGS	13.0	0.0	11.2	9.8	10.3
8	CO	DENVER	14.0	60.9	12.5	10.1	11.5
8	CO	PUEBLO	12.0	47.5	10.0	9.1	13.4
8	CO	OTHER URBAN AREAS	14.5	50.2	12.4	10.1	11.6
8	CO	AVE. FOR STATE	14.5	50.2	12.4	10.1	11.6
8	MT	BILLINGS	13.0	0.0	11.2	9.8	10.4
8	MT	GREAT FALLS	15.0	0.0	12.6	11.5	12.2
8	MT	OTHER URBAN AREAS	14.0	0.0	12.0	10.5	11.3
8	MT	AVE. FOR STATE	14.0	0.0	12.0	10.5	11.3
8	ND	FARGO	21.0	73.5	17.9	16.1	19.0
8	ND	OTHER URBAN AREAS	21.0	73.5	17.9	16.1	19.0
8	ND	AVE. FOR STATE	21.0	73.5	17.9	16.1	19.0
8	SD	SIOUX FALLS	25.0	90.1	21.9	18.7	21.3
8	SD	OTHER URBAN AREAS	25.0	90.1	21.9	18.7	21.3
8	SD	AVE. FOR STATE	25.0	90.1	21.9	18.7	21.3
8	UT	OGDEN	17.0	0.0	15.0	12.4	13.5
8	UT	PROVO	13.0	0.0	11.6	9.2	10.1
8	UT	SALT LAKE CITY	15.0	0.0	13.2	10.9	12.0
8	UT	OTHER URBAN AREAS	15.0	0.0	13.4	10.9	12.0
8	UT	AVE. FOR STATE	15.0	0.0	13.4	10.9	12.0
8	WY	URBAN AREAS	15.0	0.0	12.9	11.3	12.0
8	WY	AVE. FOR STATE	15.0	0.0	12.9	11.3	12.0
8		AVE. FOR REGION 8	17.4	64.2	13.7	11.5	13.0

TABLE V-10 WET WEATHER BOD LOADINGS

EPA REG	STATE ID	URBANIZED AREA	TN/YR ANNL. PRECP	WET WEATHER BOD (LBS/ACRE-YEAR) COMB	STORM	UNSEW	AVER
9	AK	URBAN AREAS	30.0	111.0	27.0	21.2	26.5
9	AK	AVE. FOR STATE	30.0	111.0	27.0	21.2	26.5
9	AZ	PHOENIX	7.0	0.0	6.2	5.0	5.5
9	AZ	TUCSON	11.0	0.0	9.5	8.3	8.9
9	AZ	OTHER URBAN AREAS	9.0	0.0	7.0	5.8	6.3
9	AZ	AVE. FOR STATE	9.0	0.0	7.0	5.8	6.3
9	CA	BAKERSFIELD	11.0	0.0	9.8	8.0	8.8
9	CA	FRESNO	11.0	0.0	9.6	8.2	8.9
9	CA	LOS ANGELES	13.0	0.0	11.5	9.6	11.1
9	CA	MODESTO	25.0	0.0	21.4	18.9	20.3
9	CA	OXNARD	15.0	0.0	13.4	10.8	11.8
9	CA	SACRAMENTO	18.0	65.2	15.8	13.1	17.9
9	CA	SALINAS	15.0	0.0	13.9	11.3	12.5
9	CA	SAN BERNANDINO	18.0	0.0	16.3	12.6	14.0
9	CA	SAN DIEGO	11.0	0.0	9.8	8.0	8.9
9	CA	SAN FRANCISCO	21.0	91.1	18.8	14.4	29.4
9	CA	SAN JOSE	14.0	0.0	12.7	10.1	11.4
9	CA	SANTA BARBARA	18.0	0.0	15.5	13.5	14.7
9	CA	SANTA ROSA	30.0	0.0	25.1	23.3	23.8
9	CA	SEASIDE	16.0	0.0	13.4	12.4	13.3
9	CA	SIMI VALLEY	25.0	0.0	21.4	18.9	19.9
9	CA	STOCKTON	14.0	0.0	12.1	10.5	11.4
9	CA	OTHER URBAN AREAS	17.2	88.7	12.5	11.5	14.9
9	CA	AVE. FOR STATE	17.2	88.7	12.5	11.5	14.9
9	HI	HONOLULU	23.0	0.0	20.6	16.7	18.8
9	HI	OTHER URBAN AREAS	23.0	0.0	20.6	16.7	18.8
9	HI	AVE. FOR STATE	23.0	0.0	20.6	16.7	18.8
9	NV	LAS VEGAS	4.0	0.0	3.5	2.9	3.1
9	NV	RENO	7.0	26.2	5.9	5.2	9.5
9	NV	OTHER URBAN AREAS	5.5	26.2	4.0	3.5	4.9
9	NV	AVE. FOR STATE	5.5	26.2	4.0	3.5	4.9
9		AVE. FOR REGION 9	16.9	86.4	12.4	10.9	14.2
10	ID	BOISE	11.0	0.0	9.3	8.5	8.9
10	ID	OTHER URBAN AREAS	11.0	0.0	9.3	8.5	8.9
10	ID	AVE. FOR STATE	11.0	0.0	9.3	8.5	8.9
10	OR	EUGENE	38.0	136.5	33.2	28.1	33.4
10	OR	PORTLAND	40.0	146.3	35.5	29.1	60.2
10	OR	SALEM	40.0	0.0	34.3	30.2	32.0
10	OR	OTHER URBAN AREAS	39.3	146.0	34.9	29.0	53.8
10	OR	AVE. FOR STATE	39.3	146.0	34.9	29.0	53.8
10	WA	SEATTLE	35.0	127.3	30.9	25.5	53.3
10	WA	SPOKANE	17.0	56.8	0.0	13.8	44.7
10	WA	TACOMA	39.0	141.1	34.3	28.6	33.0
10	WA	OTHER URBAN AREAS	30.3	103.9	32.1	25.3	48.3
10	WA	AVE. FOR STATE	30.3	103.9	32.1	25.3	48.3
10		AVE. FOR REGION 10	26.9	116.1	29.4	25.0	46.5
		AVERAGE FOR THE U.S.	33.4	136.6	30.5	25.9	43.6

