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Supplemental Manual On The Development And Implementation Of Local Discharge Limitations Under The Pretreatment Program

Residential And Commercial Toxic Pollutant Loadings And POTW Removal Efficiency Estimation

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DISCLAIMER

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INTRODUCTION

The National Pretreatment Program as implemented under the Clean Water Act (CWA) and General Pretreatment Regulations [40 Code of Federal Regulations (CFR) Part 403] is designed to control the introduction of nondomestic wastes to Publicly Owned Treatment Works (POTWs). The specific objectives of the Program are to protect POTWs from pass through and interference, to protect the receiving waters and to improve opportunities to recycle sludges. To accomplish these objectives, the program relies on National categorical standards, prohibited discharge standards and local limits.

Control Authorities are required to develop and enforce local limits as mandated by 40 CFR 403.5 and 40 CFR 403.8. In December 1987, the U.S. Environmental Protection Agency (EPA) published a technical document entitled Guidance Manual on the Development and Implementation of Local Discharge Limitations (referred to as the "1987 local limits guidance" in the remainder of this document). That guidance addressed the key elements in developing local limits such as identifying all industrial users, determining the character and volume of pollutants in industrial user discharges, collecting data for local limits development, identifying pollutants of concern, calculating removal efficiencies, determining the allowable headworks loading, and implementing appropriate local limits to ensure that the Maximum Allowable Headworks Loadings (MAHLs) are not exceeded. This manual is intended to supplement the 1987 local limits guidance and assumes that the reader has a thorough understanding of local limits development; it builds on information contained in the 1987 local limits guidance. This is a two-part document which provides information on toxic pollutant loadings from residential and commercial sources (Part 1) and calculation of removal efficiencies achieved by municipal wastewater treatment plants (Part 2).

Part 1 of this document provides background information on pollutant levels in residential wastewater and in wastewaters from commercial sources, and characterizes toxic pollutant discharges from these sources. Residential and commercial source monitoring data summarized in Part 1 are intended to supplement similar data found in the 1987 local limits guidance.

The monitoring data provided in Part 1 demonstrate the importance of accurately characterizing all sources of toxic pollutants during the local limits development process. While the monitoring data summarized in this guidance and in the 1987 local limits guidance can be used to estimate pollutant loadings from specified sources, collection of site-specific monitoring data is always preferred.

Part 2 of this guidance expands on the 1987 local limits guidance methodology for calculating POTW removals of toxic pollutants. Calculation of removal efficiencies for local limits development is necessary to determine the portion of a given pollutant loading that is discharged to the receiving stream and the portion that is removed to sludge. The mean approach to calculating removal efficiencies is probably the most familiar calculation. The decile approach is a statistical method which allows POTWs to select, with a particular level of confidence, removal efficiencies for the development of local limits which will protect the POTW from interference and pass through. These methods are clearly defined and illustrated with examples and actual POTW sampling and analysis data. A "worksheet" format is included to simplify the decile approach. In addition, difficulties that can be encountered (e.g. negative removals) when applying the calculations to analytical sampling data are discussed.

PART 1

RESIDENTIAL AND COMMERCIAL SOURCES OF TOXIC POLLUTANTS

1.0 RESIDENTIAL AND COMMERCIAL SOURCES OF TOXIC POLLUTANTS

In the local limits development process, the Maximum Allowable Headworks Loading (MAHL) of a particular toxic pollutant is allocated to both residential and industrial sources. Thus, the POTW classifies each site-specific source as either a residential or an industrial user. This classification depends on the size of the facility, and on the toxic pollutant concentrations and loadings discharged to the POTW. To make informed decisions regarding this classification, the POTW must have a clear understanding of toxic pollutant contributions from all sources, including households, commercial establishments (e.g., radiator shops, car washes, laundries, etc.), and heavy industries.

Occasionally, a POTW may find that the loadings of a toxic pollutants exceed the MAHL. Elevated loadings from nonindustrial sources may be attributable to:

- Nonpoint sources (e.g., runoff) discharging to combined sewers
- Elevated pollutant levels in water supplies
- Household disposal of chemicals into sanitary sewers
- Toxic pollutant discharges from commercial sources.

The first three sources listed above can be controlled through the implementation of various management practices/programs outside the scope of local limits development. Nonpoint sources of pollutants are addressed through combined sewer overflow abatement programs and urban and agricultural chemical management practice programs. The POTW can address elevated pollutant levels in water supplies by interacting with the City Water Department. For example, elevated metals levels in water supplies often arise from leaching in water distribution pipes; the City Water Department may be able to reduce such leaching by adjusting the pH and/or alkalinity of the water supply. The POTW can encourage proper disposal of household chemicals by instituting public education programs and establishing chemical and used oil recovery stations.

Elevated pollutant levels in discharges from commercial sources are most effectively addressed through local limits. Commercial sources such as radiator shops, car washes, and laundries are often not considered as significant sources of toxics due to their small size and generally low flows, and/or an assumption of insignificant pollutant levels or loadings. These commercial sources, often discharge at surprisingly high pollutant levels and should not be overlooked during local limits development. Some of these commercial sources may warrant consideration as significant industrial users, including routine monitoring and regulation through local limits.

In addition to commercial sources, other wastewater sources should be considered when establishing local limits, (e.g., septage haulers' loads and landfill leachates).

Given the importance of characterizing wastewaters from these sources, the purpose of Part 1 of this guidance is to provide data on observed pollutant levels in residential wastewater, wastewaters from specific types of commercial sources, septage haulers' loads, and landfill leachates accepted by POTWs. The wastewater characterization data provided will enable the POTW to:

- Compare pollutant loadings in its system with those found at other POTWs
- Estimate pollutant loadings from these sources as a supplement to, or in the absence of, pollutant loadings derived from actual site-specific monitoring data. These estimated loadings can be used in local limits calculations when site-specific monitoring data are not available.
- Identify toxic pollutant sources and determine which sources warrant consideration during local limits development, routine monitoring, and regulation under the local pretreatment program.

While the data provided can be used to derive reasonable estimates of pollutant loadings from specified sources, collection of site-specific data is preferable.

The monitoring data summarized in this guidance were obtained from a variety of POTWs. It was summarized by various statistics, including range, mean, and median pollutant levels. Section 1.1 describes this monitoring data. While the procedures for data analysis are detailed in Section 1.2. Sections 1.3-1.6 present and discuss the monitoring data summaries. A summary of the conclusions is provided in Section 1.7.

1.1 SUMMARY OF DATA RECEIVED

To obtain the residential and commercial source monitoring data presented in this guidance, POTWs were requested to submit the following types of monitoring data:

- Residential/commercial trunk line monitoring data - Pollutant levels and flow monitoring data for trunk lines receiving entirely or primarily residential wastewaters
- Specific commercial source monitoring data - Pollutant levels and flow monitoring data for specific types of commercial sources (i.e., hospitals, radiator shops, car washes, truck cleaners, dry cleaners, and commercial laundries)
- Septage hauler monitoring data - Pollutant levels in septage haulers' loads
- Monitoring data - Pollutant levels in landfill leachates accepted by POTWs.

The monitoring data provided by POTWs did not predate 1986.

Table 1 summarizes the types of residential and commercial source monitoring data received from POTWs and incorporated into this guidance. As can be seen from Table 1, 38 POTWs located in all 10 EPA Regions provided monitoring data.

1.2 DATA ANALYSIS AND LIMITATIONS

Pollutant monitoring data provided by POTWs were summarized by calculating the following statistics:

- Mean pollutant level
- Minimum reported pollutant level
- Maximum reported pollutant level
- Median pollutant level.

The number of pollutant detections versus the number of monitoring events (e.g., a pollutant detected 5 times in 7 monitoring events) was tracked for each pollutant. Pollutant levels reported as below specified detection limits were considered in the data analysis and, for the purpose of statistical

TABLE 1. MUNICIPALITIES WHICH PROVIDED RESIDENTIAL/COMMERCIAL DATA

MUNICIPALITY	RESIDENTIAL/ COMMERCIAL DATA	COMMERCIAL SOURCE DATA						SEPTAGE HAULER DATA	LEACHATE DATA
		HOSPITALS	RADIATOR SHOPS	CAR WASHES	TRUCK CLEANERS	DRY CLEANERS	LAUNDRIES		
REGION 1									
BANGOR, ME		●					●		
LAWRENCE, MA									●
MERRIMACK, NH				●		●			
PORTLAND, ME	●			●			●		●
WARWICK, RI	●							●	
REGION 2									
AUBURN, NY									●
BUFFALO, NY	●						●		
ONONDAGA COUNTY, NY			●					●	●
ONEIDA COUNTY, NY									●
TONAWANDA, NY									●
REGION 3									
ALLENTOWN, PA	●	●		●		●		●	
ALTOONA, PA		●							
HAMPTON ROADS, VA	●	●			●		●	●	
WSSC, MD			●						
REGION 4									
BOWLING GREEN, KY							●		
LOUISVILLE, KY		●					●		
NORTH CHARLESTON, SC		●					●		●
W.CAROLINA, SC									●
REGION 5									
CHICAGO, IL			●				●	●	
COLUMBUS, OH							●		
HOLLAND, MI	●								
INDIANAPOLIS, IN	●								
MILWAUKEE, WI	●								
ROCKFORD, IL	●						●		
ST. PAUL, MN							●		
REGION 6									
BATON ROUGE, LA		●	●		●	●	●		
DALLAS, TX								●	
REGION 7									
FORT DODGE, IA			●						
WATERLOO, IA								●	
WICHITA, KS							●	●	
REGION 8									
GREELEY, CO	●						●		
LOUISVILLE, CO	●								
REGION 9									
LOS ANGELES, CA	●								
ORANGE COUNTY, CA	●								
SAN FRANCISCO, CA	●		●						
SANTA ROSA, CA								●	
REGION 10									
UNIFIED SEWER AUTHORITY, OR	●								

analysis, were considered equal to the detection limit. Pollutant levels reported below detection were incorporated into the statistical analysis as follows:

- Calculation of mean pollutant levels - The mean pollutant levels presented in this guidance are based on the use of detection limits (as specified by the POTWs) as surrogates for pollutant levels reported below detection. For example, the mean of the following data set would be reported as 4 milligrams per liter (mg/l) (assuming a 2 mg/l detection limit).

  6 mg/l
  4 mg/l
  < 2 mg/l

- Determination of minimum and maximum pollutant levels - The use of specified detection limits as surrogates in the determination of minimum and maximum reported pollutant levels is demonstrated as follows:

Set 1:	< 2 mg/l	Set 2:	1 mg/l
	4 mg/l		< 2 mg/l
	< 6 mg/l		5 mg/l
	minimum - < 2 mg/l		minimum - 1 mg/l
	maximum - < 6 mg/l		maximum - 5 mg/l

- Calculation of median pollutant levels - Specified detection limits were also used as surrogates in calculating median pollutant levels:

Set 1:	1 mg/l	Set 2:	1 mg/l
	< 2 mg/l		< 2 mg/l
	5 mg/l		3 mg/l
	5 mg/l		
	median - < 2 mg/l		median - < 2 mg/l
	mean - 3.25 mg/l		mean - 2 mg/l

In lieu of averaging two detection limits to obtain a median, the lower of the two detection limits was selected as the median:

1 mg/l
< 2 mg/l
< 3 mg/l
5 mg/l

median - < 2 mg/l
mean - 2.25 mg/l

Some POTWs reported no pollutant levels below specified detection limits. For these facilities, the number of monitoring events for each pollutant equals the corresponding number of pollutant detections and no detection limits appear as minimum, maximum, or median pollutant levels.

The monitoring data provided by POTWs are assumed to adequately represent the types of discharges to their systems indicated (i.e., residential trunk line, specific commercial source, hauled septage, or landfill leachate). Associated sampling and laboratory quality assurance/quality control data and protocols were not requested of the municipalities nor reviewed during the survey; therefore, the assumption of representative monitoring data has not been verified. This verification was not deemed essential in providing <u>estimates</u> of pollutant levels in residential/commercial source discharges. It should be emphasized again that accurate data may only be ensured through the implementation of site-specific monitoring programs.

The POTWs had obtained their monitoring data through a variety of local sampling programs, instituted for a variety of purposes, including local limits development, industrial user compliance monitoring, and industrial user self-monitoring. The POTWs indicated that both grab and composite sampling techniques had been employed, depending on the specifics of the local monitoring program and the nature of the discharges being monitored. Consistent sampling techniques were not employed by all respondent POTWs. For a given wastewater source discharging to a given POTW, both grab and composite monitoring data were often submitted. Due to such variation in sampling technique, no attempt has been made in this report to resolve monitoring data in accordance with sample type.

The commercial source and landfill leachate monitoring data submitted by respondent POTWs were obtained by sampling at the facilities' sewer connections, downstream of any installed pretreatment units. The submitted monitoring data therefore reflect the level of pretreatment, if any, installed at the time of monitoring. The nature and efficiency of pretreatment units depend upon the particular discharge being considered, and no attempt has been made in this document to classify pollutant levels as either raw or treated levels. The pollutant levels provided in this document should be considered as neither raw nor treated pollutant levels, but rather as reflective of the discharge levels currently being received by the various POTWs.

The types of commercial sources considered in this document (e.g., radiator shops, hospitals, etc.) were defined on the basis of the services they provide, rather than on any similarities in process operations. Process flowcharts for individual industries were not requested or reviewed to identify similarities in process operations or wastewater treatment technologies and practices. The assumption should be made that facilities may perform a diversity of process operations and may or may not pretreat wastewaters prior to discharge. Also, as indicated previously, the accuracy and representativeness of the commercial source monitoring data provided in this report can only be verified through site-specific monitoring of individual facilities.

Since process flowcharts were not reviewed while developing this guidance, it is not known whether the individual industries considered in this study perform any operations regulated by Federal categorical pretreatment standards. For example, a radiator shop performing acid etching or phosphate coating would be subject to the electroplating/metal finishing categorical standards (40 CFR 413/40 CFR 433). POTWs should be aware that consideration of a type of commercial source, such as radiator shops, in this document does not preclude the applicability of Federal categorical pretreatment standards. Each POTW should review process flowcharts for each of its industrial users, to determine the applicability of Federal categorical pretreatment standards on a case-by-case basis.

1.3 RESIDENTIAL AND COMMERCIAL MONITORING DATA

As discussed in the introduction, POTWs should establish total pollutant loadings from residential sources as part of the local limits development process. The recommended procedure in the 1987 local limits guidance for determining residential pollutant loadings is through a site-specific monitoring program. Such a program entails the periodic collection and analysis of samples from trunk lines receiving wastewater from residential and commercial sources. Site-specific total residential loadings are calculated from pollutant level and wastewater flow monitoring data resulting from a residential/commercial trunk line monitoring program.

Many POTWs have established residential/commercial trunk line monitoring programs. Monitoring data provided by 15 POTWs is presented in this section. Of these POTWs, nine reported that their residential/commercial trunk line programs were established specifically to support local limits development.

Table 2 summarizes residential/commercial trunk line monitoring data provided by 15 POTWs located in 7 EPA Regions. Average, minimum, and maximum pollutant levels; number of detections; and number of observations are provided for each pollutant. The monitoring data summarized in Table 2 were obtained through monitoring of sewer trunk lines which receive wastewaters exclusively from residences and small commercial sources. The pollutant monitoring data provided in Table 2 have been sorted by average pollutant level.

The pollutants identified in Table 2 at highest average levels are ammonia, phosphate, iron, zinc, and copper. The most frequently detected pollutants are cadmium, chromium, copper, lead, nickel, and zinc.

The monitoring data provided in Table 2 can be used by POTWs in estimating total pollutant loadings from residential/commercial sources, for the purpose of calculating local limits. As previously discussed, municipalities should also establish residential/commercial monitoring programs to obtain site-specific data for use in local limits calculations.

The monitoring data summarized in Table 2 are intended to supplement existing summaries of residential/commercial wastewater monitoring data, such as those provided in the 1987 local limits guidance. Table 3 presents a comparison of the Table 2 monitoring data with typical residential/commercial wastewater levels presented in the 1987 local limits guidance. The 1987 local limits guidance provides levels for nine metals and cyanide, based on compilations of monitoring data from four POTWs.

TABLE 2. RESIDENTIAL/COMMERCIAL TRUNKLINE MONITORING DATA

POLLUTANT	NUMBER OF DETECTIONS	NUMBER OF SAMPLES	MIN. CONC. (mg/l)	MAX. CONC. (mg/l)	AVG. CONC.* (mg/l)
INORGANICS					
PHOSPHATE	2	2	27.4	30.2	28.8
IRON	18	18	0.0002	3.4	0.989
TOTAL PHOSPHOROUS	1	1	0.7	0.7	0.7
BORON	4	4	0.1	0.42	0.3
FLUORIDE	2	2	0.24	0.27	0.255
BARIUM	3	3	0.04	0.216	0.115
MANGANESE	3	3	0.04	0.16	0.087
CYANIDE	7	7	0.01	0.37	0.082
NICKEL	313	540	<0.001	1.6	0.047
LITHIUM	2	2	0.03	0.031	0.031
CADMIUM	361	538	0.00076	0.11	0.008
ARSENIC	140	205	0.0004	0.088	0.007
CHROMIUM (III)	1	2	<0.005	0.007	0.006
CHROMIUM (T)	311	522	<0.001	1.2	0.034
MERCURY	218	235	<0.0001	0.054	0.002
SILVER	181	224	0.0007	1.052	0.019
ORGANICS					
METHYLENE CHLORIDE	7	30	0.00008	0.055	0.027
TETRACHLOROETHENE	5	29	0.00001	0.037	0.014
1,2,4-TRICHLOROBENZENE	1	3	<0.002	0.035	0.013
TRANS-1,2-DICHLOROETHENE	1	28	0.013	0.013	0.013
PHENOLS	2	2	0.00002	0.00003	0.01

*Parameters are ranked by concentrations from high to low.

TABLE 2. RESIDENTIAL/COMMERCIAL TRUNKLINE MONITORING DATA (Continued)

POLLUTANT	NUMBER OF DETECTIONS	NUMBER OF SAMPLES	MIN. CONC. (mg/l)	MAX. CONC. (mg/l)	AVG. CONC.* (mg/l)
ORGANICS					
CHLOROFORM	21	30	<0.002	0.069	0.009
1,1-DICHLOROETHENE	2	29	0.005	0.008	0.007
1,1-DICHLOROETHANE	1	28	0.026	0.026	0.007
BIS (2-ETHYLHEXYL) PHTHALATE	5	5	0.00002	0.022	0.006
TOTAL ENDOSULFAN	3	3	0.002	0.002	0.002
FLUORANTHENE	2	5	0.00001	<0.001	0.001
TOTAL BHC	3	3	0.001	0.001	0.001
4,4-DDD	3	3	0.00026	0.0004	0.0003
PYRENE	2	3	0.00001	<0.005	0.0002

*Parameters are ranked by concentrations from high to low.