TABLE V-11 DRY-WEATHER BOD LOADINGS

EPA REG	STATE ID	URBANIZED AREA	IN/YR ANNL. PRECP	DRY-WEATHER BOD (LBS/ACRE-YEAR) COMB	STORM	UNSEW	AVER
1	CT	BRIDGEPORT	42.0	769.	769.	296.	516.
1	CT	BRISTOL	43.0	0.	857.	227.	468.
1	CT	DANBURY	42.0	0.	750.	247.	428.
1	CT	HARTFORD	42.0	823.	823.	278.	564.
1	CT	MERIDEN	45.0	0.	779.	240.	436.
1	CT	NEW BRITAIN	43.0	0.	702.	342.	552.
1	CT	NEW HAVEN	45.0	744.	744.	315.	546.
1	CT	NORWALK	44.0	2277.	276.	275.	503.
1	CT	STAMFORD	45.0	0.	745.	309.	508.
1	CT	WATERBURY	46.0	773.	773.	291.	507.
1	CT	OTHER URBAN AREAS	43.7	836.	736.	288.	521.
1	CT	AVE. FOR STATE	43.7	836.	736.	288.	521.
1	ME	LEWISTON	44.0	638.	0.	205.	414.
1	ME	PORTLAND	43.0	465.	0.	465.	465.
1	ME	OTHER URBAN AREAS	43.5	519.	0.	318.	444.
1	ME	AVE. FOR STATE	43.5	519.	0.	318.	444.
1	MA	BOSTON	43.0	982.	982.	226.	593.
1	MA	BROCKTON	45.0	0.	770.	296.	519.
1	MA	FALL RIVER	45.0	789.	789.	291.	544.
1	MA	FITCHBURG	46.0	761.	761.	244.	431.
1	MA	LAWRENCE	41.0	637.	0.	362.	493.
1	MA	LOWELL	40.0	864.	864.	252.	527.
1	MA	NEW BEDFORD	41.0	699.	699.	344.	589.
1	MA	PITTSFIELD	44.0	0.	788.	238.	439.
1	MA	SPRINGFIELD	45.0	480.	0.	480.	480.
1	MA	WORCESTER	46.0	1011.	685.	320.	526.
1	MA	OTHER URBAN AREAS	43.6	704.	931.	281.	554.
1	MA	AVE. FOR STATE	43.6	704.	931.	281.	554.
1	NH	MANCHESTER	40.0	630.	0.	305.	496.
1	NH	NASHUA	42.0	459.	0.	459.	459.
1	NH	OTHER URBAN AREAS	41.0	560.	0.	368.	481.
1	NH	AVE. FOR STATE	41.0	560.	0.	368.	481.
1	RI	PROVIDENCE	40.0	984.	721.	261.	546.
1	RI	OTHER URBAN AREAS	40.0	984.	721.	261.	546.
1	RI	AVE. FOR STATE	40.0	984.	721.	261.	546.
1	VT	URBAN AREAS	35.0	544.	0.	480.	509.
1	VT	AVE. FOR STATE	35.0	544.	0.	480.	509.
1		AVE. FOR REGION 1	41.1	700.	851.	290.	533.
2	NJ	ATLANTIC CITY	42.0	0.	864.	226.	471.
2	NJ	NEW YORK CITY METRO	43.0	2039.	944.	211.	517.
2	NJ	PHILADELPHIA METRO	43.0	615.	0.	109.	601.
2	NJ	TRENTON	42.0	0.	698.	345.	607.
2	NJ	VINELAND	44.0	0.	664.	271.	409.
2	NJ	AVE. FOR STATE	42.8	948.	921.	214.	520.
2	NY	ALBANY	38.0	873.	873.	253.	543.
2	NY	BINGHAMPTON	36.0	593.	0.	347.	543.
2	NY	BUFFALO	36.0	1041.	566.	301.	665.
2	NY	NEW YORK CITY	43.0	3879.	1730.	0.	2688.
2	NY	ROCHESTER	32.0	1045.	1045.	219.	601.
2	NY	SYRACUSE	38.0	749.	749.	318.	588.
2	NY	UTICA	44.0	740.	740.	311.	494.
2	NY	OTHER URBAN AREAS	38.1	2428.	1383.	272.	1533.
2	NY	AVE. FOR STATE	38.1	2428.	1383.	272.	1533.
2		AVE. FOR REGION 2	40.5	2284.	1126.	229.	979.