TABLE 3. COMPARISON OF RESIDENTIAL/COMMERCIAL TRUNKLINE MONITORING DATA WITH TYPICAL DOMESTIC WASTEWATER LEVELS FROM THE 1987 LOCAL LIMITS GUIDANCE

	Local Limits Guidance Typical Domestic Average Wastewater Level (mg/l)	Overall Average Pollutant Levels from Table 2 (mg/l)
Cadmium	0.003	0.008
Chromium	0.05	0.034
Copper	0.061	0.109
Lead	0.049	0.116
Nickel	0.021	0.047
Zinc	0.175	0.212
Arsenic	0.003	0.007
Mercury	0.0003	0.002
Silver	0.004	0.019
Cyanide	0.041	0.082

*From Guidance Manual on the Development and Implementation of Local Discharge Limitations Under the Pretreatment Program, United States Environmental Protection Agency Office of Water Enforcement and Permits, December 1987, p. 3-59

As shown in Table 3, the greatest differences in pollutant levels are for mercury and silver. The average mercury level from Table 2 is 0.002 mg/l, nearly seven times the mercury level of 0.0003 mg/l reported in the 1987 local limits guidance. The average silver level from Table 2 is 0.019 mg/l, nearly five times the silver level of 0.004 mg/l reported in the local limits guidance. For all other pollutants listed in Table 3 except chromium, the Table 2 average pollutant level is higher than the 1987 local limits guidance level by at least a factor of two.

The average residential/commercial trunk line pollutant levels for metals and cyanide provided in Table 2 are higher than those provided in the 1987 local limits guidance and hence, are more conservative. Also, they are based on monitoring data from more POTWs, and as such, may more adequately characterize residential/commercial wastewaters received by most POTWs. Site-specific monitoring data should always be used in preference to reliance on any literature data.

Appendix A, Table A.1, provides residential/commercial trunk line monitoring data summaries for each of the 15 POTWs. Average, median, minimum, and maximum pollutant levels; number of detections; number of observations; the combined total residential/commercial flow to the POTW; and the residential/commercial percent of the POTW's total flow are provided for each POTW.

The residential/commercial trunk line monitoring data provided in this section can be used as a supplement to, or in the absence of, actual site-specific monitoring data in the calculation of local limits. As pollutant levels in residential/commercial trunk lines can depend on site-specific factors such as the size of the municipality, it is important to recognize that the literature data serve only as surrogates for actual site-specific monitoring data. Rather than continuing to rely exclusively on <u>any</u> literature data, POTWs in the process of establishing local limits should consider instituting appropriate residential/commercial trunk line monitoring programs to establish accurate site-specific data.

1.4 SPECIFIC COMMERCIAL SOURCE MONITORING DATA

Commercial source monitoring data are useful to POTWs in identifying sources of toxic pollutants, and in determining which commercial sources should be considered as regulated sources for the purpose of calculating local limits. Such data are also helpful in determining which commercial sources warrant routine monitoring. Data for various types of commercial source are presented and discussed. The monitoring data provided in this section are intended to assist the POTW in characterizing those pollutants most frequently discharged, and those pollutants discharged at elevated levels by various types of commercial facilities. This information can be used by the POTW to better understand the sources of toxic pollutants and in determining compliance and monitoring priorities.

Specific commercial source monitoring data were provided by 21 POTWs. These POTWs are located in nine EPA Regions. Monitoring data were provided for six types of commercial sources:

- Hospitals
- Automobile radiator shops
- Car washes
- Truck cleaners
- Dry cleaners
- Commercial laundries.

Table A.2 in Appendix A provides commercial source monitoring data summaries for each of the 21 POTWs and 6 commercial source types. Average, median, minimum, and maximum pollutant levels; number of detections; number of observations; number of commercial sources; and total commercial source flow are provided for each POTW.

As discussed above, specific commercial source monitoring data should be used in establishing commercial facilities warranting regulation through local limits. Of the 21 POTWs which submitted data, 14 indicated that they issue discharge permits (or other control mechanisms) to commercial facilities belonging to the above categories. The discharge permits issued by these municipalities required compliance with the municipalities' local limits.

Four of the municipalities reported establishing local Total Toxic Organics (TTO) limits to address organic solvents known to be discharged by industrial users, including the above commercial. One municipality reported establishing a TTO limit specifically for laundries, owing to concern regarding solvent discharges from these facilities.

Fourteen POTWs required commercial sources belonging to the categories listed above to be routinely monitored for local limits compliance. Reported compliance monitoring frequencies ranged from quarterly to once every 2 years, with annual monitoring being typical. Five municipalities required commercial sources to self-monitor, usually on a quarterly basis.

The monitoring data in this section can be used to determine those types of commercial sources which may be of concern. The criteria by which this evaluation is conducted will vary from POTW to POTW and will depend on such issues as POTW size, POTW permitting and monitoring resources, and the magnitude of pollutant loadings currently received by the POTW relative to the maximum allowed. Specific commercial sources identified by the POTW to be of potential concern should be surveyed, routinely monitored, and/or issued discharge permits, as determined by site-specific considerations.

Monitoring data obtained for each of the six types of commercial facilities listed above are discussed and evaluated in the following subsections. Each subsection addresses a particular type of commercial facility.

Hospitals

Hospital wastewater monitoring data are summarized in Table 4 for a total of 42 sources discharging to 7 POTWs. Pollutants present in hospital wastewaters at the highest average levels included total dissolved solids, Chemical Oxygen Demand (COD), phosphate, surfactants, formaldehyde, phenol, and fluoride. Metals at the highest average levels included lead, iron, barium, copper, and zinc. POTWs may assume that these pollutants are characteristic of hospital wastewaters. Based on Table 4, the most frequently detected pollutants in hospital wastewaters were COD, phenol, silver, lead, copper, and zinc.

TABLE 4. SPECIFIC COMMERCIAL SOURCE WASTEWATER MONITORING DATA HOSPITALS

POLLUTANT	NUMBER OF DETECTIONS	NUMBER OF SAMPLES	MIN. CONC. (mg/l)	MAX. CONC. (mg/l)	AVG. CONC.* (mg/l)
INORGANICS					
PHOSPHATE	16	16	0.5	9.7	4.465
IRON	62	62	0.22	35.1	2.249
BARIUM	57	62	0.065	17.5	1.779
LEAD	127	183	<.001	34	0.881
FLUORIDE	9	9	0.06	2.7	0.637
ZINC	222	224	<.001	6.4	0.563
COPPER	126	129	<0.02	10.6	0.452
CHROMIUM (T)	355	586	0.001	2.24	0.117
SILVER	384	635	0.001	4.9	0.098
NICKEL	83	132	0.005	0.86	0.06
ARSENIC	64	97	0.001	0.502	0.026
CADMIUM	76	130	<0.001	0.658	0.018
ANTIMONY	1	5	0.001	0.04	0.018
SELENIUM	42	70	0.0027	0.02	0.011
MERCURY	56	69	<.0002	0.022	0.002
NONCONVENTIONALS					
TDS	12	12	331	580	426.583
COD	96	96	20	1345	346.721
SURFACTANTS	11	11	0.52	4.6	1.791

*Parameters are ranked by concentrations from high to low.

TABLE 4. SPECIFIC COMMERCIAL SOURCE WASTEWATER MONITORING DATA
HOSPITALS (Continued)

POLLUTANT	NUMBER OF DETECTIONS	NUMBER OF SAMPLES	MIN. CONC. (mg/l)	MAX. CONC. (mg/l)	AVG. CONC.* (mg/l)
ORGANICS					
FORMALDEHYDE	19	35	<0.1	1.4	0.58
PHENOL	38	38	.025	0.698	0.2

*Parameters are ranked by concentrations from high to low.

Radiator Shops

Table 5 summarizes automobile radiator shop monitoring data for a total of 32 sources discharging to 7 POTWs. Pollutants discharged at highest average levels included zinc, lead, and copper. The most frequently detected pollutants were also zinc, lead and copper. Based on the data provided in Table 5, POTWs should consider radiator shop wastewaters to contain elevated levels of these metals.

Car Washes

Table 6 summarizes car wash monitoring data provided for 11 facilities discharging to 3 POTWs. Pollutants discharged at highest levels included COD and the metals zinc, lead, and copper. The metals zinc, lead, and copper are the most frequently identified pollutants.

Truck Cleaners

Table 7 provides monitoring data for six truck cleaning facilities discharging to 2 POTWs . Pollutants detected at highest average levels included COD, total dissolved solids, cyanide, phosphate, phenol, zinc, and aluminum. The most frequently detected pollutants were chromium, lead, copper, zinc, COD, and phenol. POTWs should anticipate that truck cleaning wastewaters may contain a variety of organic and/or inorganic pollutants, potentially at elevated levels.

Dry Cleaners

Table 8 summarizes monitoring data for 31 dry cleaning facilities discharging to 3 POTWs. Pollutants at highest average levels were tot dissolved solids, COD, phosphate, iron, zinc, and copper, as well as t organic solvents butyl cellosolve and N-butyl benzene sulfonamide. Th frequently identified pollutants in the dry cleaners' wastewaters wer phosphate.

Laundries

Table 9 presents a summary of monitoring data for 59 com discharging to 14 POTWs. Organic pollutants found at highe were COD, ethyl toluene, n-propyl alcohol, isopropyl alcoh ethylbenzene, and bis (2-ethylhexyl) phthalate. Metals

TABLE 5. SPECIFIC COMMERCIAL SOURCE WASTEWATER MONITORING DATA
RADIATOR SHOPS

POLLUTANT	NUMBER OF DETECTIONS	NUMBER OF SAMPLES	MIN. CONC. (mg/l)	MAX. CONC. (mg/l)	AVG. CONC.* (mg/l)
INORGANICS					
IRON	21	21	0.1	770	64.43
ZINC	494	503	<0.02	1720	22.17
LEAD	455	486	0.02	2280	21.408
COPPER	503	504	0.03	395	9.34
MANGANESE	1	1	1.23	1.23	1.23
NICKEL	104	144	0.01	3.29	0.18
CHROMIUM (T)	22	26	0.01	0.95	0.14
CADMIUM	128	141	0.005	1.3	0.052
CYANIDE	11	11	0.014	0.098	0.03
SILVER	5	5	0.011	0.044	0.024
ARSENIC	5	5	.0018	0.0351	0.012
MERCURY	16	25	0.0001	0.0012	0.0004
NONCONVENTIONALS					
COD	2	3	<3.7	11.3	7.667

*Parameters are ranked by concentrations from high to low.

TABLE 6. SPECIFIC COMMERCIAL SOURCE WASTEWATER MONITORING DATA
CAR WASHES

POLLUTANT	NUMBER OF DETECTIONS	NUMBER OF SAMPLES	MIN. CONC. (mg/l)	MAX. CONC. (mg/l)	AVG. CONC.* (mg/l)
INORGANICS					
ZINC	37	37	0.02	3	0.543
LEAD	29	34	0.002	0.99	0.162
COPPER	29	33	0.03	0.39	0.139
NICKEL	17	26	0.02	0.25	0.08
CHROMIUM (T)	18	29	0.01	0.24	0.074
SILVER	3	12	<0.001	<.05	0.018
CADMIUM	21	33	<.002	0.07	0.017
NONCONVENTIONALS					
COD	3	3	34	250	126.33

* Parameters are ranked by concentrations from high to low.

TABLE 7. SPECIFIC COMMERCIAL SOURCE WASTEWATER MONITORING DATA
TRUCK CLEANERS

POLLUTANT	NUMBER OF DETECTIONS	NUMBER OF SAMPLES	MIN. CONC. (mg/l)	MAX. CONC. (mg/l)	AVG. CONC.* (mg/l)
INORGANICS					
CYANIDE	5	9	0.005	250	55.587
PHOSPHATE	5	5	0.09	34.2	7.85
ALUMINUM	4	4	4.8	13.1	7.7
ZINC	83	83	0.09	80.98	4.416
LEAD	56	85	0.005	6.4	0.353
COPPER	72	74	0.007	1.8	0.233
NICKEL	53	65	0.01	1.05	0.177
CHROMIUM (T)	46	79	0.004	0.98	0.12
ANTIMONY	6	17	0.01	0.64	0.09
ARSENIC	9	23	0.002	0.85	0.068
THALLIUM	2	14	0.005	0.13	0.042
CADMIUM	59	71	0.001	0.427	0.027
BERYLLIUM	1	15	0.001	0.1	0.013
SELENIUM	5	22	0.001	0.05	0.012
NONCONVENTIONALS					
COD	63	63	35.3	17850000	36478.502
TDS	5	5	361	11700	3364
ORGANICS					
PHENOL	78	83	0.005	62	1.881

*Parameters are ranked by concentrations from high to low.

TABLE 8. SPECIFIC COMMERCIAL SOURCE WASTEWATER MONITORING DATA
DRY CLEANERS

POLLUTANT	NUMBER OF DETECTIONS	NUMBER OF SAMPLES	MIN. CONC. (mg/l)	MAX. CONC. (mg/l)	AVG. CONC.* (mg/l)
INORGANICS					
PHOSPHATE	30	31	0.1	297	25.719
IRON	1	1	0.51	0.51	0.51
ZINC	5	5	0.07	0.25	0.174
COPPER	5	5	0.05	0.12	0.086
LEAD	3	7	<.025	0.05	0.032
CHROMIUM (T)	5	5	0.02	0.03	0.022
NICKEL	3	5	<.007	0.01	0.009
CADMIUM	1	2	0.006	<0.01	0.008
COBALT	1	5	<0.003	0.01	0.004
NONCONVENTIONALS					
TDS	1	1	625	625	625
COD	82	87	1	3865	315.565
ORGANICS					
BUTYL CELLOSOLVE	1	1	1.3	1.3	1.3
N-BUTYL BENZENESULFONAMIDE	1	1	1.2	1.2	1.2
2-(2-BUTOXYETHOXY) ETHANOL	1	1	0.59	0.59	0.59
BIS(2-ETHYLHEXYL) PHTHALATE	1	1	0.37	0.37	0.37
PHENOL	6	8	0.006	0.53	0.117

*Parameters are ranked by concentrations from high to low.

TABLE 8. SPECIFIC COMMERCIAL SOURCE WASTEWATER MONITORING DATA
DRY CLEANERS (Continued)

POLLUTANT	NUMBER OF DETECTIONS	NUMBER OF SAMPLES	MIN. CONC. (mg/l)	MAX. CONC. (mg/l)	AVG. CONC.* (mg/l)
ORGANICS					
DI-N-OCTYL PHTHALTE	1	1	0.042	0.042	0.042
STYRENE	1	1	0.02	0.02	0.02
TOLUENE	1	1	0.016	0.016	0.016

*Parameters are ranked by concentrations from high to low.

TABLE 9. SPECIFIC COMMERCIAL SOURCE WASTEWATER MONITORING DATA
LAUNDRIES

POLLUTANT	NUMBER OF DETECTIONS	NUMBER OF SAMPLES	MIN. CONC. (mg/l)	MAX. CONC. (mg/l)	AVG. CONC.* (mg/l)
INORGANICS					
PHOSPHATE	5	5	4.4	18.4	13.2
SULFIDE	1	3	<0.2	14	4.8
IRON	431	441	<.01	145	3.796
ZINC	1166	1264	<0.005	234	1.873
LEAD	953	1212	0.01	150	1.514
MANGANESE	3	3	0.26	0.83	0.553
BARIUM	37	37	0.089	1.1	0.506
COPPER	1038	1063	0.01	14.6	0.452
CHROMIUM (T)	572	908	0.003	36.8	0.216
NICKEL	332	863	<0.001	2.93	0.14
SILVER	50	76	<.0002	0.017	0.123
CYANIDE	124	125	0.002	3.4	0.101
ARSENIC	30	43	<.002	<0.81	0.034
CADMIUM	525	905	<.002	0.518	0.034
SELENIUM	17	41	<.002	0.021	0.016
NONCONVENTIONALS					
COD	274	274	60	20000	1421.409

*Parameters are ranked by concentrations from high to low.

TABLE 9. SPECIFIC COMMERCIAL SOURCE WASTEWATER MONITORING DATA
LAUNDRIES (Continued)

POLLUTANT	NUMBER OF DETECTIONS	NUMBER OF SAMPLES	MIN. CONC. (mg/l)	MAX. CONC. (mg/l)	AVG. CONC.* (mg/l)
ORGANICS					
1-ETHYL-4-METHYL BENZENE	2	3	<150	150	150
1-ETHYL-3-METHYL BENZENE	3	4	<150	150	150
1-ETHYL-2-METHYL BENZENE	3	4	<150	150	150
n-PROPYL ALCOHOL	1	1	74	74	74
ISOPROPYL ALCOHOL	2	2	12	39	25.5
M-XYLENE	1	4	<1.47	22.57	6.744
TOLUENE	6	10	0.014	16	4.032
P-XYLENE	1	4	<0.96	11.29	3.543
ETHYLBENZENE	4	9	0.033	3.16	0.95
BIS (2-ETHYLHEXYL) PHTHALATE	1	1	0.35	1.1	0.725
NAPTHALENE	1	1	0.310	0.31	0.31
PHENOL	214	231	<0.01	6.51	0.244
TETRACHLOROETHENE	5	5	0.096	0.32	0.163
CHLOROFORM	6	10	<0.001	0.62	0.141
1,1,2,2-TETRACHLOROETHANE	2	5	<0.001	0.43	0.099
DI-N-OCTYL PHTHALATE	1	1	0.057	0.057	0.057
DI-N-BUTYL PHTHALATE	2	2	0.012	0.07	0.041
BUTYL BENZYL PHTHALATE	2	2	0.02	0.046	0.033
TRANS-1,2-DICHLOROETHENE	3	10	<0.001	0.18	0.026
BROMOFORM	1	5	<0.001	0.074	0.026
1,1,1-TRICHLOROETHANE	1	5	<0.001	0.09	0.025
CARBON TETRACHLORIDE	1	5	<0.001	<0.025	0.01
CHLOROBENZENE	1	5	<0.001	<0.025	0.009

*Parameters are ranked by concentrations from high to low.

TABLE 9. SPECIFIC COMMERCIAL SOURCE WASTEWATER MONITORING DATA
LAUNDRIES (Continued)

POLLUTANT	NUMBER OF DETECTIONS	NUMBER OF SAMPLES	MIN. CONC. (mg/l)	MAX. CONC. (mg/l)	AVG. CONC.* (mg/l)
ORGANICS					
BROMODICHLOROMETHANE	2	5	<0.001	<0.025	0.009
METHYLENE CHLORIDE	1	5	0.011	0.011	0.006

*Parameters are ranked by concentrations from high to low.

levels included iron, lead, zinc, and copper. Other inorganics identified in laundry wastewaters included phosphate and sulfide. The most frequently detected pollutants were the metals zinc, lead, copper, and chromium. POTWs should anticipate that laundries may discharge a variety of organic solvents as well as metals, and that organic pollutant levels in laundry wastewaters may be elevated.

The monitoring data provided in Table 9 provide a basis for POTWs to determine the significance of various commercial sources and the need for regulation through local limits.

1.5 SEPTAGE HAULER MONITORING DATA

Existing septage hauler monitoring data are useful to the POTW in evaluating the need for monitoring septage haulers' loads to verify compliance with local limits. In this section of the document, septage hauler monitoring data obtained from POTWs are summarized and discussed.

Table A.3 of Appendix A provides septage hauler monitoring data summaries for each of nine POTWs. The monitoring data were obtained through periodic spot sampling of septage haulers' loads discharged to these POTWs. Average, median, minimum, and maximum pollutant levels; number of detections; number of observations; and total septage hauler flows are provided for each POTW.

Table 10 summarizes septage hauler monitoring data provided by the nine POTWs. Metals identified at highest average levels in septage haulers' loads included iron, zinc, copper, lead, chromium, and manganese. The most frequently identified metals were copper, nickel, chromium, and lead.

Organics identified at highest average levels were COD, acetone, isopropyl alcohol, methyl alcohol, and methyl ethyl ketone. Based on these data, POTWs should anticipate that hauled septage may contain relatively high levels of heavy metals and organic solvents. POTWs should periodically monitor septage haulers' loads to verify compliance with applicable local limits for the metals listed above, as well as for common organic solvents (especially ketones and alcohols) and for COD.

TABLE 10. SEPTAGE HAULER MONITORING DATA

POLLUTANT	NUMBER OF DETECTIONS	NUMBER OF SAMPLES	MIN. CONC. (mg/l)	MAX. CONC. (mg/l)	AVG. CONC.* (mg/l)
INORGANICS					
IRON	464	464	0.2	2740	39.287
ZINC	959	967	<0.001	444	9.971
MANGANESE	5	5	0.55	17.05	6.088
BARIUM	128	128	0.002	202	5.758
COPPER	963	971	.01	260.9	4.835
LEAD	962	1067	<0.025	118	1.21
NICKEL	813	1030	0.01	37	0.526
CHROMIUM (T)	931	1019	0.01	34	0.49
CYANIDE	575	577	0.001	1.53	0.469
COBALT	16	32	<0.003	3.45	0.406
ARSENIC	144	145	0	3.5	0.141
SILVER	237	272	<0.003	5	0.099
CADMIUM	825	1097	0.005	8.1	0.097
TIN	11	25	<.015	1	0.076
MERCURY	582	703	0.0001	0.742	0.005
NONCONVENTIONALS					
COD	183	183	510	117500	21247.951

*Parameters are ranked by concentrations from high to low.

TABLE 10. SEPTAGE HAULER MONITORING DATA (Continued)

POLLUTANT	NUMBER OF DETECTIONS	NUMBER OF SAMPLES	MIN. CONC. (mg/l)	MAX. CONC. (mg/l)	AVG. CONC.* (mg/l)
ORGANICS					
METHYL ALCOHOL	117	117	1	396	15.84
ISOPROPYL ALCOHOL	117	117	1	391	14.055
ACETONE	118	118	0	210	10.588
METHYL ETHYL KETONE	115	115	1	240	3.65
TOLUENE	*113*	*113*	*.005*	*1.95*	*0.17*
METHYLENE CHLORIDE	115	115	0.005	2.2	0.101
ETHYLBENZENE	115	115	0.005	1.7	0.067
BENZENE	112	112	0.005	3.1	0.062
XYLENE	87	87	0.005	0.72	0.051

*Parameters are ranked by concentrations from high to low.

1.6 LANDFILL LEACHATE MONITORING DATA

Landfill leachate monitoring data were obtained from eight POTWs which accept landfill leachates for treatment. Four of these eight POTWs indicated that discharge permits are issued to landfill leachate dischargers that require compliance with the POTWs' local limits. Reported compliance monitoring frequencies varied from weekly to annually. Most of the POTWs reported that routine compliance monitoring was for metals only; however, one POTW reported conducting periodic Polychlorinated Biphenols (PCB) analyses, and another POTW indicated requiring full priority pollutant scans on an annual basis.

Table A.4 of Appendix A provides landfill leachate monitoring data summaries for each of the eight POTWs. Average, median, minimum, and maximum pollutant levels; number of detections; and number of observations are provided for each POTW.

Table 11 summarizes landfill leachate monitoring data submitted by the eight POTWs. Table 11 indicates that such wastewaters may contain a variety of organic pollutants as well as metals. Metals identified at highest average levels included iron, manganese, and zinc. Organics identified at highest average levels include COD, methyl ethyl ketone, acetone, phenols, and 1,2-dichloroethane (ethylene dichloride). The most frequently detected pollutants were the metals cadmium, chromium, copper, lead, nickel, and zinc Based on these data, POTWs should anticipate that landfill leachates may contain a wide variety of metals and organic pollutants.

1.7 SUMMARY

To characterize the composition of wastewaters from residential and commercial sources, monitoring data provided by 24 POTWs, located in all 10 EPA Regions, have been summarized (by POTW) and discussed. Based on a review of the monitoring data summaries provided in Tables 12, 13, and 14, wastewaters from residential and commercial sources may be characterized as follows:

TABLE 11. LANDFILL LEACHATE MONITORING DATA**

POLLUTANT	MIN. CONC. (mg/l)	MAX. CONC. (mg/l)	AVG. CONC.* (mg/l)
INORGANICS			
IRON	1.5	4500	33.8
MANGANESE	0.63	73.2	13.224
ZINC	<.01	58	12.006
CHROMIUM (T)	0.007	12.1	0.633
NICKEL	0.003	12.09	0.55
COPPER	0.007	10.87	0.395
BARIUM	<0.1	0.55	0.201
LEAD	0.005	9.8	0.156
ANTIMONY	0.008	0.3	0.142
ARSENIC	0.002	0.13	0.042
CADMIUM	<0.001	1.25	0.03
CYANIDE	.04	0.05	0.029
SILVER	<0.01	0.05	0.019
SELENIUM	<.002	0.02	0.01
MERCURY	<.0002	0.002	0.001
ORGANICS			
METHYL ETHYL KETONE	5.3	29	13.633
ACETONE	2.8	2.8	2.8
1,2-DICHLOROETHANE	<0.005	6.8	1.136
PHENOL	0.008	2.9	1.06
TOLUENE	0.0082	1.6	0.735

*Parameters are ranked by concentrations from high to low.

**Number of detections/number of observations could not be determined from data provided.

TABLE 11. LANDFILL LEACHATE MONITORING DATA**
(Continued)

POLLUTANT	MIN. CONC. (mg/l)	MAX. CONC. (mg/l)	AVG. CONC.* (mg/l)
ORGANICS			
VINYL ACETATE	0.25	0.25	0.25
BENZOIC ACID	0.020	<0.4	0.19
ETHYLBENZENE	0.017	0.54	0.171
NAPTHALENE	<0.01	<0.4	0.113
DIETHYL PHTHALATE	0.11	0.11	0.11
2,4-DIMETHYL PHENOL	0.005	<0.4	0.107
1,4-DICHLOROBENZENE	<0.005	<0.4	0.101
METHYL BUTYL KETONE	0.028	0.16	0.094
VINYL CHLORIDE	<0.002	0.21	0.067
4-METHYLPHENOL	0.065	0.065	0.065
BENZENE	<0.002	0.031	0.025
TRICHLOROETHENE	<0.001	<0.1	0.025
CHLOROETHANE	<0.001	<0.1	0.021
1,1,1-TRICHLOROETHANE	0.011	0.022	0.019
P-CHLORO-M-CRESOL	0.018	0.018	0.018
PENTACHLOROPHENOL	0.016	0.016	0.016
N-NITROSODIPHENYLAMINE	0.011	0.011	0.011
CHLOROBENZENE	0.011	0.011	0.011
DIMETHYL PHTHALATE	0.0049	0.0049	0.005
DI-N-BUTYL PHTHALATE	0.0044	0.0044	0.004
1,1-DICHLOROETHANE	<0.001	0.052	0.002

*Parameters are ranked by concentrations from high to low.

**Number of detections/number of observations could not be determined from data provided.

Commercial Sources:

- Of the six categories of commercial facilities considered in this guidance, radiator shops, truck cleaning facilities, and industrial laundries were identified as discharging the highest average levels of metals. Average levels of the metals zinc, nickel, chromium, cadmium, lead, iron, and manganese for these three categories of commercial facilities were at least three times the corresponding average residential/commercial trunk line levels for these pollutants.

- Truck cleaners and industrial laundries were identified as discharging elevated levels of organics. The average COD concentration for truck cleaners was 36,500 mg/l, and the average COD for industrial laundries was 1,400 mg/l. Industrial laundries were identified as discharging a number of organic solvents, including aromatics (toluene and xylene) and alcohols.

- Truck cleaning facilities were identified as discharging elevated levels of cyanide and total dissolved solids.

- Inorganic pollutants characteristic of hospital wastewaters included total dissolved solids, barium, lead, silver, and fluoride.

- Inorganic pollutants characteristic of dry cleaners' wastewaters included total dissolved solids and phosphate.

Septage Haulers:

- Metals levels in septage haulers' loads were considerably higher than in residential/commercial trunk line wastewater. Average levels of arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, nickel, and zinc for hauled septage were at least 10 times the corresponding average residential/commercial trunk line levels for these pollutants.

- Septage haulers were identified as discharging elevated levels of COD; the average concentration of COD in hauled septage was 21,250 mg/l.

- Solvents identified in septage haulers' loads included methyl alcohol, acetone, and methyl ethyl ketone.

Landfill Leachates:

- Average levels of the metals manganese, zinc, iron, chromium, and nickel in landfill leachates were at least 10 times the corresponding average residential/commercial trunk line levels for these pollutants.

- Solvents identified in landfill leachates included methyl ethyl ketone and acetone.

Tables 12, 13, and 14 present a summary of the overall, average, inorganic, organic, and nonconventional pollutant levels for residential and commercial sources as well as septage haulers and landfill leachates. From these tables the following pollutants have been identified as characteristic of the wastewater sources indicated:

- Residential/commercial trunk lines - Phosphate, ammonia, and the metals cadmium, chromium, copper, lead, nickel, and zinc
- Hospitals - Total dissolved solids, fluoride, and the metals barium, lead, and silver
- Radiator shops - Zinc, lead, and copper
- Car washes - Zinc, lead, and copper
- Truck cleaners - COD, total dissolved solids, cyanide, phenol and the metals lead, zinc, chromium, and copper
- Dry cleaners - Total dissolved solids and phosphate
- Laundries - COD, ethyl toluene, propanol, xylene, toluene, and the metals iron, lead, zinc, and copper
- Septage haulers - COD, methyl alcohol, acetone, methyl ethyl ketone, arsenic, and the metals cadmium, chromium, copper, lead, nickel, zinc, barium, iron, and manganese
- Landfill leachates - Methyl ethyl ketone, acetone, and the metals manganese, zinc, iron, chromium and nickel.

The data provided in this guidance may be used in deriving reasonable estimates of pollutant loadings from the above listed wastewater sources. Each municipality should determine which of the above listed sources are of concern on a site-specific basis and should establish residential/commercial trunk line and specific commercial source monitoring programs to determine actual pollutant loadings received from those sources.

TABLE 12. OVERALL AVERAGE ORGANIC POLLUTANT LEVELS (MG/L)

POLLUTANT	RES. AVERAGE	SEPTAGE AVERAGE	LEACHATE AVERAGE	COMMERCIAL FACILITIES					
				CAR WASH AVERAGE	DRY CLEANER AVERAGE	HOSPITAL AVERAGE	INDUSTRIAL LAUNDRIES AVERAGE	RADIATOR SHOP AVERAGE	TRUCK CLEANERS AVERAGE
ACETONE		10.588	2.8						
BENZENE		0.062	0.025						
BENZOIC ACID			0.19						
BIS(2-ETHYLHEXYL)PHTHALATE	0.006				0.37		0.725		
BROMODICHLOROMETHANE							0.009		
BROMOFORM							0.026		
2-BUTANONE			13.633						
2-(2-BUTOXYETHOXY) ETHANOL					0.59				
BUTYL BENZYL PHTHALATE							0.033		
BUTYL CELLOSOLVE					1.3				
CARBON TETRACHLORIDE							0.010		
CHLOROBENZENE			0.011				0.009		
CHLOROETHANE			0.021						
CHLOROFORM	0.009						0.141		
4,4'-DDD	0.0003								
1,4-DICHLOROBENZENE			0.101						
1,1 DICHLOROETHANE	0.026		0.575						
1,1 DICHLOROETHENE	0.007		0.030						
DIETHYL PHTHALATE			0.11						
DIMETHYL PHTHALATE			0.005						
2,4 DIMETHYLPHENOL			0.107						
DI-N-OCTYL PHTHALATE					0.042		0.057		
ETHYL BENZENE		0.067	0.171				0.950		
1-ETHYL-2-METHYL BENZENE							150		

TABLE 12. OVERALL AVERAGE ORGANIC POLLUTANT LEVELS (MG/L) (Continued)

POLLUTANT	RES. AVERAGE	SEPTAGE AVERAGE	LEACHATE AVERAGE	COMMERCIAL FACILITIES					
				CAR WASH AVERAGE	DRYCLEANER AVERAGE	HOSPITAL AVERAGE	INDUSTRIAL LAUNDRIES AVERAGE	RADIATOR SHOP AVERAGE	TRUCK CLEANERS AVERAGE
1-ETHYL-4-METHYL BENZENE							150		
FLUORANTHENE	0.001								
FORMALDEHYDE						0.58			
2-HEXANONE			0.094						36478.502
ISOPROPYL ALCOHOL	14.055								
METHYL ALCOHOL		15.84							
METHYL ETHYL KETONE		3.650							
METHYLENE CHLORIDE	0.027	0.101	0.310				0.006		
4-METHYLPHENOL			0.065						
4-METHYL-2-PENTANONE			0.43						
M-XYLENE							6.744		
NAPHTHALENE			0.113				0.310		
N-BUTYL BENZENESULFONAMIDE					1.2				
N-NITROSODIPHENYLAMINE			0.011						
PENTACHLOROPHENOL			0.016						
PHENOLS	0.010		0.710		0.117	0.201	0.244		
2-PROPANOL							25.5		
1-PROPANOL							74		
PYRENE	0.0002								
P-CHLORO-M-CRESOL			0.018						
P-XYLENE							3.543		1.881
1,1,2,2 TETRACHLOROETHANE							0.099		
TETRACHLOROETHENE	0.015						0.163		

TABLE 12. OVERALL AVERAGE ORGANIC POLLUTANT LEVELS (MG/L) (Continued)

POLLUTANT	RES. AVERAGE	SEPTAGE AVERAGE	LEACHATE AVERAGE	COMMERCIAL FACILITIES					
				CAR WASH AVERAGE	DRYCLEANER AVERAGE	HOSPITAL AVERAGE	INDUSTRIAL LAUNDRIES AVERAGE	RADIATOR SHOP AVERAGE	TRUCK CLEANERS AVERAGE
TETRACHLOROETHYLENE	0.00001								
TOLUENE		0.170	0.735		0.016		4.032		
TOTAL BHC	0.001								
TOTAL ENDOSULFAN	0.002								
TRANS-1,2-DICHLOROETHENE	0.013						0.026		
1,2,4-TRICHLOROBENZENE	0.013								
1,1,1-TRICHLOROETHANE			0.019				0.025		
TRICHLOROETHENE			0.028						
TRICHLOROETHYLENE			0.018						
VINYL ACTETATE			0.250						
VINYL CHLORIDE			0.067						
XYLENE		0.051	0.317						

TABLE 13. OVERALL AVERAGE INORGANIC POLLUTANT LEVELS (MG/L)

POLLUTANT	RES. AVERAGE	SEPTAGE AVERAGE	LEACHATE AVERAGE	COMMERCIAL FACILITIES					
				CAR WASH AVERAGE	DRY CLEANER AVERAGE	HOSPITAL AVERAGE	INDUSTRIAL LAUNDRIES AVERAGE	RADIATOR SHOP AVERAGE	TRUCK CLEANERS AVERAGE
ALUMINUM			0.34					1.13	7.7
ANTIMONY			0.142			0.018			0.09
ARSENIC	0.007	0.141	0.042			0.026	0.034	0.012	0.068
BARIUM	0.115	5.758	0.201			1.779	0.506		
BERYLLIUM									0.013
BORON	0.3								
CADMIUM	0.008	0.097	0.030	0.017	0.008	0.018	0.034	0.165	0.027
CHROMIUM	0.034	0.490	0.633	0.074	0.022	0.117	0.216	0.128	0.120
CHROMIUM(III)	0.006								
COBALT		0.406			0.004				
COPPER	0.109	4.835	0.395	0.139	0.086	0.452	0.552	22.218	0.233
CYANIDE	0.082	0.469	0.029				0.101	0.030	55.587
FLUORIDE	0.255					0.637			
IRON	0.989	39.287	33.8		0.51	2.249	3.796	64.430	
LEAD	0.116	1.210	0.156	0.162	0.032	0.881	1.514	69.210	0.353
LITHIUM	0.031								
MANGANESE	0.087	6.088	13.224				0.553	1.23	
MERCURY	0.002	0.005	0.001			0.002	0.004	0.0004	
NICKEL	0.047	0.526	0.550	0.080	0.009	0.060	0.140	0.300	0.177
SELENIUM	0.004		0.010			0.011	0.016		0.012
SILVER	0.019	0.099	0.019	0.018		0.098	0.123	0.024	0.114
THALLIUM									0.042
TIN		0.076							
ZINC	0.212	9.971	12.006	0.543	0.174	0.563	1.873	145.295	4.416

TABLE 14. OVERALL AVERAGE NONCONVENTIONAL POLLUTANT LEVELS (MG/L)

POLLUTANT	RES. AVERAGE	SEPTAGE AVERAGE	LEACHATE AVERAGE	COMMERCIAL FACILITIES					
				CAR WASH AVERAGE	DRY CLEANER AVERAGE	HOSPITAL AVERAGE	INDUSTRIAL LAUNDRIES AVERAGE	RADIATOR SHOP AVERAGE	TRUCK CLEANERS AVERAGE
AMMONIA	43.111								
COD		21247.951	34.545	126.333	315.565	346.721	1421.409	7.667	
PHOSPHATE	28.8				25.719	4.465	13.2		7.85
SULFIDE							4.800		
SURFACTANTS					0.02	1.791			
TDS					625	426.583			3364
TOTAL PHOSPHORUS	0.7								

PART 2

REMOVAL EFFICIENCY ESTIMATION FOR LOCAL LIMITS

2.0 REMOVAL EFFICIENCY ESTIMATION GUIDANCE

This guidance was produced to describe further the determination and application of removal efficiencies using methods discussed in Chapter 3 of the 1987 local limits guidance, specifically the mean removal efficiency and decile approaches. Another method for removal efficiency estimation, called the average daily removal, is also presented here.