TABLE V-11 DRY-WEATHER BOD LOADINGS

EPA REG	STATE ID	URBANIZED AREA	TN/YR ANNL. PRECP	DRY-WEATHER BOD (LBS/ACRE-YEAR) COMB	STORM	UNSEW	AVER
3	DE	WILMINGTON	45.0	760.	760.	309.	553.
3	DE	OTHER URBAN AREAS	45.0	760.	760.	309.	553.
3	DE	AVE. FOR STATE	45.0	760.	760.	309.	553.
3	DC	WASHINGTON,D.C.	41.0	1950.	884.	0.	1243.
3	DC	AVE. FOR STATE	41.0	1950.	884.	0.	1243.
3	MD	BALTIMORE	43.0	0.	824.	301.	667.
3	MD	WASHINGTON DC METRO	41.0	0.	852.	274.	589.
3	MD	OTHER URBAN AREAS	42.0	0.	830.	292.	647.
3	MD	AVE. FOR STATE	42.0	0.	830.	292.	647.
3	PA	ALLENTOWN	44.0	837.	837.	276.	572.
3	PA	ALTOONA	44.0	701.	701.	343.	600.
3	PA	ERIE	38.0	723.	687.	344.	592.
3	PA	HARRISBURG	38.0	871.	871.	252.	535.
3	PA	JOHNSTOWN	45.0	619.	619.	406.	557.
3	PA	LANCASTER	43.0	690.	690.	351.	530.
3	PA	PHILADELPHIA	43.0	906.	785.	317.	690.
3	PA	PITTSBURGH	37.0	1313.	1313.	143.	536.
3	PA	READING	42.0	0.	699.	345.	599.
3	PA	SCRANTON	38.0	539.	0.	363.	476.
3	PA	WILKES-BARRE	39.0	746.	746.	309.	511.
3	PA	YORK	40.0	0.	660.	373.	550.
3	PA	OTHER URBAN AREAS	41.0	942.	834.	234.	608.
3	PA	AVE. FOR STATE	41.0	942.	834.	234.	608.
3	VA	LYNCHBERG	40.0	424.	0.	0.	424.
3	VA	NEWPORT NEWS	45.0	0.	792.	261.	464.
3	VA	NORFOLK	45.0	0.	902.	218.	484.
3	VA	PETERSBURG	43.0	0.	915.	218.	494.
3	VA	RICHMOND	44.0	783.	783.	293.	522.
3	VA	ROANOKE	42.0	697.	697.	345.	493.
3	VA	WASHINGTON DC METRO	41.0	994.	877.	0.	879.
3	VA	OTHER URBAN AREAS	42.9	660.	862.	254.	602.
3	VA	AVE. FOR STATE	42.9	660.	862.	254.	602.
3	WV	CHARLESTON	45.0	766.	766.	293.	503.
3	WV	HUNTINGTON	40.0	508.	0.	0.	508.
3	WV	STEUBENVILLE METRO	40.0	376.	0.	0.	376.
3	WV	WHEELING	39.0	622.	622.	406.	550.
3	WV	OTHER URBAN AREAS	41.0	555.	748.	320.	498.
3	WV	AVE. FOR STATE	41.0	555.	748.	320.	498.
3		AVE. FOR REGION 3	42.1	846.	838.	253.	622.

TABLE V-11 DRY-WEATHER BOD LOADINGS

EPA REG	STATE ID	URBANIZED AREA	IN/YR ANNL. PRECP	DRY-WEATHER BOD (LBS/ACRE-YEAR) COMB	STORM	UNSEW	AVER
4	AL	BIRMINGHAM	53.0	0.	715.	330.	499.
4	AL	GADSDEN	55.0	0.	753.	246.	429.
4	AL	HUNTSVILLE	52.0	0.	767.	230.	426.
4	AL	MOBILE	68.0	0.	759.	267.	445.
4	AL	MONTGOMERY	54.0	0.	753.	305.	515.
4	AL	TUSCALOOSA	53.0	0.	611.	417.	468.
4	AL	OTHER URBAN AREAS	55.8	0.	732.	302.	473.
4	AL	AVE. FOR STATE	55.8	0.	732.	302.	473.
4	FL	FT. LAUDERDALE	60.0	0.	812.	275.	524.
4	FL	GAINESVILLE	52.0	0.	691.	351.	493.
4	FL	JACKSONVILLE	53.0	0.	758.	240.	443.
4	FL	MIAMI	60.0	0.	794.	304.	640.
4	FL	ORLANDO	51.0	882.	882.	229.	480.
4	FL	PENSACOLA	63.0	0.	779.	286.	502.
4	FL	ST. PETERSBURG	55.0	0.	871.	252.	535.
4	FL	TALLAHASSEE	57.0	0.	803.	274.	506.
4	FL	TAMPA	52.0	0.	923.	227.	519.
4	FL	WEST PALM BEACH	62.0	0.	756.	293.	478.
4	FL	OTHER URBAN AREAS	56.5	882.	812.	264.	533.
4	FL	AVE. FOR STATE	56.5	882.	812.	264.	533.
4	GA	ALBANY	48.0	393.	0.	0.	393.
4	GA	ATLANTA	47.0	710.	710.	345.	512.
4	GA	AUGUSTA	39.0	504.	0.	504.	504.
4	GA	COLUMBUS	49.0	687.	687.	350.	469.
4	GA	MACON	44.0	0.	748.	306.	500.
4	GA	SAVANNAH	52.0	955.	310.	285.	504.
4	GA	OTHER URBAN AREAS	46.5	609.	699.	349.	499.
4	GA	AVE. FOR STATE	46.5	609.	699.	349.	499.
4	KY	HUNTINGTON METRO	40.0	685.	685.	357.	493.
4	KY	LEXINGTON	44.0	0.	714.	339.	593.
4	KY	LOUISVILLE	41.0	883.	883.	256.	562.
4	KY	OWENSBORO	44.0	697.	697.	347.	621.
4	KY	OTHER URBAN AREAS	42.3	747.	837.	273.	566.
4	KY	AVE. FOR STATE	42.3	747.	837.	273.	566.
4	MS	BILOXI	58.0	0.	683.	352.	465.
4	MS	JACKSON	51.0	0.	737.	312.	508.
4	MS	OTHER URBAN AREAS	54.5	0.	719.	330.	490.
4	MS	AVE. FOR STATE	54.5	0.	719.	330.	490.
4	NC	ASHEVILLE	48.0	0.	852.	228.	465.
4	NC	CHARLOTTE	43.0	0.	686.	355.	508.
4	NC	DURHAM	43.0	0.	631.	412.	491.
4	NC	FAYETTEVILLE	47.0	0.	694.	347.	483.
4	NC	GREENSBORO	42.0	0.	778.	286.	499.
4	NC	HIGHPOINT	46.0	0.	593.	420.	460.
4	NC	RALEIGH	46.0	0.	747.	331.	479.
4	NC	WILMINGTON	52.0	0.	873.	222.	471.
4	NC	WINSTON-SALEM	47.0	0.	693.	348.	480.
4	NC	OTHER URBAN AREAS	46.0	0.	718.	339.	487.
4	NC	AVE. FOR STATE	46.0	0.	718.	339.	487.
4	SC	CHARLESTON	47.0	0.	684.	358.	488.
4	SC	COLUMBIA	47.0	0.	710.	348.	491.
4	SC	GREENVILLE	46.0	0.	694.	347.	483.
4	SC	OTHER URBAN AREAS	46.7	0.	697.	351.	488.
4	SC	AVE. FOR STATE	46.7	0.	697.	351.	488.
4	TN	CHATTANOOGA	54.0	721.	721.	316.	466.
4	TN	KNOXVILLE	46.0	0.	707.	343.	483.
4	TN	MEMPHIS	48.0	0.	878.	255.	554.
4	TN	NASHVILLE	45.0	760.	609.	253.	432.
4	TN	OTHER URBAN AREAS	48.3	755.	785.	277.	491.
4	TN	AVE. FOR STATE	48.3	755.	785.	277.	491.
4		AVE. FOR REGION 4	49.6	663.	766.	304.	507.