Each of these methods for removal efficiency determination is defined and illustrated with examples and actual POTW sampling and analysis data. Step-by-step procedures for performing the calculations, together with computational formats, are also provided. This document discusses and illustrates difficulties, such as handling nondetections in the calculations, that may be encountered in applying these methods to analytical sampling data on POTW influent and effluent.

Both the mean removal efficiency and average daily removal methods provide a single point measure of removal efficiency. That is, the removal efficiency is described by a single number that is an average removal efficiency. The actual removal efficiency of a POTW varies from day to day. On some days it will exceed an average value and on other days it will be less than that average, although neither of these two methods indicates how often the actual efficiency is above or below the single number efficiency value. Such information can be critical because the objective of local limits is to protect water and sludge quality. If, during a period of time, the actual removal efficiency is very high, sludge quality may deteriorate during that period. During those times when the removal efficiency is low, receiving water quality may be adversely impacted.

The decile approach, however, yields the frequency distribution of daily removal efficiencies, providing estimates based on the available data of how frequently the actual daily removal efficiency will be above or below a specified value. Thus, even though the decile approach is somewhat more tedious to implement, it provides the POTW with the ability to determine how often it attains an average removal or other specified removal rate. The 1987 local limits guidance contains an illustrative example of the decile approach and the use of a frequency plot to display the deciles (see pages 3-18 to 3-21 of the 1987 local limits guidance). Also, EPA's PRELIM Version 4.0 computer program calculates both the mean and decile values.

The three methodologies and their applications are discussed using sampling data for copper, zinc, and nickel. The copper data are used to illustrate the overall approach that would be applied following the methodologies found in the 1987 local limits guidance. The other two data sets were selected to provide examples of the types of problems and questions that are likely to be experienced when determining removal efficiencies. For each of the pollutants, a review of the data is provided to determine which values, if any, should be considered for exclusion. Data exclusion should be performed only if a technical justification exists to support such action (e.g., poor removals due to maintenance or operational problems or known sampling problems). Once the data to be used have been determined, mean removals are calculated and a guided worksheet designed to assist in the calculation of the nine decile values is provided. The individual decile values can be used to assess how often a POTW attains a specific removal efficiency value, as well as to compare the allowable headworks loadings obtained from an average removal value to that based on a selected decile removal.

2.1 DEFINITIONS

Before illustrating the steps needed to apply the removal estimation procedures outlined in the 1987 local limits guidance, the following terms are defined in this section:

- Daily removal efficiency
- Mean removal efficiency
- Decile removal efficiency.

2.1.1 DAILY REMOVAL EFFICIENCY

A daily removal efficiency is defined as the percent change of a pollutant's mass values for samples taken before and after a treatment system or a stage of treatment, such as primary or secondary treatment. The "before" treatment samples are typically influent sample values and the "after" treatment values are usually effluent sample values. For example, suppose the mass level for copper in an influent wastewater sample taken on a specific day was calculated to be 100 lbs/day, and the mass level of copper in an effluent wastewater sample taken on the same day might have been 7 lbs/day. The daily removal efficiency corresponding to those two samples is the percent change between the two sample values [(100) x (100 - 7)/100 = 93%]. That is, the treatment system is assumed to have reduced the influent sample's mass value of copper by 93 percent from 100 lbs/day to 7 lbs/day. (Sometimes an influent sample value is less than the corresponding effluent sample value for the same day). In such cases, the daily removal efficiency is expressed as a negative percent change. For example, if the mass of the influent sample was calculated at 20 lbs/day and the corresponding effluent sample at 35 lbs/day, then the daily removal efficiency would be expressed as (100) x (20 - 35)/20 = -75%; that is, the mass value for the effluent sample was 75 percent higher than the mass value of the influent sample.

Daily removal efficiency (expressed as a percent) is exemplified by the following equation:

Daily Removal Efficiency = 100 x (Influent - Effluent)/Influent

where:

Influent = Specific value for a daily sample taken prior to treatment or prior to some stage (e.g., secondary effluent) of treatment

and

Effluent = A pollutant-specific value for a daily sample taken after some particular stage of treatment.

It is important to realize that 93 percent removal for a metal means that 93 percent of the mass went to the sludge, while 7 percent remained in the effluent. Mass balances are readily determined for metals and conservative pollutants. However, it is difficult to estimate the mass balance for organics because of volatility and biodegradability. (For additional discussion on this topic, refer to Section 2.6 of this document.)

2.1.2 MEAN AND AVERAGE DAILY REMOVAL EFFICIENCIES

A mean (or average) removal efficiency can be calculated in more than one way. One method is to calculate the arithmetic average of individual daily removal values. In this document, this type of average will be referred to as the average daily removal.

Average Daily Removal = (Daily Removal Efficiency for day 1 + ... + Daily Removal Efficiency for day n)/n

where:

"n" is the number of paired daily influent and effluent sample values that are available.

For example, consider the following set of influent and effluent mass values for three daily samples containing a pollutant X:

SAMPLE DAY	INFLUENT MASS (lbs/day)	EFFLUENT MASS (lbs/day)	DAILY REMOVAL EFFICIENCY (%)
1	20	5	75
2	10	3	70
3	40	8	80
AVERAGE	23.3	5.3	75%
			Average Daily Removal

The mean removal could be calculated by taking the average of the three individual daily removal values [i.e., (75% + 70% + 80%)/3 = 75%]. Extreme daily removals (i.e., isolated, small or large removals or negative removals) can have a substantial effect on the average daily removal, especially in the case of small sample sizes.

Another way to compute a mean removal would be to determine the averages of the influent and effluent samples, and then determine a removal efficiency based on the percent change between the average influent and average effluent values. This removal estimate is the statistic that is presented and defined in the 1987 local limits guidance. In this document, it will be called the mean removal efficiency and is calculated as follows:

Mean Removal Efficiency = (100) x (Average Influent - Average Effluent)/Average Influent

where:

Average Influent = Mean influent value for the daily sample values

and

Average Effluent = Mean effluent for the daily sample values.

In the previous example, the average influent level is (20 + 10 + 40)/3 = 23.3 lbs/day the average effluent level is (5 + 3 + 8)/3 = 5.3 lbs/day; thus, the mean removal is (100) x (23.3 - 5.3)/23.3 = 77%. Whereas the average daily removal efficiency required individual, paired influent and effluent sample values, the mean removal efficiency could be based on influent and effluent sample values that are not always paired. (For example, an effluent sample may have been lost or destroyed; therefore, the average effluent value could be based on one less effluent sample value. However, the influent sample value might be used for calculating an average influent value.) Caution should be exercised in constructing influent and effluent averages in this way to avoid calculating meaningless measures of removal.

As defined in Section 2.1.1 of this document, each of the individual daily removals receive the same weight in calculating the average daily removal. If the individual daily removals are weighted by their corresponding daily influent mass (expressed as a proportion of their summed influent mass), then the average daily removal and mean removal estimates are equivalent.

In many cases, the two averaging procedures (i.e., average daily removal and mean removal) will provide different estimates of removal efficiency. The POTW can produce both of the average removal estimates and then decide whether either of the estimates is reasonable for use in determining the allowable headworks loading. The decile approach provides a basis for evaluating whether either the average daily or mean removal can be used, as well as alternative removal estimates. PRELIM Version 4.0 calculates all three of these values and allows the user to choose the most appropriate removal efficiency value.

2.1.3 DECILE REMOVAL EFFICIENCY

The two average removal efficiencies described previously are specifically defined estimates of removal. An individual POTW may not know how often it meets that level of average removal. For that reason, an alternative approach was recommended by EPA, which it has called the decile approach. The method involves ordering the daily removal efficiencies and identifying nine decile values. In other words, after the daily removals have been calculated, the removal values are arranged in ascending order, and an individual daily removal value (below which 10 percent of the daily removals fall) is identified. This value is called the first decile. Similarly, the second decile is the daily removal value below which 20 percent of the daily removals fall. The third through ninth deciles are defined in a similar way. The removal value below which half of the daily removals fall is the fifth decile or median.

The value of the decile approach is that the average daily removal efficiency and the mean removal efficiency values can be located within the set of nine deciles, thereby allowing the estimation of how often a POTW could expect to exceed either of the average removal values. For example, suppose that the average daily removal was determined from a set of daily removal values to be 43 percent and the mean removal from the same set of values was calculated to be 61 percent. What percentage of the time will the POTW have removals above either 43 or 61 percent? Suppose the 9 estimated deciles (first decile through the ninth decile, respectively) are: 8 percent, 15 percent, 30 percent, 45 percent, 48 percent, 55 percent, 60 percent, 81 percent, and 87 percent. The average daily removal of 43 percent lies between the third and the fourth deciles (30 percent and 45 percent, respectively); therefore, the POTW exceeds a level of 43 percent removal between 60 percent and 70 percent of the time.

On the other hand, the mean removal value of 61 percent lies between the seventh and eighth deciles (60 percent and 81 percent, respectively); therefore, the POTW exceeds a level of 61 percent removal about 20 percent to 30 percent of the time. If a POTW requires a removal estimate for use in calculating allowable headworks loadings that is not exceeded more than 50 percent of the time, the average daily removal of 43 percent would be unacceptable because it is exceeded between 60 percent to 70 percent of the time. However, if a POTW required a removal value to be exceeded no more than 10 percent of the time, clearly neither the average daily removal nor the mean removal value would be acceptable.

To apply the decile approach as described in the 1987 local limits guidance, a minimum of nine daily removal values are required. If only nine removal values are available, then the nine estimated deciles are simply the nine ordered daily removals. If 10 or more daily removals are available, then some arithmetic must be performed to produce the nine decile estimates. To assist in the process of estimating the deciles, a decile estimation worksheet has been designed. The use of that worksheet will be demonstrated using the example data sets. Also EPA's PRELIM Version 4.0 computer program calculates deciles, from influent, effluent, and flow data.

2.2 ILLUSTRATIVE DATA AND APPLICATIONS

In this section, the methods intended to assist POTWs in developing removal efficiency estimates (either mean removal, average daily removal, or deciles) will be illustrated. In general, the overall approach will encompass the following steps:

- Displaying the influent, effluent, and daily removal data
- Deciding which data, if any, are candidates to exclude
- Calculating daily average and mean removals
- Ordering (i.e., sorting) the individual daily removal values
- Using the decile worksheet to estimate the nine decile removals.

The data that will be examined are daily influent and effluent sample values (reported in lbs/day) from a single POTW for 51 days covering the period July 1, 1987, through June 21, 1988.

2.2.1 DAILY INFLUENT, DAILY EFFLUENT, AND DAILY REMOVAL DATA

Table 1 presents the first example data set--a set of 51 influent and effluent sample pairs for copper. A good, first step in examining any set of data is to graph the data. Removals are based on influent and effluent values that are collected over time; therefore, it makes sense to plot daily

TABLE 1. COPPER MASS VALUES (LBS/DAY) AND DAILY REMOVALS

	POLLUTANT	MONTH	DAY	YEAR	INFLUENT--MASS	EFFLUENT--MASS	% REMOVAL
1	Cu	7	1	87	68.85	16.27	76.36
2	Cu	7	6	87	95.13	6.26	93.42
3	Cu	7	15	87	62.59	12.52	80.00
4	Cu	7	25	87	82.62	12.52	84.85
5	Cu	7	29	87	88.87	10.01	88.73
6	Cu	8	8	87	116.41	18.78	83.87
7	Cu	8	9	87	95.13	16.27	82.89
8	Cu	8	22	87	73.85	16.27	77.97
9	Cu	8	23	87	52.57	15.02	71.43
10	Cu	8	30	87	82.62	17.52	78.79
11	Cu	9	10	87	172.74	21.28	87.68
12	Cu	9	16	87	153.97	15.02	90.24
13	Cu	9	21	87	81.36	15.02	81.54
14	Cu	9	27	87	62.59	10.01	84.00
15	Cu	10	9	87	77.61	22.53	70.97
16	Cu	10	14	87	161.48	22.53	86.05
17	Cu	10	22	87	60.08	26.29	56.25
18	Cu	10	25	87	179.00	30.04	83.22
19	Cu	11	4	87	122.67	20.03	83.67
20	Cu	11	11	87	98.89	35.05	64.56
21	Cu	11	21	87	87.62	30.04	65.71
22	Cu	11	22	87	71.35	27.54	61.40
23	Cu	11	29	87	41.31	22.53	45.45
24	Cu	12	9	87	123.92	42.56	65.66
25	Cu	12	19	87	92.63	30.04	67.57
26	Cu	12	20	87	247.85	103.90	58.08
27	Cu	12	29	87	72.60	22.53	68.97
28	Cu	1	5	88	96.38	12.52	87.01
29	Cu	1	12	88	95.13	28.79	69.74
30	Cu	1	23	88	111.41	11.27	89.89
31	Cu	1	24	88	60.08	20.03	66.67
32	Cu	2	6	88	116.41	35.05	69.89
33	Cu	2	7	88	107.65	31.29	70.93
34	Cu	2	16	88	255.36	32.55	87.25
35	Cu	2	25	88	85.12	35.05	58.82
36	Cu	3	8	88	81.36	35.05	56.92
37	Cu	3	18	88	171.49	36.30	78.83
38	Cu	3	21	88	145.20	42.56	70.69
39	Cu	3	29	88	75.10	37.55	50.00
40	Cu	4	5	88	58.83	46.31	21.28
41	Cu	4	11	88	85.12	28.79	66.18
42	Cu	4	18	88	93.88	30.04	68.00
43	Cu	4	24	88	85.12	41.31	51.47
44	Cu	5	2	88	113.91	35.05	69.23
45	Cu	5	11	88	256.61	38.80	84.88
46	Cu	5	15	88	81.36	28.79	64.62
47	Cu	5	22	88	76.36	45.06	40.98
48	Cu	6	1	88	185.26	23.78	87.16
49	Cu	6	6	88	96.38	25.03	74.03
50	Cu	6	14	88	135.19	30.04	77.78
51	Cu	6	21	88	117.66	33.80	71.28

influent, daily effluent, and daily removal over time. Figures 1, 2, and 3 display plots of influent copper mass, effluent copper mass, and copper removal over time.

The influent data contained no influent concentration values reported as below the detection limit or as zero. Whenever a daily influent sample is zero (or it was reported as below the detection limit and was assigned a value of zero), it is impossible to calculate a daily removal, regardless of the effluent level. Influent and effluent sample pairs for which the influent level is reported as zero are useless for purposes of calculating daily or average removals. Such data pairs will be eliminated from the data set and are not included in any subsequent arithmetic. For the most part, influent levels in Figure 1 appear to be between 40 and 140 lbs/day, with a few values occasionally reaching 160 to 180 lbs/day, and a few falling in the 240 to 260 lbs/day range. No extremely high or low copper influent values are apparent from this graph, however.

The effluent copper mass values in Figure 2 reveal an isolated effluent copper value around 110 lbs/day. There are formal statistical procedures that can be applied to evaluate whether a value can be classified as an "outlier" or extreme value relative to the rest of the data values. The primary intention here, however, is to identify any values that might be candidates for exclusion. The final decision to exclude data should rest on technical justification. An examination of Figures 1 and 2 simultaneously shows that one of the three high influent values occurred at the same time as the high effluent value. By referring to Table 1, it is noted that the largest copper effluent value (103.9 lbs/day) was associated with the third largest influent value (247.85 lbs/day). The occurrence of corresponding extreme influent and effluent values should be investigated to determine whether the data values can be explained by technical or operational problems not related to treatment system performance (e.g., maintenance, repair, or sampling problems). If this is the case, dropping the data pair from the data set might be considered. Another characteristic displayed in Figure 2 is that there appears to be a pattern showing increasing effluent values over time; a similar pattern was not observed for the influent copper values in Figure 1. Because daily influent and effluent values enter into the calculation of the daily removal