TABLE V-11 DRY-WEATHER BOD LOADINGS

EPA REG	STATE ID	URBANIZED AREA	IN/YR ANNL. PRECP	DRY-WEATHER BOD (LBS/ACRE-YEAR) COMB	STORM	UNSEW	AVER
5	IL	AURORA	34.0	0.	868.	252.	532.
5	IL	BLOOMINGTON	36.0	0.	831.	275.	558.
5	IL	CHAMPAIGN	37.0	0.	791.	318.	699.
5	IL	CHICAGO	33.0	1338.	291.	272.	719.
5	IL	DAVENPORT METRO	34.0	611.	611.	421.	541.
5	IL	DECATUR	37.0	512.	0.	512.	512.
5	IL	JOLIET	33.0	0.	780.	291.	520.
5	IL	PEORIA	35.0	489.	0.	489.	489.
5	IL	ROCKFORD	36.0	0.	884.	253.	553.
5	IL	SPRINGFIELD	35.0	701.	701.	342.	565.
5	IL	OTHER URBAN AREAS	35.0	1236.	450.	295.	676.
5	IL	AVE. FOR STATE	35.0	1236.	450.	295.	676.
5	IN	ANDERSON	36.0	252.	0.	0.	252.
5	IN	CHICAGO METRO	33.0	870.	870.	257.	551.
5	IN	EVANSVILLE	41.0	558.	0.	0.	558.
5	IN	FORT WAYNE	34.0	879.	879.	252.	546.
5	IN	INDIANAPOLIS	40.0	832.	832.	213.	480.
5	IN	LAFAYETTE	35.0	900.	139.	0.	603.
5	IN	MUNCIE	39.0	615.	615.	406.	567.
5	IN	SOUTH BEND	36.0	537.	0.	491.	518.
5	IN	TERRA HAUTE	41.0	0.	620.	425.	502.
5	IN	OTHER URBAN AREAS	37.2	683.	775.	270.	508.
5	IN	AVE. FOR STATE	37.2	683.	775.	270.	508.
5	MI	ANN ARBOR	31.0	0.	699.	344.	592.
5	MI	BAY CITY	28.0	530.	0.	530.	530.
5	MI	DETROIT	31.0	925.	741.	272.	630.
5	MI	FLINT	30.0	746.	746.	316.	557.
5	MI	GRAND RAPIDS	31.0	834.	834.	254.	495.
5	MI	JACKSON	34.0	546.	0.	430.	480.
5	MI	KALAMAZOO	34.0	0.	760.	290.	476.
5	MI	LANSING	31.0	734.	734.	321.	539.
5	MI	MUSKEGON	32.0	0.	804.	260.	473.
5	MI	SAGINAW	28.0	552.	0.	552.	552.
5	MI	OTHER URBAN AREAS	31.0	875.	750.	290.	594.
5	MI	AVE. FOR STATE	31.0	875.	750.	290.	594.
5	MN	DULUTH	29.0	751.	751.	269.	442.
5	MN	FARGO METRO	21.0	616.	616.	406.	565.
5	MN	MINNEAPOLIS	25.0	780.	780.	254.	492.
5	MN	ROCHESTER	29.0	0.	653.	374.	580.
5	MN	OTHER URBAN AREAS	26.0	768.	771.	257.	492.
5	MN	AVE. FOR STATE	26.0	768.	771.	257.	492.
5	OH	AKRON	38.0	0.	846.	254.	510.
5	OH	CANTON	38.0	966.	865.	252.	540.
5	OH	CINCINNATI	34.0	658.	658.	374.	549.
5	OH	CLEVELAND	32.0	1054.	1054.	171.	532.
5	OH	COLUMBUS	36.0	980.	980.	221.	552.
5	OH	DAYTON	35.0	0.	821.	273.	534.
5	OH	HAMILTON	40.0	914.	914.	218.	494.
5	OH	LIMA	36.0	430.	0.	0.	430.
5	OH	LORAIN	35.0	3105.	764.	261.	460.
5	OH	MANSFIELD	43.0	0.	606.	418.	465.
5	OH	SPRINGFIELD	40.0	611.	611.	406.	578.
5	OH	STEUBENVILLE	40.0	645.	0.	0.	571.
5	OH	TOLEDO	32.0	797.	740.	296.	526.
5	OH	YOUNGSTOWN	42.0	775.	775.	296.	534.
5	OH	OTHER URBAN AREAS	37.2	778.	896.	247.	531.
5	OH	AVE. FOR STATE	37.2	778.	896.	247.	531.
5	WI	APPLETON	29.0	890.	890.	253.	562.
5	WI	DULUTH METRO	29.0	0.	650.	276.	407.
5	WI	GREEN BAY	27.0	666.	666.	358.	451.
5	WI	KENOSHA	32.0	865.	590.	0.	637.
5	WI	LA CROSSE	31.0	693.	693.	349.	507.
5	WI	MADISON	31.0	0.	843.	257.	528.
5	WI	MILWAUKEE	28.0	1461.	402.	378.	514.
5	WI	OSHKOSH	28.0	0.	608.	0.	608.
5	WI	RACINE	32.0	0.	698.	345.	605.
5	WI	OTHER URBAN AREAS	29.7	1324.	547.	351.	522.
5	WI	AVE. FOR STATE	29.7	1324.	547.	351.	522.
5		AVE. FOR REGION 5	32.7	942.	688.	279.	571.