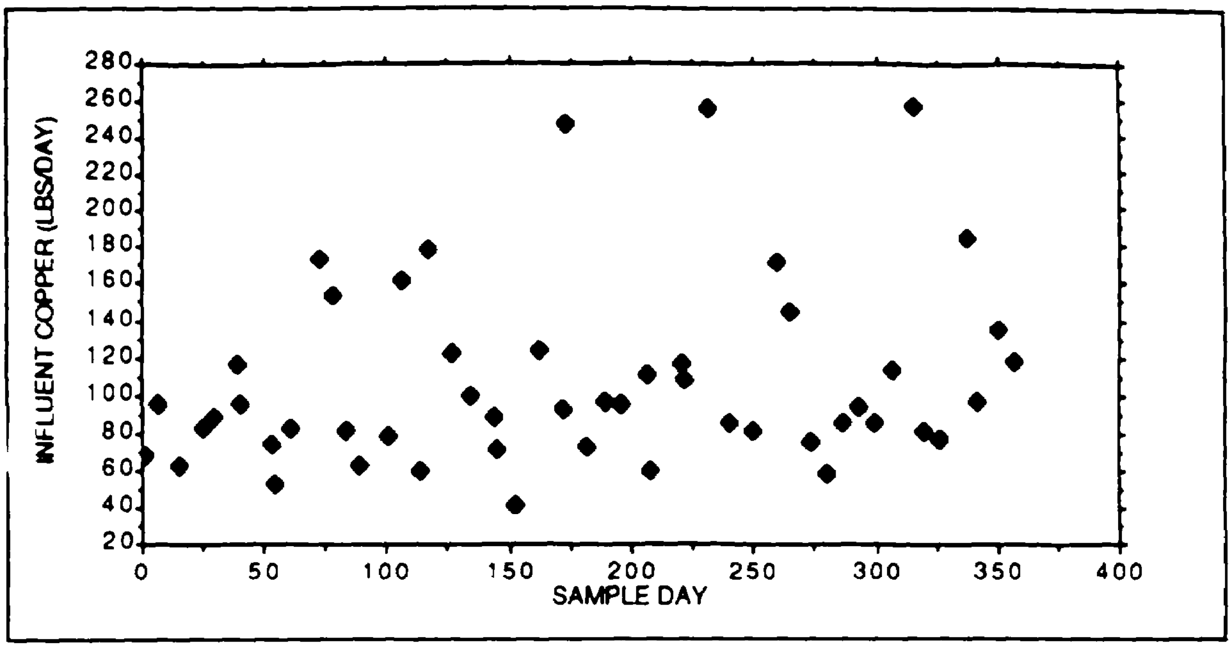

FIGURE 1. INFLUENT COPPER MASS VALUES

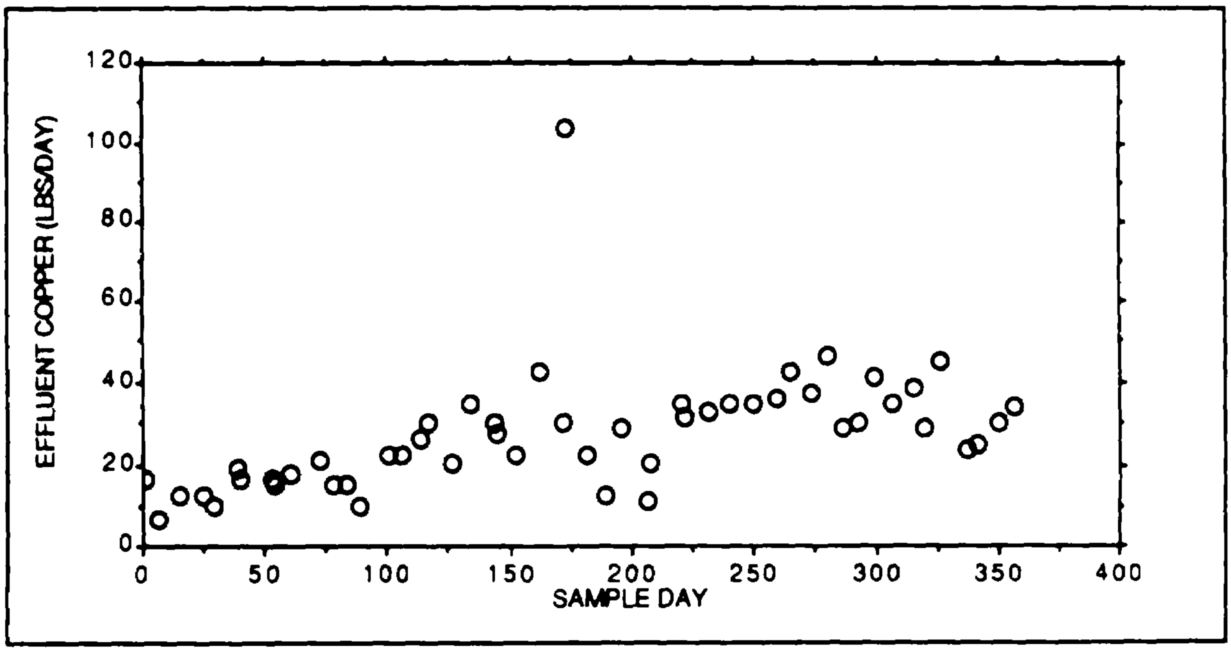

FIGURE 2. EFFLUENT COPPER MASS VALUES

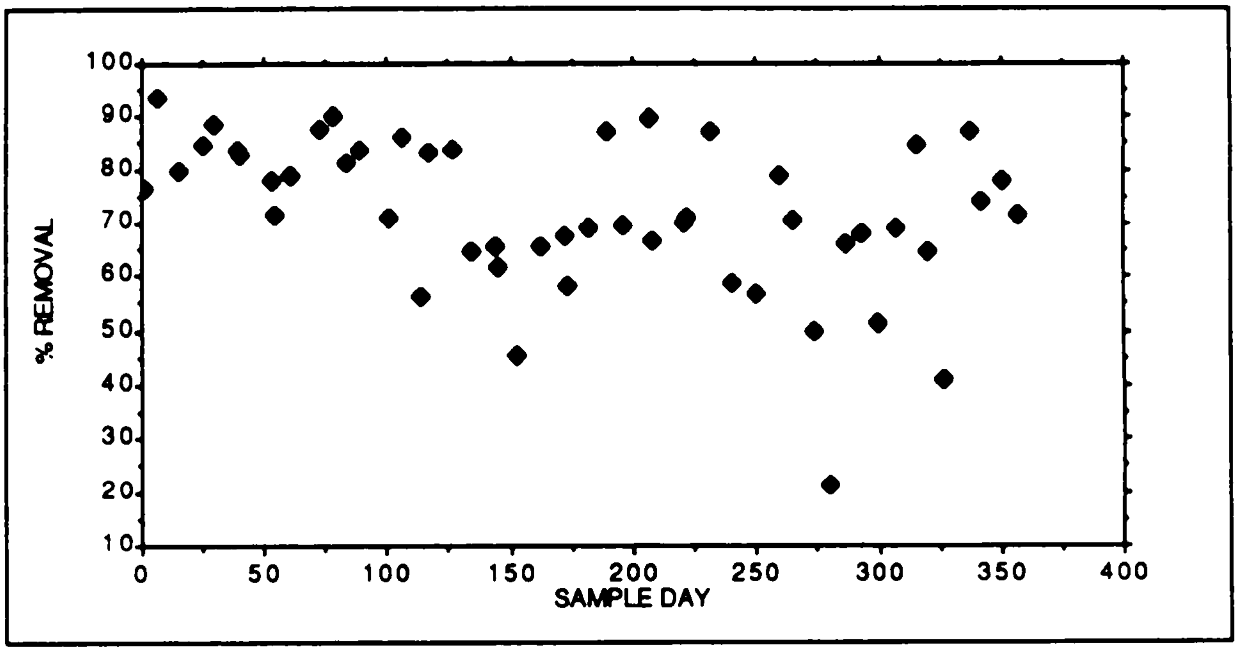

FIGURE 3. DAILY PERCENT REMOVALS FOR COPPER

efficiency, if the influent values tend to be fairly constant over time and the effluent values display an increasing pattern over time, the daily removals will likely show a decreasing pattern over time.

Figure 3 is a plot of the daily removal values over time. A general pattern of decreasing daily removal over time is evident. In addition, the plot shows that there is one low removal at approximately 20 percent. Such unusual data values warrant review. For example, the laboratory quality control samples could be checked to determine whether blank or duplicate samples indicated anything out of the ordinary. This might explain unusual data values.

Another plot that can provide assistance in the search for data values that might be considered for exclusion is presented in Figure 4. In this figure, influent sample values are plotted against their corresponding effluent sample values. Again, the isolated influent and effluent data pair (of 247.85 lbs/day and 103.9 lbs/day, respectively) are evident. There are also two other influent values of approximately 250 lbs/day. These influent values, however, had effluent levels more in line with the rest of the effluent data. Thus, this plot provides some evidence that the treatment system has reduced influent copper levels around 250 lbs/day to effluent copper levels substantially below 100 lbs/day.

For this example, it is assumed that the data were reviewed and justification did not exist for excluding any of the data pairs identified for review. That is, the sample data are assumed to reflect the range of influent and effluent levels that are reasonable for that treatment system.

2.2.2 AVERAGE DAILY AND MEAN REMOVALS

In this section, the copper data set is used to calculate the average daily removal and mean removal values described earlier. Table 1 lists the daily influent, daily effluent, and daily removal values for these data. The average daily removal is calculated by adding the individual daily removal values and dividing the total by 51 the number of values added). That is, using Table 1, the average daily removal for copper is (76.36% + 93.42% + ... + 77.78% + 71.28%)/51 = 72.0%.

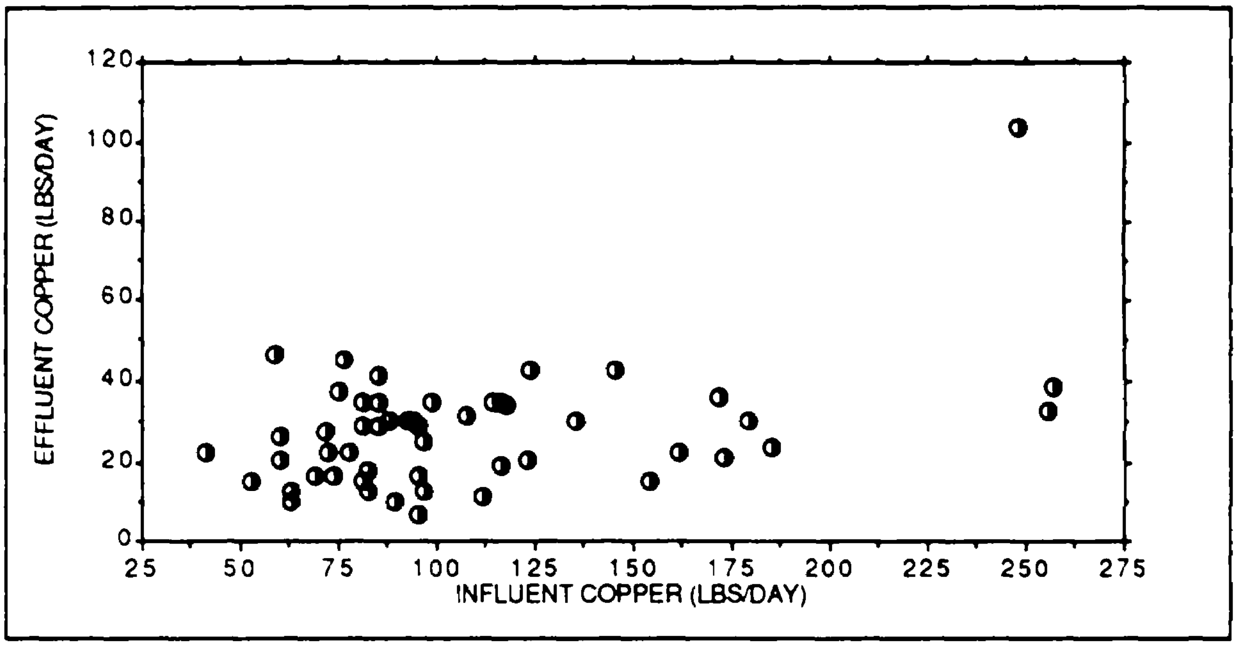

FIGURE 4. INFLUENT COPPER vs. EFFLUENT COPPER

The mean removal efficiency for copper is the percent change between the average influent value (i.e., the sum of the 51 influent values divided by 51) and the average effluent value (i.e., the sum of the 51 effluent values divided by 51). For these data, the average influent value is 108.09 lbs/day [i.e., (68.85 lbs/day + 95.13 lbs/day + ... + 135.19 lbs/day + 117.66 lbs/day) /51 = 108.09 lbs/day] and the average effluent value is 27.51 lbs/day [i.e., (16.27 lbs/day + 6.26 lbs/day + ... + 30.04 lbs/day + 33.80 lbs/day)/51 = 27.51 lbs/day]. Therefore, the mean removal efficiency is calculated by subtracting the effluent average from the influent average and dividing that difference by the influent average [i.e., (100) x (108.09 lbs/day - 27.51 lbs/day)/ 108.09 lbs/day = 74.5%].

In summary, the average daily removal for copper was calculated as 72.0 percent, and the mean removal was calculated as 74.5 percent. Note that the two averages yield slightly different results for this particular data set. (Later, another pollutant data set will show that substantially different results can exist when using the two averaging methods.) Both of these individual values can be evaluated to determine how often the daily removals exceed each of those values.

2.2.3 DECILE ESTIMATES

The set of 51 daily removal values will be used to estimate how often the POTW will exceed a specific level of removal, such as 72.0 percent or 74.5 percent. The nine decile removals discussed previously will be developed from the set of 51 daily removals.

The first step in estimating the deciles is to take the set of 51 daily removal values and order the values from smallest to largest. Table 2 presents the same information as Table 1 except that the information is sorted or ordered on percent removal (daily removal) value from smallest to largest. Table 2 will be used to fill in Table 3 (Decile Estimation Worksheet for Copper Data). The columns contain general instructions for completing the worksheet. The worksheet will be filled in column by column, from left to right. The entries for the Column #8 provide the estimated deciles. (Appendix B contains a blank decile estimation worksheet for copying purposes.)

TABLE 2. COPPER MASS VALUES (LBS/DAY) AND ORDERED REMOVALS

	POLLUTANT	MONTH	DAY	YEAR	INFLUENT--MASS	EFFLUENT--MASS	% REMOVAL
1	Cu	4	5	88	58.83	46.31	21.28
2	Cu	5	22	88	76.36	45.06	40.98
3	Cu	11	29	87	41.31	22.53	45.45
4	Cu	3	29	88	75.10	37.55	50.00
5	Cu	4	24	88	85.12	41.31	51.47
6	Cu	10	22	87	60.08	26.29	56.25
7	Cu	3	6	88	81.36	35.05	56.92
8	Cu	12	20	87	247.85	103.90	58.08
9	Cu	2	25	88	85.12	35.05	58.82
10	Cu	11	22	87	71.35	27.54	61.40
11	Cu	11	11	87	98.89	35.05	64.56
12	Cu	5	15	88	81.36	28.79	64.62
13	Cu	12	9	87	123.92	42.56	65.66
14	Cu	11	21	87	87.62	30.04	65.71
15	Cu	4	11	88	85.12	28.79	66.18
16	Cu	1	24	88	60.08	20.03	66.67
17	Cu	12	19	87	92.63	30.04	67.57
18	Cu	4	18	88	93.88	30.04	68.00
19	Cu	12	29	87	72.60	22.53	68.97
20	Cu	5	2	88	113.91	35.05	69.23
21	Cu	1	12	88	95.13	28.79	69.74
22	Cu	2	6	88	116.41	35.05	69.89
23	Cu	3	21	88	145.20	42.56	70.69
24	Cu	2	7	88	107.65	31.29	70.93
25	Cu	10	9	87	77.61	22.53	70.97
26	Cu	6	21	88	117.66	33.80	71.28
27	Cu	8	23	87	52.57	15.02	71.43
28	Cu	6	6	88	96.38	25.03	74.03
29	Cu	7	1	87	68.85	16.27	76.36
30	Cu	6	14	88	135.19	30.04	77.78
31	Cu	8	22	87	73.85	16.27	77.97
32	Cu	8	30	87	82.62	17.52	78.79
33	Cu	3	16	88	171.49	36.30	78.83
34	Cu	7	15	87	62.59	12.52	80.00
35	Cu	9	21	87	81.36	15.02	81.54
36	Cu	8	9	87	95.13	16.27	82.89
37	Cu	10	25	87	179.00	30.04	83.22
38	Cu	11	4	87	122.67	20.03	83.67
39	Cu	8	8	87	116.41	18.78	83.87
40	Cu	9	27	87	62.59	10.01	84.00
41	Cu	7	25	87	82.62	12.52	84.85
42	Cu	5	11	88	256.61	38.80	84.88
43	Cu	10	14	87	161.48	22.53	86.05
44	Cu	1	5	88	96.38	12.52	87.01
45	Cu	6	1	88	185.26	23.78	87.16
46	Cu	2	16	88	255.36	32.55	87.25
47	Cu	9	10	87	172.74	21.28	87.68
48	Cu	7	29	87	88.87	10.01	88.73
49	Cu	1	23	88	111.41	11.27	89.89
50	Cu	9	16	87	153.97	15.02	90.24
51	Cu	7	6	87	95.13	6.26	93.42

TABLE 3. DECILE ESTIMATION WORKSHEET FOR COPPER DATA

DECILES	COL. #1 CALCULATE DECILE POSITION FOR ORDERED LIST OF REMOVALS*	COL. #2 WRITE THE WHOLE NUMBER GIVEN IN COL. #1	COL. #3 RECORD THE ORDERED REMOVAL FOR THE COL. #2 ENTRY**	COL. #4 RECORD THE ORDERED REMOVAL FOLLOWING THE COL. #3 ENTRY**	COL. #5 COL. #4 ENTRY MINUS COL. #3 ENTRY	COL. #6 LIST THE DECIMAL IN COL. #1	COL. #7 MULTIPLY COL. #5 ENTRY BY COL. #6 ENTRY	COL. #8 ADD COL. #3 AND COL. #7 ENTRIES / ESTIMATED DECILES
1st	5.2	5	51.47	56.25	4.78	.2	.956	52.426
2nd	10.4	10	61.40	64.56	3.16	.4	1.264	62.664
3rd	15.6	15	66.18	66.67	.49	.6	.294	66.474
4th	20.8	20	69.23	69.74	.51	.8	.408	69.638
5th	26.0	26	71.28	71.43	.15	.0	.000	71.28
6th	31.2	31	77.97	78.79	.82	.2	.164	78.134
7th	36.4	36	82.89	83.22	.33	.4	.132	83.022
8th	41.6	41	84.85	84.88	.03	.6	.018	84.868
9th	46.8	46	87.25	87.68	.43	.8	.344	87.594

*Numbers in column defined as multiples of (N+1)/10, where N = the number of data pairs used.[i.e. (51+1/10=5.2), (2x5.2=10.4) etc.]
**Uses the list of ordered removals.

- Step 1 - The entries for the first column are obtained by performing the calculations described in the footnote (referenced in the column heading at the bottom of the worksheet). The footnote defines the starting location for the first decile; and then, calculations for the next eight multiples of that number for the second through ninth deciles are made. For example, the copper data set contains 51 influent and effluent data pairs that are used. Thus, the location of the first decile in the ordered list of removals is (N + 1)/10 = (51 + 1)/10 = 5.2. The location of the second decile is 2 x 5.2 = 10.4; the location of the third decile is 3 x 5.2 = 15.6, etc.; and the location of the ninth decile is 9 x 5.2 = 46.8. Therefore, the nine entries for Column #1 (proceeding from the first through the ninth decile) are 5.2, 10.4, 15.6, 20.8, 26.0, 31.2, 36.4, 41.6, and 46.8. See the entries for Column #1.

- Step 2 - For the entries in Column #2, the whole number part of each of the nine values listed in Column #1 is used. For example, the first decile had a value of 5.2 in Column #1; therefore, the entry for the first decile in Column #2 is the whole number part of 5.2 (i.e., 5). Similarly, the other eight whole number values are 10, 15, 20, 26, 31, 36, 41, and 46.

- Step 3 - The entries for Column #3 require the use of Table 2 that contains the ordered list of daily removal values. (Note the footnote marked **.) Entries for Column #3 are the ordered removal values corresponding to the locations specified in Column #2. For example, the first entry for Column #3 will be the ordered removal for the Column #2 entry of five. That is, the first entry in Column #3 will be the fifth ordered, daily removal value from Table 2, which is 51.47 percent. Similarly, the second entry for Column #3 will be the ordered removal for the Column #2 entry of 10, which is the 10th ordered daily removal in Table 2 (61.40 percent). The remaining entries for Column #3 are selected from the ordered list of daily removals based on the values specified in Column #2.

- Step 4 - The entries for Column #4 are also obtained from the ordered list of daily removals presented in Table 2. The Column #4 entries are the daily removals in Table 2, which immediately follow the Column #3 entries. For example, the first entry in Column #3 is 51.47 percent; the daily removal value immediately following 51.47 percent in Table 2 is 56.25 percent. Similarly, for the second entry in Column #4, the daily removal value in Table 2 (immediately after 61.40 percent) is 64.56 percent.

- Step 5 - The entries for Column #5 are determined by subtracting Column #3 from Column #4 for a specified decile. For example, for the first decile, the Column #3 entry of 51.47 percent is subtracted from the Column #4 entry of 56.25 percent, producing a result of 4.78 percent for the first entry in Column #5. The rest of the column is obtained by performing the same subtraction process for the decile row of interest.

- Step 6 - The entries for Column #6 are the decimal part of the entries specified in Column #1. For example, the first entry in Column #1 is 5.2, which has a decimal part of .2; therefore, the first entry for Column #6 is .2.

- <u>Step 7</u> - The entries for Column #7 are obtained by multiplying the entries of Column #5 by the entries of Column #6. For example, the first entry in Column #7 is 4.78% x .2 = .956%.

- <u>Step 8</u> - The entries for Column #8 are obtained by adding the entries of Column #3 and the entries of Column #7. For example, the first entry in Column #8 is 51.47% + .956% = 52.426%.

Column #8 provides the following nine estimated decile removals (rounded to the nearest tenth):

- 1st decile = 52.4 percent
- 2nd decile = 62.7 percent
- 3rd decile = 66.5 percent
- 4th decile = 69.6 percent
- 5th decile = 71.3 percent
- 6th decile = 78.1 percent
- 7th decile = 83.0 percent
- 8th decile = 84.9 percent
- 9th decile = 87.6 percent.

Thus, it can be seen from the nine deciles that the average daily removal of 72.0 percent and the mean removal of 74.5 percent both fall between the fifth and sixth deciles. Based on the decile estimates, between 40 to 50 percent of the daily removals exceed the specified individual removals.

2.3 USE OF REMOVAL ESTIMATES FOR ALLOWABLE HEADWORKS LOADINGS

In this section, the use of the average removals and decile removals for calculation of allowable headworks loadings will be demonstrated. In general, allowable headworks loading equations are expressed in a number of ways, including:

Effluent quality headworks loading (lbs/day) =

$$[(8.34) \times (C_{CRIT}) \times (Q_{POTW}))/(1 - R_{POTW})],$$

where:

8.34 = conversion factor which takes into account the density of water

C_{CRIT} = NPDES permit limit, mg/l

Q_{POTW} = POTW average flow, MGD

R_{POTW} = Removal efficiency across the POTW, decimal

The quantity $[(8.34) \times (C_{CRIT}) \times (Q_{POTW})]$ is a National Pollutant Discharge Elimination System (NPDES)-based maximum permissible mass discharge limit and R is an estimated removal efficiency expressed as a decimal (for example, see page 3-3 of the 1987 local limits guidance).

Sludge quality headworks loading (lbs/day) =

$[(8.34) \times (C_{SLCRIT}) \times (PS/100) \times (Q_{SLDG})/R_{POTW}]$,

where:

8.34 = conversion factor which takes into account the density of water

C_{SLCRIT} = sludge disposal criterion, mg/kg dry sludge

PS = percent solids of sludge to disposal

Q_{SLDG} = sludge flow to disposal, MGD

R_{POTW} = removal efficiency across the POTW, decimal

The quantity $[((8.34) \times (C_{SLCRIT}) \times (PS/100) \times Q_{SLDG})]$ is a maximum permissible mass sludge loading and R is an estimated removal efficiency expressed as a decimal (for example, see page 3-11 of the 1987 local limits guidance).

The nine decile estimates, the average daily removal estimate, and the mean removal estimate can be used to examine the effect that each has on the two allowable headworks loading equations specified above. The headworks loadings corresponding to the nine deciles, mean value, and average daily removal efficiencies are displayed on the following pages.

In developing local limits, appropriate removal efficiencies must be selected for calculation of an allowable headworks loading for each pollutant. The typical procedure is for the POTW to select the pollutant's average removal efficiency for this purpose. This procedure, however, does not account for variabilities in removal efficiencies which occur over time. An alternative procedure, which does account for removal efficiency variability, is the decile approach. The decile approach entails calculation of allowable headworks loadings based on judiciously selected removal efficiency deciles rather than average removals. The decile approach is illustrated by the following example.

The following effluent quality-based MAHLs for copper to a POTW have been previously calculated assuming the NPDES-based maximum permissible mass discharge is 10 lbs/day.

Decile	Removal Efficiency %	Allowable Headworks Loading lbs/day (Effluent Quality-based)
1	52.4	21.0
2	62.7	26.8
3	66.5	29.9
4	69.6	32.9
5	71.3	34.8
Average Daily	72.0	35.7
Mean Removal	74.5	39.2
6	78.1	45.7
7	83.0	58.8
8	84.9	66.2
9	87.6	80.6

The typical procedure is for the POTW to establish MAHLS based on a chosen removal rate. In this case, the effluent quality-based allowable headworks loading for copper would then be 35.7 lbs/day, corresponding to the average removal of 72.0 percent. The POTW might choose to establish local limits based on this MAHL, and assume that industrial user compliance with the local limits will ensure POTW compliance with its effluent quality limitations.

Suppose, however, that the POTW actually receives 30 lbs/day copper at its headworks. Comparing this copper loading with the allowable copper loadings listed above, we find that the copper MAHLs for the first, second, and third deciles are less than the 30 lbs/day copper being received. It can be concluded that for 30 percent of the year (three deciles), the POTW will be unable to comply with its effluent quality limitations. At the same time, the POTW's industrial users may all be in compliance with local limits, since the 30 lbs/day copper currently received is well below the 35.7 lbs/day allowable loading established by the POTW based on average removal.

In using the decile approach, the POTW can establish a more stringent copper local limit by taking into account variability in copper removal efficiencies over time. For example, the POTW can base its copper allowable headworks loading on the second decile removal of 62.7 percent. The copper allowable headworks loading would then be 26.8 lbs/day, which is considerably more stringent than the 35.7 lbs/day allowable headworks loading based on average removal. The 30 lbs/day copper loading currently received exceeds this allowable headworks loading, implying that the industrial user would be in noncompliance with the local limit. Once the industrial user achieves compliance with the limit, the POTW can be reasonably certain it will maintain compliance with its effluent quality limitations.

A similar procedure is followed in applying the decile approach to establishing sludge quality-based MAHLs. In this regard, the following removal efficiency deciles and sludge quality-based MAHLs of copper have been calculated assuming the maximum permissible sludge loading is 20 lbs/day.

Decile	Removal Efficiency %	Sludge Quality-based Allowable Headworks Loading lbs/day
1	52.4	38.2
2	62.7	31.9
3	66.5	30.1
4	69.6	28.7
5	71.3	28.1
Average Daily	72.0	27.8
Mean Removal	74.5	26.8
6	78.1	25.6
7	83.0	24.1
8	84.9	23.6
9	87.6	22.8

From the above information, it can be seen that allowable headworks loadings of copper decrease with increasing removal efficiency deciles. Thus, in order to establish a MAHLs more stringent than the allowable loading based on the average removal (27.8 lbs/day), a decile higher than the fifth decile must be selected. The POTW may elect to establish a sludge quality-based allowable headworks loading corresponding to the eighth decile; from the above information, this loading would be 23.6 lbs/day.

The final step in the decile approach is to choose a percent removal that results in an allowable headworks loading that will be met most of the time and compare selected effluent quality and sludge quality-based allowable headworks loadings and select the most stringent.

Loading Basis	Decile	Allowable Headworks Loading lbs/day
Effluent quality	2	26.8
Sludge quality	8	23.6

From the above information, it can be seen that the POTW should base its copper local limits on an allowable headworks loading of 23.6 lbs/day. The resultant local limits will be protective of both the POTW's effluent quality and sludge quality.

2.4 EXAMPLE ZINC AND NICKEL DATA SETS

In this section, more complicated data sets than the ones previously used will be examined. The data sets illustrate some of the problems (e.g., negative removals) that might be encountered in using individual influent and effluent values to determine removal efficiency.

2.4.1 ZINC SAMPLING DATA

First, zinc data will be reviewed using the figures discussed earlier. Table 4 presents the 51 influent and effluent samples for zinc. Figure 5 is a plot of the influent zinc values over time. All of the influent values are above 0; 49 of the 51 influent values are above 100 lbs/day. There are a few high influent values. Table 4 shows the four highest influent values have daily removals of at least 70 percent. Based on examination of the influent zinc values it would not be suspected that these data values would be candidates for elimination from the data set.

Figure 6 is a plot of the effluent zinc values over time showing 2 effluent values that are noticeably above the other 49 effluent values. Table 4 shows that one of the 2 pairs (lines 25 and 26 of Table 3) with the highest effluent values was noted in review of the influent values. The other pair has a negative removal. The occurrence of these results on successive days (December 19, 1987, to December 20, 1987) may indicate that the POTW treatment

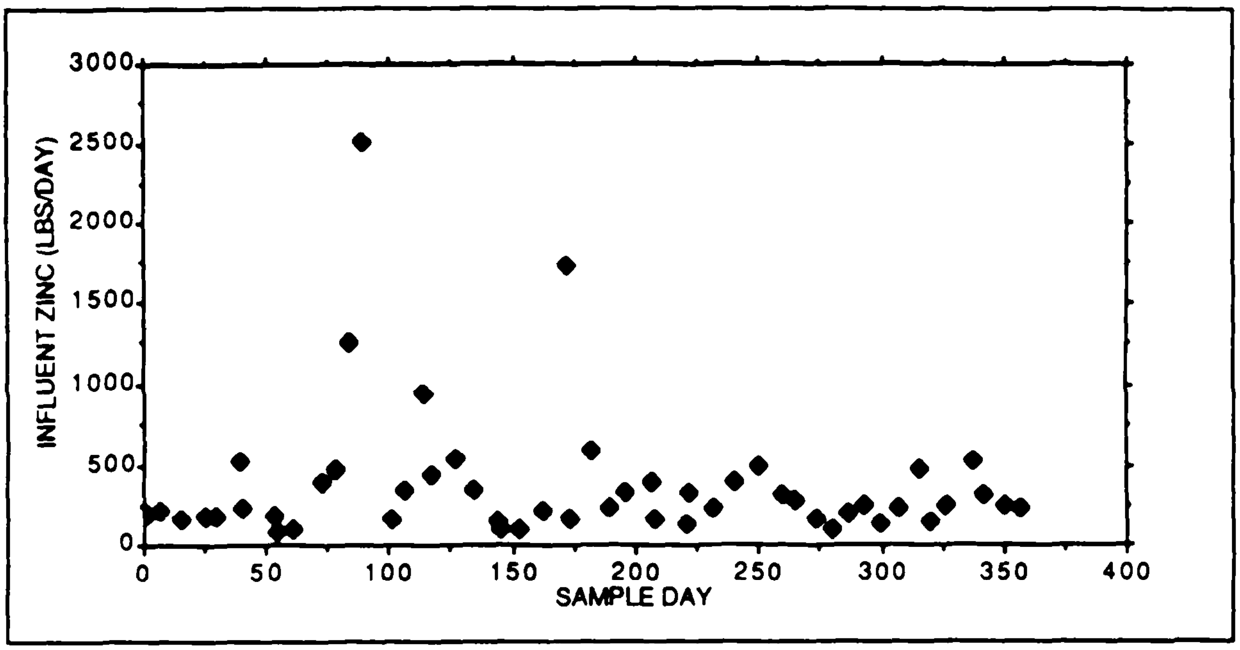

FIGURE 5. INFLUENT ZINC MASS VALUES

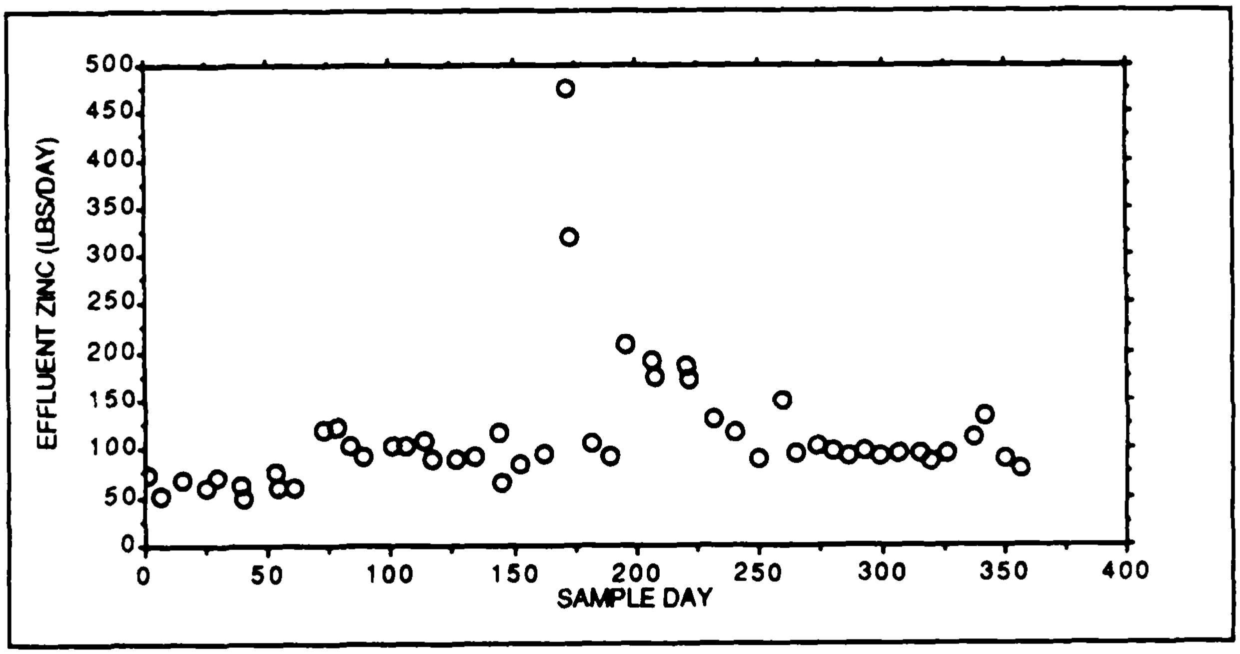

FIGURE 6. EFFLUENT ZINC MASS VALUES

TABLE 4. ZINC MASS VALUES (LBS/DAY) AND DAILY REMOVALS

	POLLUTANT	MONTH	DAY	YEAR	INFLUENT--MASS	EFFLUENT--MASS	% REMOVAL
1	Zn	7	1	87	196.52	72.60	63.06
2	Zn	7	6	87	216.55	52.57	75.72
3	Zn	7	15	87	168.99	67.59	60.00
4	Zn	7	25	87	185.26	58.83	68.24
5	Zn	7	29	87	172.74	71.35	58.70
6	Zn	8	8	87	528.24	62.59	88.15
7	Zn	8	9	87	229.07	50.07	78.14
8	Zn	8	22	87	172.74	76.36	55.80
9	Zn	8	23	87	85.12	61.34	27.94
10	Zn	8	30	87	93.88	60.08	36.00
11	Zn	9	10	87	393.05	120.17	69.43
12	Zn	9	16	87	473.16	122.67	74.07
13	Zn	9	21	87	1266.77	103.90	91.80
14	Zn	9	27	87	2501.00	93.88	96.25
15	Zn	10	9	87	160.22	103.90	35.16
16	Zn	10	14	87	349.24	103.90	70.25
17	Zn	10	22	87	948.83	108.90	88.52
18	Zn	10	25	87	449.38	91.38	79.67
19	Zn	11	4	87	533.25	88.87	83.33
20	Zn	11	11	87	345.48	93.88	72.83
21	Zn	11	21	87	155.22	116.41	25.00
22	Zn	11	22	87	106.40	65.09	38.82
23	Zn	11	29	87	100.14	83.87	16.25
24	Zn	12	9	87	215.30	96.38	55.23
25	Zn	12	19	87	1739.93	474.41	72.73
26	Zn	12	20	87	166.48	320.45	-92.48
27	Zn	12	29	87	582.06	106.40	81.72
28	Zn	1	5	88	231.57	92.63	60.00
29	Zn	1	12	88	330.46	207.79	37.12
30	Zn	1	23	88	390.55	191.52	50.96
31	Zn	1	24	88	163.98	173.99	-6.11
32	Zn	2	6	88	133.94	185.26	-38.32
33	Zn	2	7	88	331.71	171.49	48.30
34	Zn	2	16	88	230.32	131.43	42.93
35	Zn	2	25	88	399.31	116.41	70.85
36	Zn	3	6	88	490.69	91.38	81.38
37	Zn	3	16	88	314.19	148.96	52.59
38	Zn	3	21	88	272.88	96.38	64.68
39	Zn	3	29	88	166.48	105.15	36.84
40	Zn	4	5	88	105.15	97.64	7.14
41	Zn	4	11	88	195.27	93.88	51.92
42	Zn	4	18	88	239.08	97.64	59.16
43	Zn	4	24	88	131.43	92.63	29.52
44	Zn	5	2	88	234.08	95.13	59.36
45	Zn	5	11	88	473.16	96.38	79.63
46	Zn	5	15	88	148.96	86.37	42.02
47	Zn	5	22	88	24..59	96.38	60.10
48	Zn	6	1	88	518.22	111.41	78.50
49	Zn	6	6	88	306.68	132.69	56.73
50	Zn	6	14	88	246.59	91.38	62.94
51	Zn	6	21	88	235.33	78.86	66.49

system was experiencing some operational difficulties or interference at the time. Inquiries should be made to determine whether there are valid reasons for dropping these data for purposes of calculating removals.