TABLE V-11 DRY-WEATHER BOD LOADINGS

EPA RFG	STATE ID	URBANIZED AREA	IN/YR ANNL. PRECP	DRY-WEATHER BOD (LBS/ACRE-YEAR) COMB	STORM	UNSEW	AVER.
6	AR	FORT SMITH	43.0	430.	0.	430.	430.
6	AR	LITTLE ROCK	49.0	0.	736.	402.	491.
6	AR	PINE BLUFF	52.0	0.	665.	373.	524.
6	AR	OTHER URBAN AREAS	48.0	430.	712.	405.	482.
6	AR	AVE. FOR STATE	48.0	430.	712.	405.	482.
6	LA	BATON ROUGE	60.0	0.	748.	315.	526.
6	LA	LAFAYETTE	59.0	0.	662.	373.	537.
6	LA	LAKE CHARLES	58.0	0.	690.	352.	505.
6	LA	MONROE	50.0	0.	643.	408.	485.
6	LA	NEW ORLEANS	64.0	0.	1167.	0.	1167.
6	LA	SHREVEPORT	45.0	0.	686.	356.	499.
6	LA	OTHER URBAN AREAS	56.0	0.	961.	352.	749.
6	LA	AVE. FOR STATE	56.0	0.	961.	352.	749.
6	NM	ALBUQUERQUE	9.0	0.	786.	287.	506.
6	NM	OTHER URBAN AREAS	9.0	0.	786.	287.	506.
6	NM	AVE. FOR STATE	9.0	0.	786.	287.	506.
6	OK	LAWTON	30.0	0.	626.	414.	481.
6	OK	OKLAHOMA CITY	31.0	0.	849.	220.	455.
6	OK	TULSA	37.0	0.	801.	260.	474.
6	OK	OTHER URBAN AREAS	32.7	0.	815.	252.	464.
6	OK	AVE. FOR STATE	32.7	0.	815.	252.	464.
6	TX	ABILENE	24.0	0.	759.	232.	424.
6	TX	AMARILLO	20.0	0.	809.	258.	476.
6	TX	AUSTIN	33.0	0.	733.	320.	534.
6	TX	BEAUMONT	54.0	824.	824.	224.	445.
6	TX	BROWNSVILLE	27.0	0.	617.	406.	563.
6	TX	BRYAN	39.0	0.	824.	224.	445.
6	TX	CORPUS CHRISTI	28.0	0.	838.	222.	451.
6	TX	DALLAS	35.0	0.	846.	198.	470.
6	TX	EL PASO	8.0	0.	859.	240.	520.
6	TX	FORT WORTH	30.0	0.	849.	220.	454.
6	TX	GALVESTON	43.0	2258.	0.	344.	512.
6	TX	HARLINGEN	26.0	0.	503.	429.	441.
6	TX	HOUSTON	46.0	1552.	689.	351.	537.
6	TX	LAREDO	19.0	0.	661.	373.	541.
6	TX	LUBBOCK	18.0	0.	686.	351.	468.
6	TX	MCALLEN	21.0	0.	620.	422.	515.
6	TX	MIDLAND	14.0	0.	602.	419.	464.
6	TX	ODESSA	14.0	0.	660.	373.	547.
6	TX	PORT ARTHUR	54.0	0.	660.	359.	448.
6	TX	SAN ANGELO	19.0	0.	603.	418.	464.
6	TX	SAN ANTONIO	28.0	0.	881.	255.	559.
6	TX	SHERMAN	39.0	0.	540.	426.	447.
6	TX	TEXARKANA	46.0	0.	602.	419.	464.
6	TX	TEXAS CITY	45.0	0.	704.	259.	417.
6	TX	TYLER	45.0	0.	691.	351.	494.
6	TX	WACO	32.0	0.	769.	242.	433.
6	TX	WICHITA FALL	29.0	0.	631.	412.	490.
6	TX	OTHER URBAN AREAS	31.0	1228.	766.	278.	496.
6	TX	AVE. FOR STATE	31.0	1228.	766.	278.	496.
6		AVE. FOR REGION 6	35.3	675.	803.	291.	520.