Influent zinc levels versus effluent zinc levels are plotted in Figure 7. The removal efficiency on December 19, 1987, (72.23 percent with an associated influent value of 1,750 lbs/day) contrasts sharply with the removal efficiency on September 27, 1987 (95.25 percent with an associated influent value of 2,500 lbs/day). Thus, the data show that the POTW was capable of treating influent zinc considerably above 1,750 lbs/day.

Figure 8 is a plot of the daily removals over time. The three negative removals are quite apparent from the plot. It is assumed for this example that justification to discard any of these data was not possible. Negative daily removals should not automatically result in data elimination; such values may be visible evidence of treatment system variability. Based on the 51 daily influent, effluent, and removal values, the summary removals were calculated; the average daily removal was 53.4 percent and the mean removal was 69.5 percent. Note that the two removal averages are considerably different. (Had the influent and effluent data for the negative removals been discarded, the removal averages would still have been considerably different; average daily removal would have been 59.6 percent, and the mean removal would have been 72.4 percent.)

The decile approach can now be used to evaluate these removal averages with respect to the nine decile estimates. Table 5 presents the ordered daily removals for use with the decile estimation worksheet.

Table 6 presents the results of using the worksheet. Since the number of influent and effluent zinc data pairs is 51, the entries for Column #1 are, again, multiples of 5.2 (see the first footnote at the bottom of the worksheet). Likewise, the entries for Column #2 are the whole numbers of Column #1. The ordered removal entries for Columns #3 and #4 are taken from

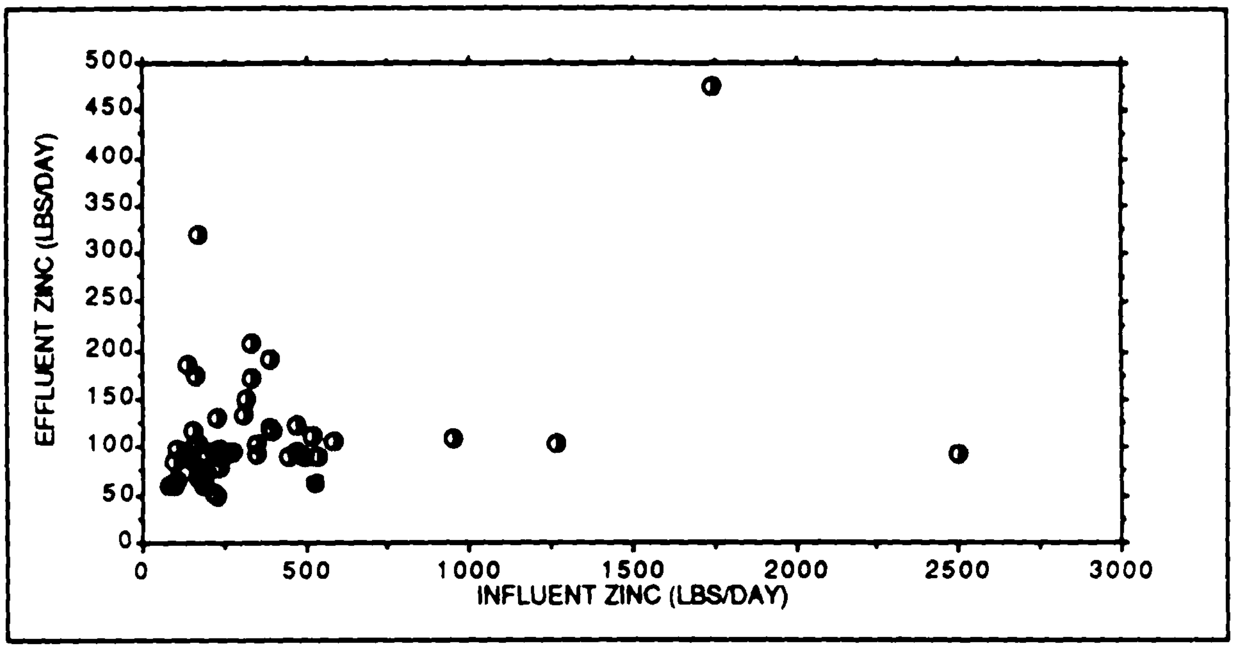

FIGURE 7. INFLUENT ZINC vs. EFFLUENT ZINC

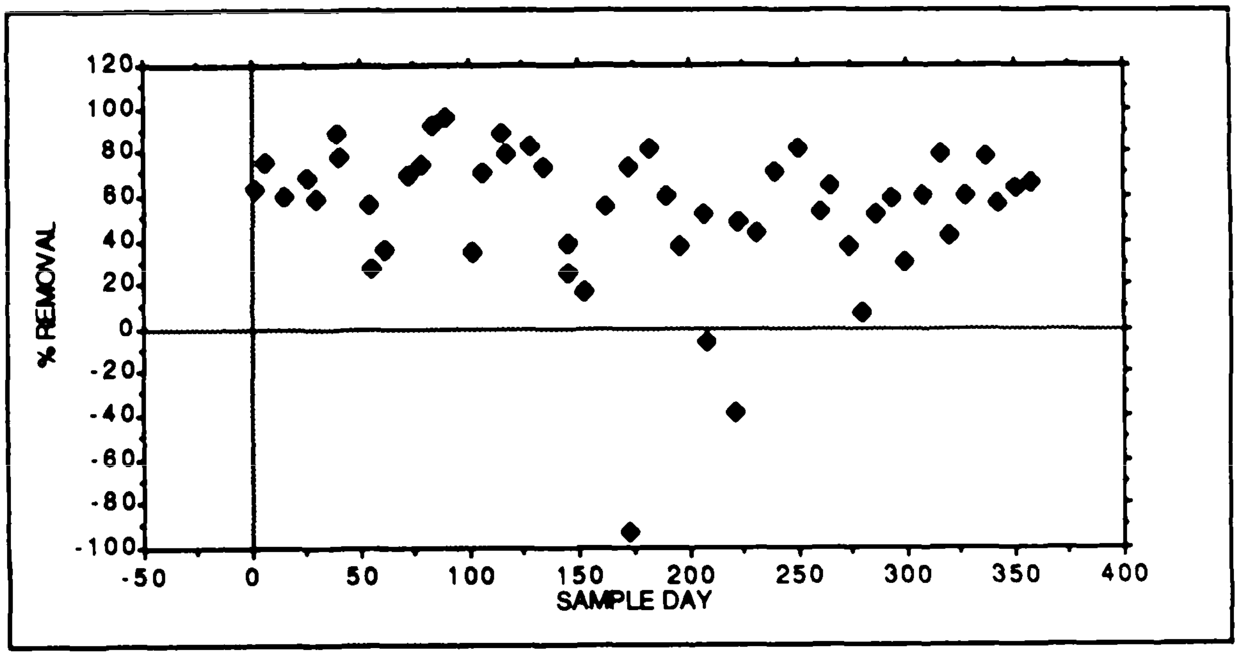

FIGURE 8. DAILY PERCENT REMOVALS FOR ZINC

TABLE 5. ZINC MASS VALUES (LBS/DAY) AND ORDERED REMOVALS

	POLLUTANT	MONTH	DAY	YEAR	INFLUENT--MASS	EFFLUENT-MASS	% REMOVAL
1	Zn	12	20	87	166.48	320.45	-92.48
2	Zn	2	6	88	133.94	185.26	-38.32
3	Zn	1	24	88	163.98	173.99	-6.11
4	Zn	4	5	88	105.15	97.64	7.14
5	Zn	11	29	87	100.14	83.87	16.25
6	Zn	11	21	87	155.22	116.41	25.00
7	Zn	8	23	87	85.12	61.34	27.94
8	Zn	4	24	88	131.43	92.63	29.52
9	Zn	10	9	87	160.22	103.90	35.16
10	Zn	8	30	87	93.88	60.08	36.00
11	Zn	3	29	88	166.48	105.15	36.84
12	Zn	1	12	88	330.46	207.79	37.12
13	Zn	11	22	87	106.40	65.09	38.82
14	Zn	5	15	88	148.96	86.37	42.02
15	Zn	2	16	88	230.32	131.43	42.93
16	Zn	2	7	88	331.71	171.49	48.30
17	Zn	1	23	88	390.55	191.52	50.96
18	Zn	4	11	88	195.27	93.88	51.92
19	Zn	3	16	88	314.19	148.96	52.59
20	Zn	12	9	87	215.30	96.38	55.23
21	Zn	8	22	87	172.74	76.36	55.80
22	Zn	6	6	88	306.68	132.69	56.73
23	Zn	7	29	87	172.74	71.35	58.70
24	Zn	4	18	88	239.08	97.64	59.16
25	Zn	5	2	88	234.08	95.13	59.36
26	Zn	1	5	88	231.57	92.63	60.00
27	Zn	7	15	87	168.99	67.59	60.00
28	Zn	5	22	88	241.59	96.38	60.10
29	Zn	6	14	88	246.59	91.38	62.94
30	Zn	7	1	87	196.52	72.60	63.06
31	Zn	3	21	88	272.88	96.38	64.68
32	Zn	6	21	88	235.33	78.86	66.49
33	Zn	7	25	87	185.26	58.83	68.24
34	Zn	9	10	87	393.05	120.17	69.43
35	Zn	10	14	87	349.24	103.90	70.25
36	Zn	2	25	88	399.31	116.41	70.85
37	Zn	12	19	87	1739.93	474.41	72.73
38	Zn	11	11	87	345.48	93.88	72.83
39	Zn	9	16	87	473.16	122.67	74.07
40	Zn	7	6	87	216.55	52.57	75.72
41	Zn	8	9	87	229.07	50.07	78.14
42	Zn	6	1	88	518.22	111.41	78.50
43	Zn	5	11	88	473.16	96.38	79.63
44	Zn	10	25	87	449.38	91.38	79.67
45	Zn	3	6	88	490.69	91.38	81.38
46	Zn	12	29	87	582.06	106.40	81.72
47	Zn	11	4	87	533.25	88.87	83.33
48	Zn	8	8	87	528.24	62.59	88.15
49	Zn	10	22	87	948.83	108.90	88.52
50	Zn	9	21	87	1266.77	103.90	91.80
51	Zn	9	27	87	2501.00	93.88	96.25

TABLE 6. DECILE ESTIMATION WORKSHEET FOR ZINC DATA

DECILES	COL. #1 CALCULATE DECILE POSITION FOR ORDERED LIST OF REMOVALS*	COL. #2 WRITE THE WHOLE NUMBER GIVEN IN COL. #1	COL. #3 RECORD THE ORDERED REMOVAL FOR THE COL. #2 ENTRY**	COL. #4 RECORD THE ORDERED REMOVAL FOLLOWING THE COL. #3 ENTRY**	COL. #5 COL. #4 ENTRY MINUS COL. #3 ENTRY	COL. #6 LIST THE DECIMAL IN COL. #1	COL. #7 MULTIPLY COL. #5 ENTRY BY COL. #6 ENTRY	COL. #8 ADD COL. #3 AND COL. #7 ENTRIES — ESTIMATED DECILES
1st	5.2	5	16.25	25.00	8.75	0.2	1.75	18.00
2nd	10.4	10	36.00	36.84	0.84	0.4	0.336	36.336
3rd	15.6	15	42.93	48.30	5.37	0.6	3.222	46.152
4th	20.8	20	55.23	55.80	0.57	0.8	0.456	55.686
5th	26.0	26	60.00	60.00	0	0.0	0.0	60.0
6th	31.2	31	64.68	66.49	1.81	0.2	0.362	65.042
7th	36.4	36	70.85	72.73	1.88	0.4	0.752	71.602
8th	41.6	41	78.14	78.50	0.36	0.6	0.216	78.356
9th	46.8	46	81.72	83.33	1.61	0.8	1.288	83.008

*Numbers in column defined as multiples of (N+1)/10, where N = the number of data pairs used.[i.e. (51+1/10=5.2), (2x5.2=10.4) etc.]
**Uses the list of ordered removals.

Table 5. Column #5 is obtained by subtracting Column #3 from Column #4. Column #6 is the decimal part of the entries in Column #1. Column #7 is obtained by multiplying Columns #5 and #6. The estimated deciles, Column #8, are obtained by adding the entries of Column #3 to those of Column #7. The nine estimated deciles for the zinc data are:

- 1st decile - 18.0 percent
- 2nd decile - 36.3 percent
- 3rd decile - 46.2 percent
- 4th decile - 55.7 percent
- 5th decile - 60.0 percent
- 6th decile - 65.0 percent
- 7th decile - 71.6 percent
- 8th decile - 78.4 percent
- 9th decile - 83.0 percent.

The decile estimates then can be used to estimate how often the POTW's daily removals of zinc exceed the average daily removal of 53.4 percent and the mean removal of 69.5 percent. The former lies between the third and fourth decile, and therefore is exceeded between 60 and 70 percent of the time. The latter lies between the sixth and seventh decile, and therefore is exceeded between 30 and 40 percent of the time.

2.4.2 NICKEL SAMPLING DATA

The last example involves working initially with a data set of 51 daily influent and effluent nickel mass values. Table 7 presents reported influent and effluent values and, when possible, their daily removals. The table shows that a number of the daily removals cannot be determined because of reported zero influent levels. <u>These reported zero levels more than likely indicate nondetections or below detection limit concentration values</u>. In this section, the reported zero levels are treated as measurements having the value of zero. For discussion of this practice and alternate approaches, refer to Section 2.6.

Figure 9 is a plot of the 51 influent nickel mass values over time. The large number of zero influent values is apparent along the horizontal axis (sample day); the zero values are spread out over the sampling period. An