TABLE V-11 DRY-WEATHER BOD LOADINGS

EPA REG	STATE ID	URBANIZED AREA	TN/YR ANNL. PRECP	DRY-WEATHER BOD (LBS/ACRE-YEAR) COMB	STORM	UNSEW	AVER
7	IA	CEDAR RAPIDS	33.0	0.	692.	348.	478.
7	IA	DAVENPORT	34.0	738.	738.	273.	436.
7	IA	DES MOINES	31.0	1827.	364.	267.	490.
7	IA	DUBUQUE	33.0	0.	620.	406.	556.
7	IA	SIOUX CITY	25.0	0.	813.	234.	448.
7	IA	WATERLOO	32.0	0.	665.	358.	450.
7	IA	OTHER URBAN AREAS	31.3	1763.	612.	299.	473.
7	IA	AVE. FOR STATE	31.3	1763.	612.	299.	473.
7	KS	KANSAS CITY METRO	34.0	734.	734.	321.	541.
7	KS	TOPEKA	34.0	752.	752.	305.	499.
7	KS	WICHITA	31.0	0.	695.	347.	522.
7	KS	OTHER URBAN AREAS	33.0	741.	714.	328.	525.
7	KS	AVE. FOR STATE	33.0	741.	714.	328.	525.
7	MO	COLUMBIA	37.0	0.	784.	239.	438.
7	MO	KANSAS CITY	34.0	911.	409.	358.	473.
7	MO	SPRINGFIELD	41.0	0.	750.	292.	466.
7	MO	ST. JOSEPH	35.0	332.	0.	0.	332.
7	MO	ST. LOUIS	37.0	604.	0.	592.	599.
7	MO	OTHER URBAN AREAS	36.8	621.	529.	465.	537.
7	MO	AVE. FOR STATE	36.8	621.	529.	465.	537.
7	NE	LINCOLN	27.0	0.	803.	285.	526.
7	NE	OMAHA	26.0	880.	880.	252.	546.
7	NE	OTHER URBAN AREAS	26.5	880.	833.	260.	541.
7	NE	AVE. FOR STATE	26.5	880.	833.	260.	541.
7		AVE. FOR REGION 7	31.9	712.	657.	367.	520.
8	CO	BOULDER	19.0	0.	802.	306.	655.
8	CO	COLORADO SPRINGS	13.0	0.	696.	346.	487.
8	CO	DENVER	14.0	1635.	834.	267.	566.
8	CO	PUEBLO	12.0	1138.	591.	350.	543.
8	CO	OTHER URBAN AREAS	14.5	1238.	798.	290.	555.
8	CO	AVE. FOR STATE	14.5	1238.	798.	290.	555.
8	MT	BILLINGS	13.0	0.	693.	349.	508.
8	MT	GREAT FALLS	15.0	0.	629.	388.	544.
8	MT	OTHER URBAN AREAS	14.0	0.	657.	364.	525.
8	MT	AVE. FOR STATE	14.0	0.	657.	364.	525.
8	ND	FARGO	21.0	662.	662.	384.	563.
8	ND	OTHER URBAN AREAS	21.0	662.	662.	384.	563.
8	ND	AVE. FOR STATE	21.0	662.	662.	384.	563.
8	SD	SIOUX FALLS	25.0	759.	759.	328.	516.
8	SD	OTHER URBAN AREAS	25.0	759.	759.	328.	516.
8	SD	AVE. FOR STATE	25.0	759.	759.	328.	516.
8	UT	OGDEN	17.0	0.	777.	287.	497.
8	UT	PROVO	13.0	0.	813.	234.	448.
8	UT	SALT LAKE CITY	15.0	0.	789.	276.	506.
8	UT	OTHER URBAN AREAS	15.0	0.	790.	271.	495.
8	UT	AVE. FOR STATE	15.0	0.	790.	271.	495.
8	WY	URBAN AREAS	15.0	0.	693.	349.	506.
8	WY	AVE. FOR STATE	15.0	0.	693.	349.	506.
8		AVE. FOR REGION 8	17.4	988.	760.	303.	532.

TABLE V-11 DRY-WEATHER BOD LOADINGS

EPA REG	STATE ID	URBANIZED AREA	TN/YR ANNL. PRECP	DRY-WEATHER BOD (LBS/ACRE-YEAR) COMB	STORM	UNSEW	AVER
9	AK	URBAN AREAS	30.0	854.	854.	227.	466.
9	AK	AVE. FOR STATE	30.0	854.	854.	227.	466.
9	AZ	PHOENIX	7.0	0.	777.	246.	484.
9	AZ	TUCSON	11.0	0.	715.	340.	518.
9	AZ	OTHER URBAN AREAS	9.0	0.	761.	268.	492.
9	AZ	AVE. FOR STATE	9.0	0.	761.	268.	492.
9	CA	BAKERSFIELD	11.0	0.	822.	273.	535.
9	CA	FRESNO	11.0	0.	735.	321.	550.
9	CA	LOS ANGELES	13.0	0.	789.	316.	682.
9	CA	MODESTO	25.0	0.	690.	350.	537.
9	CA	OXNARD	15.0	0.	819.	256.	482.
9	CA	SACRAMENTO	18.0	776.	776.	282.	506.
9	CA	SALINAS	15.0	0.	698.	345.	602.
9	CA	SAN BERNANDINO	18.0	0.	873.	217.	464.
9	CA	SAN DIEGO	11.0	0.	815.	277.	539.
9	CA	SAN FRANCISCO	21.0	1619.	842.	183.	619.
9	CA	SAN JOSE	14.0	0.	886.	258.	574.
9	CA	SANTA BARBARA	18.0	0.	701.	342.	562.
9	CA	SANTA ROSA	30.0	0.	613.	417.	469.
9	CA	SEASIDE	16.0	0.	609.	406.	585.
9	CA	SIMI VALLEY	25.0	0.	687.	354.	487.
9	CA	STOCKTON	14.0	0.	702.	342.	555.
9	CA	OTHER URBAN AREAS	17.2	1539.	798.	262.	617.
9	CA	AVE. FOR STATE	17.2	1539.	798.	262.	617.
9	HI	HONOLULU	23.0	0.	841.	277.	583.
9	HI	OTHER URBAN AREAS	23.0	0.	841.	277.	583.
9	HI	AVE. FOR STATE	23.0	0.	841.	277.	583.
9	NV	LAS VEGAS	4.0	0.	801.	258.	469.
9	NV	RENO	7.0	893.	661.	326.	508.
9	NV	OTHER URBAN AREAS	5.5	893.	777.	277.	480.
9	NV	AVE. FOR STATE	5.5	893.	777.	277.	480.
9		AVE. FOR REGION 9	16.9	1507.	797.	263.	601.
10	ID	BOISE	11.0	0.	657.	405.	526.
10	ID	OTHER URBAN AREAS	11.0	0.	657.	405.	526.
10	ID	AVE. FOR STATE	11.0	0.	657.	405.	526.
10	OR	EUGENE	38.0	748.	748.	306.	502.
10	OR	PORTLAND	40.0	811.	811.	276.	535.
10	OR	SALEM	40.0	0.	690.	352.	501.
10	OR	OTHER URBAN AREAS	39.3	810.	780.	288.	528.
10	OR	AVE. FOR STATE	39.3	810.	780.	288.	528.
10	WA	SEATTLE	35.0	791.	791.	282.	530.
10	WA	SPOKANE	17.0	527.	0.	527.	527.
10	WA	TACOMA	39.0	774.	774.	290.	504.
10	WA	OTHER URBAN AREAS	30.3	703.	785.	302.	525.
10	WA	AVE. FOR STATE	30.3	703.	785.	302.	525.
10		AVE. FOR REGION 10	26.9	734.	763.	307.	526.
		AVERAGE FOR THE U.S.	33.4	1039.	807.	285.	594.

ABBREVIATIONS AND SYMBOLS

a	Coefficient
A_i	Area of land use i
AR	Wet-weather runoff, inches per year
α	Normalized pollutant loading factor for separate sewered areas, pounds per acre-inch
b	Coefficient
BOD	Biochemical oxygen demand
BOD_5	Biochemical oxygen demand at five days
β	Normalized pollutant loading factor for combined sewered areas, pounds per acre-inch
C	Concentration, mass pollutant per total mass or mg/l
COD	Chemical oxygen demand
com	Abbreviation for commercial
CR	Runoff coefficient
dd_i	Pounds of accumulated dust and dirt (or "surface solids") on land use i per curb-mile - dry day
DD_i	Dust and dirt loading for land use i, pounds per day
ε	Street sweeping efficiency
DWF	Abbreviation for dry-weather flow and dry-weather flow runoff, inches per year
f_1	Factor for adjustment of pollutant loads, a function of precipitation
f_2	Factor for adjustment of pollutant loads, a function of population density
f_3	Factor for adjustment of pollutant loads, a function of street sweeping interval
$F_{i,j}$	Fraction of dust and dirt on land use i that consists of pollutant j
$G_{L,i}$	Length of curb per area of land use i, curb-miles per acre

γ	Street sweeping factor
I	Imperviousness as a fraction or percent
K	Conversion factor
m	Coefficient
M	Pollutant loading, pounds per acre-year
$\overline{M}$	Pollutant loading averaged over different land uses, pounds per acre-year
M_c	Pollutant loading in combined sewered areas, pounds per acre-year
M_{Dw}	Pollutant loading under dry weather conditions, pounds per acre-year
M_s	Pollutant loading in separate sewered areas, pounds per acre-year
n	Number of storms per year, also number of times street swept since last storm
N	Total nitrogen
N_D	Number of dry days since last storm
N_s	Street sweeping interval, days
P	Precipitation rate, inches per year
P_o	Mass of pollutant on surface at end of previous storm, pounds
$P_{i,j}$	Mass of pollutant j on surface of land use i at beginning of storm, pounds
P_s	Precipitation depth during one storm, inches
PD	Population density, persons per acre
PD_d	Population density in developed area, persons per acre
PO_4	Phosphate or total phosphate
r	Correlation coefficient
res	Abbreviation for residential
ρ	Water density, pounds per cubic foot

SS	Suspended solids
TOC	Total organic carbon
TPO_4	Total phosphate
TS	Total solids
VS	Total volatile solids
w_i	Fraction of total area consisting of land use i

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