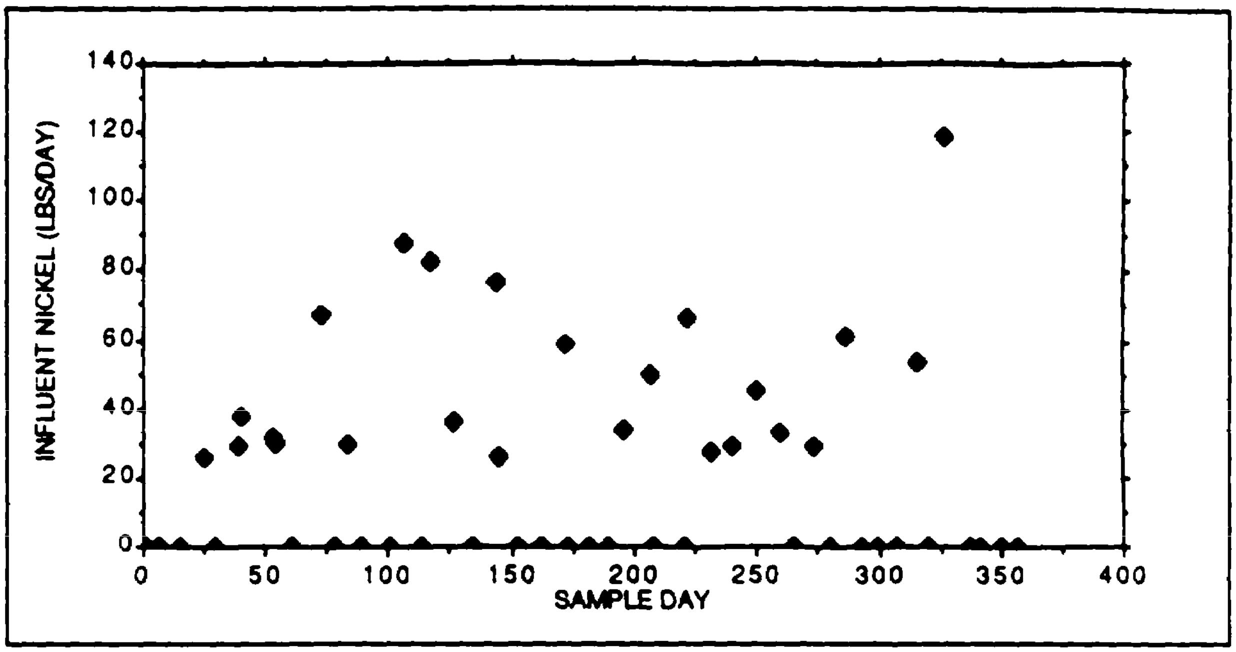

FIGURE 9. INFLUENT NICKEL MASS VALUES

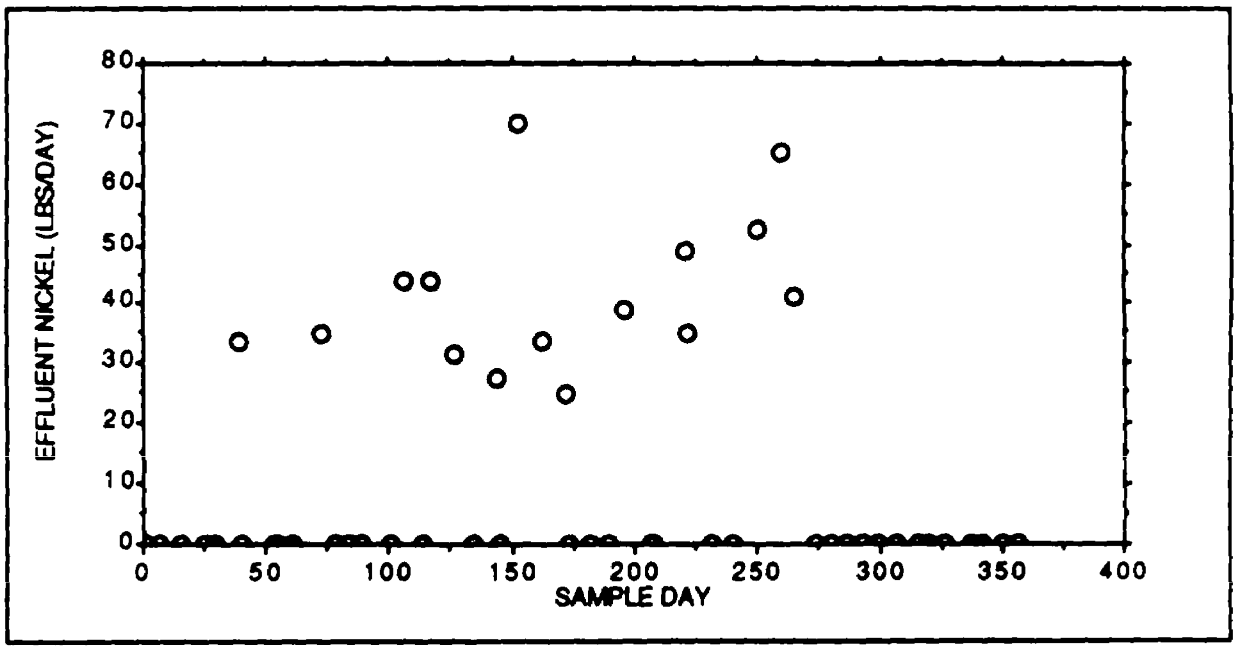

FIGURE 10. EFFLUENT NICKEL MASS VALUES

TABLE 7. NICKEL MASS VALUES (LBS/DAY) AND DAILY REMOVALS

	POLLUTANT	MONTH	DAY	YEAR	INFLUENT--MASS	EFFLUENT--MASS	% REMOVAL
1	Ni	7	1	87	0	0	.
2	Ni	7	6	87	0	0	.
3	Ni	7	15	87	0	0	.
4	Ni	7	25	87	26.29	0	100.00
5	Ni	7	29	87	0	0	.
6	Ni	8	8	87	28.79	33.80	-17.39
7	Ni	8	9	87	37.55	0	100.00
8	Ni	8	22	87	31.29	0	100.00
9	Ni	8	23	87	30.04	0	100.00
10	Ni	8	30	87	0	0	.
11	Ni	9	10	87	67.59	35.05	48.15
12	Ni	9	16	87	0	0	.
13	Ni	9	21	87	30.04	0	100.00
14	Ni	9	27	87	0	0	.
15	Ni	10	9	87	0	0	.
16	Ni	10	14	87	87.62	43.81	50.00
17	Ni	10	22	87	0	0	.
18	Ni	10	25	87	82.62	43.81	46.97
19	Ni	11	4	87	36.30	31.29	13.79
20	Ni	11	11	87	0	0	.
21	Ni	11	21	87	76.36	27.54	63.93
22	Ni	11	22	87	26.29	0	100.00
23	Ni	11	29	87	0	70.10	.
24	Ni	12	9	87	0	33.80	.
25	Ni	12	19	87	58.83	25.03	57.45
26	Ni	12	20	87	0	0	.
27	Ni	12	29	87	0	0	.
28	Ni	1	5	88	0	0	.
29	Ni	1	12	88	33.80	38.80	-14.81
30	Ni	1	23	88	50.07	0	100.00
31	Ni	1	24	88	0	0	.
32	Ni	2	6	88	0	48.82	.
33	Ni	2	7	88	66.34	35.05	47.17
34	Ni	2	16	88	27.54	0	100.00
35	Ni	2	25	88	28.79	0	100.00
36	Ni	3	6	88	45.06	52.57	-16.67
37	Ni	3	16	88	32.55	65.09	-100.00
38	Ni	3	21	88	0	41.31	.
39	Ni	3	29	88	28.79	0	100.00
40	Ni	4	5	88	0	0	.
41	Ni	4	11	88	61.34	0	100.00
42	Ni	4	18	88	0	0	.
43	Ni	4	24	88	0	0	.
44	Ni	5	2	88	0	0	.
45	Ni	5	11	88	53.83	0	100.00
46	Ni	5	15	88	0	0	.
47	Ni	5	22	88	118.92	0	100.00
48	Ni	6	1	88	0	0	.
49	Ni	6	6	88	0	0	.
50	Ni	6	14	88	0	0	.
51	Ni	6	21	88	0	0	.

isolated influent nickel value around 120 lbs/day also exists. Table 7 shows that the daily removal for that influent value is 100 percent because the corresponding effluent value is zero.

Figure 10 plots the 51 daily effluent nickel mass values over time. The effluent nickel values also show a number of zeroes, many of which will not be used because their corresponding influent value was also zero.

Figure 11 plots influent nickel mass values versus the effluent nickel mass values. The horizontal axis shows that there are a number of influent nickel values above 0 (ranging from about 25 to 120 lbs/day) that have effluent levels of 0 (that is, 100 percent removal). On the vertical axis, four influent and effluent sample pairs for which the influent was zero and the effluent mass level was greater than zero exist. Since daily removals cannot be calculated from influent values of zero, any influent or effluent data pair (regardless of effluent level) having an influent value of zero will be excluded.

Figure 12 plots the daily removal values over time. The figure shows that the POTW displays some treatment variation. The positive daily removals vary from about 10 percent to 100 percent. The figure also shows 4 negative removals; 3 of the 4 negative removals are similar in magnitude, about -15 percent. The other negative removal corresponds to an influent nickel mass of 32.55 lbs/day and an effluent mass of 65.09 lbs/day on March 16, 1988. These sample pairs should be investigated to determine whether the data should be retained. Except for the influent data values of zero, it is assumed that justification for removing the data from the process of calculating average or decile removals was not possible.

Table 8 presents the 24 influent and effluent nickel values that were used to determine individual daily removals (i.e., 27 influent and effluent sample pairs were excluded because the influent nickel level was 0). The 24 influent and effluent values are ordered on the daily removal values. The average daily removal based on the 24 daily removals is 61.6 percent; the mean removal value determined from the influent effluent data is 63.0 percent. (If

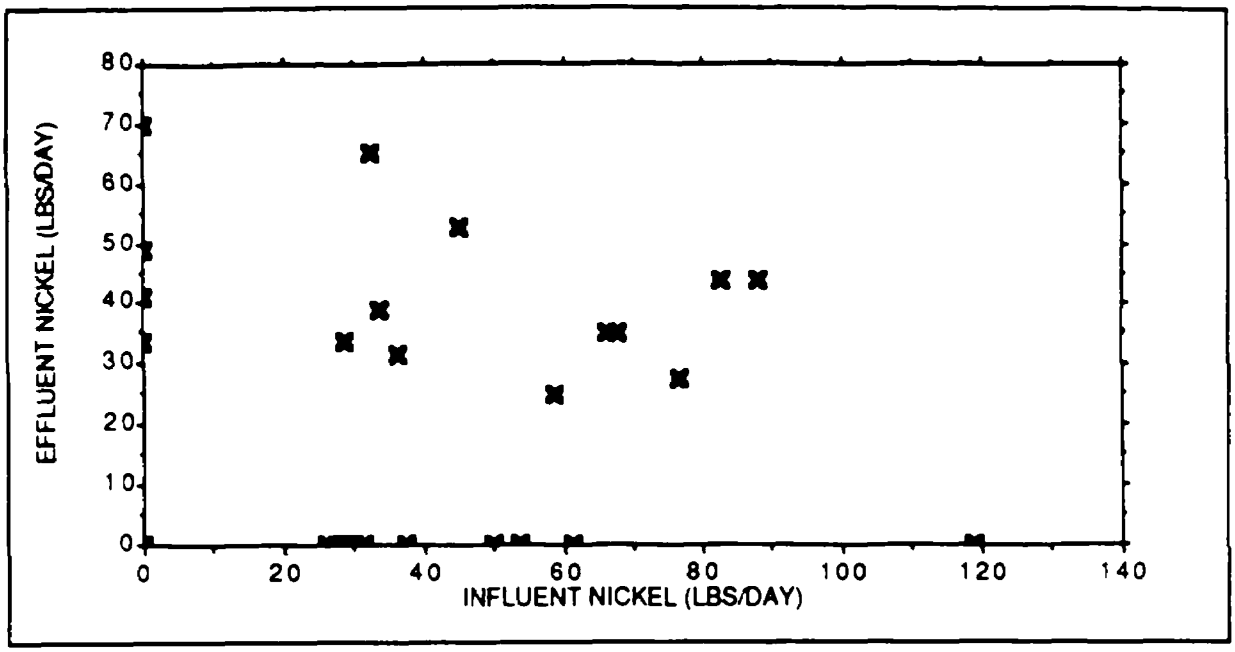

FIGURE 11. INFLUENT NICKEL vs. EFFLUENT NICKEL

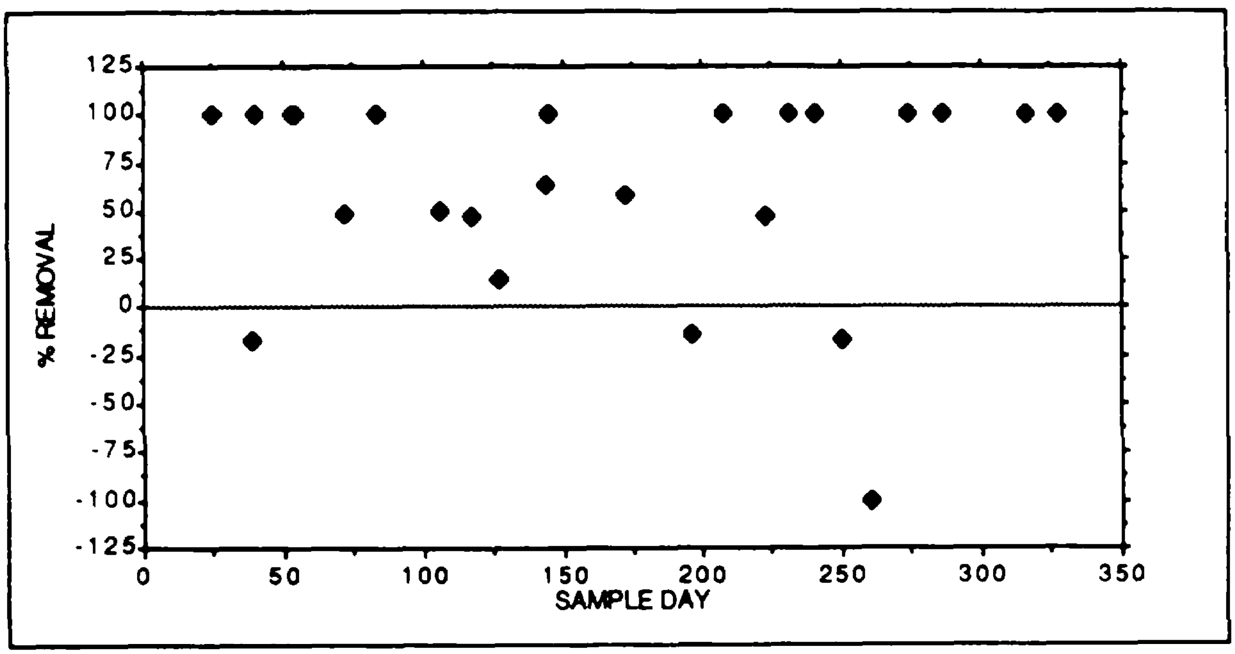

FIGURE 12. DAILY PERCENT REMOVALS FOR NICKEL

TABLE 8. NICKEL MASS VALUES (LBS/DAY) AND ORDERED REMOVALS

	POLLUTANT	MONTH	DAY	YEAR	INFLUENT--MASS	EFFLUENT--MASS	% REMOVAL
1	Ni	3	16	88	32.55	65.09	-100.00
2	Ni	8	8	87	28.79	33.80	-17.39
3	Ni	3	6	88	45.06	52.57	-16.67
4	Ni	1	12	88	33.80	38.80	-14.81
5	Ni	11	4	87	36.30	31.29	13.79
6	Ni	10	25	87	82.62	43.81	46.97
7	Ni	2	7	88	66.34	35.05	47.17
8	Ni	9	10	87	67.59	35.05	48.15
9	Ni	10	14	87	87.62	43.81	50.00
10	Ni	12	19	87	58.83	25.03	57.45
11	Ni	11	21	87	76.36	27.54	63.93
12	Ni	3	29	88	28.79	0	100.00
13	Ni	4	11	88	61.34	0	100.00
14	Ni	11	22	87	26.29	0	100.00
15	Ni	8	22	87	31.29	0	100.00
16	Ni	2	16	88	27.54	0	100.00
17	Ni	8	9	87	37.55	0	100.00
18	Ni	2	25	88	28.79	0	100.00
19	Ni	7	25	87	26.29	0	100.00
20	Ni	9	21	87	30.04	0	100.00
21	Ni	5	11	88	53.83	0	100.00
22	Ni	1	23	88	50.07	0	100.00
23	Ni	8	23	87	30.04	0	100.00
24	Ni	5	22	88	118.92	0	100.00

the 4 negative removals had been excluded from the data set, then the average daily removal, based on the remaining 20 influent and effluent nickel values, would have been 81.4 percent and the mean removal would have been 76.5 percent.)

The 24 ordered daily removals of Table 8 are used in the decile estimation worksheet presented in Table 9. (The entries for Column #1 are multiples of 2.5. Column #2 uses the whole numbers of Column #1. Columns #3 and #4 use the ordered removals from Table 8. Entries for Column #5 are obtained by subtracting Column #3 from Column #4. Column #6 is the decimal part of the entries in Column #1. Column #7 is produced by multiplying the entries of Columns #5 and #6. Finally, the estimated deciles are produced by adding the entries of Columns #3 and #7.) The nine estimated deciles for the nickel data are:

- 1st decile = -17.0 percent
- 2nd decile = 13.8 percent
- 3rd decile = 47.7 percent
- 4th decile = 57.5 percent
- 5th decile = 100 percent
- 6th decile = 100 percent
- 7th decile = 100 percent
- 8th decile = 100 percent
- 9th decile = 100 percent.

The average daily removal of 61.6 percent and the mean removal of 63.0 percent both lie between the fourth and fifth deciles. That is, based on the 24 daily removals, these average removal values are exceeded between 50 percent and 60 percent of the time.

2.5 OTHER DATA PROBLEMS

Some of the difficulties that can be encountered when examining sampling data used for removal efficiency calculations (e.g., extreme values for influent, effluent, or daily removal; or negative removals) were previously illustrated. In this section, two other data characteristics are discussed that may require special consideration in determining removal efficiency.

TABLE 9. DECILE ESTIMATION WORKSHEET FOR NICKEL DATA

DECILES	COL. #1 CALCULATE DECILE POSITION FOR ORDERED LIST OF REMOVALS*	COL. #2 WRITE THE WHOLE NUMBER GIVEN IN COL. #1	COL. #3 RECORD THE ORDERED REMOVAL FOR THE COL. #2 ENTRY**	COL. #4 RECORD THE ORDERED REMOVAL FOLLOWING THE COL. #3 ENTRY**	COL. #5 COL. #4 ENTRY MINUS COL. #3 ENTRY	COL. #6 LIST THE DECIMAL IN COL. #1	COL. #7 MULTIPLY COL. #5 ENTRY BY COL. #6 ENTRY	COL. #8 ADD COL. #3 AND COL. #7 ENTRIES ESTIMATED DECILES
1st	2.5	2	-17.39	-16.67	.72	.5	.36	-17.03
2nd	5.0	5	13.79	46.97	33.18	0	0	13.79
3rd	7.5	7	47.17	48.15	.98	.5	.49	47.66
4th	10.0	10	57.45	63.93	6.48	0	0	57.45
5th	12.5	12	100.	100	0	.5	0	100
6th	15.0	15	100	100	0	0	0	100
7th	17.5	17	100	100	0	.5	0	100
8th	20.0	20	100	100	0	0	0	100
9th	22.5	22	100	100	0	.5	0	100

*Numbers in column defined as multiples of (N+1)/10, where N = the number of data pairs used.[i.e. (51+1/10 5.2), (2x5.2=10.4) etc.]
**Uses the list of ordered removals.

2.5.1 REMARKED DATA

Sometimes influent and effluent concentration values are not reported quantitatively. For example, some sample values may be reported as Not Detected (ND), or Below Detection Limit (BDL), or less than some specified value. These types of values can occur for either influent or effluent samples. For example, assume that the following influent effluent sample values were obtained:

SAMPLE DAY	INFLUENT LEVEL (mg/l)	EFFLUENT LEVEL (mg/l)	DAILY REMOVAL EFFICIENCY(%)
1	100	40	60
2	200	ND	?
3	240	60	80

The remarked data values result from limitations in the analytical methodology used for the chemical analysis. How should such data be dealt with? A common approach applied to remarked data is to substitute a specific quantity for it. For example, suppose that some effluent samples were reported as ND and the analytical method that was used has a detection limit of 10 mg/l. A substitute value of 10 mg/l for each ND might be provided and then any calculations using that data value performed. Variations on this approach are to substitute half the detection limit (e.g, 10 x .5 = 5 mg/l), or even 0 for the not detected value. For the above example, substituting 10 mg/l, 5 mg/l, and 0 mg/l for the ND value would result in comparable daily removals of 95 percent, 97.5 percent, and 100 percent, respectively. However, if the influent concentration value associated with the effluent concentration value of ND were smaller, say 40 mg/l (instead of the 200 mg/l), then substituting 10 mg/l, 5 mg/l, and 0 mg/l for the ND would result in daily removals of 75 percent, 87.5 percent, and 100 percent, respectively. These latter removals demonstrate that the daily removals can be affected by the choice of value that is substituted. When replacing remarked data with quantitative values, it is important to determine whether the various substitute values produce substantially different mean or decile removals. The most obvious way to determine this is to perform the necessary calculations using the different substituted values and then to compare the final results.

2.5.2 SEASONALITY

Seasonal treatment performance variability can be monitored using the time plots of influent, effluent, and daily removal values. Variations in the removal efficiencies that can be traced to seasonal patterns may suggest that average or decile removal efficiencies for specific time periods be determined or that treatment performance be improved for specific time periods.

2.6 NONCONSERVATIVE POLLUTANTS

In the 1987 local limits guidance, a distinction is drawn between conservative pollutants, which are not degraded or volatilized within the unit processes of a treatment plant and nonconservative pollutants, which are, to some degree, biologically/chemically transformed and/or volatilized by wastewater aeration/turbulence within the POTW's unit processes. Conservative pollutants exit the POTW solely through the POTW's effluent and sludge streams, whereas nonconservative pollutants are also destroyed by chemical reaction (e.g., microbially mediated oxidation) and/or undergo a phase transformation from wastewater to ambient air.

Removal efficiencies considered to this point have been solely for conservative pollutants, such as metals. Conservative pollutant removal efficiencies are determined by pollutant concentrations in the POTW influent and effluent streams. The presumption applied to conservative pollu tants, that removal pollutants are exclusively transferred to the POTW's sludge streams, cannot be extended to nonconservative pollutants. Losses through degradation and volatilization do not contribute to pollutant loadings in sludge. As a consequence, nonconservative pollutant removal efficiencies cannot be used in deriving allowable headworks loadings from criteria/ standards applicable to the POTW's sludge streams* (e.g., digester inhibition data, sludge disposal criteria/standards). An alternative procedure should be used.

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* Removal efficiencies for nonconservative pollutants <u>can</u> be used to calculate allowable headworks loadings based on <u>pass through criteria</u> (e.g., biological process inhibition data, NPDES permit limits, and water quality standards). The removal efficiency guidance provided in this document can be directly applied to nonconservative pollutant removal efficiencies obtained for this purpose.

The 1987 local limits guidance provides the following equation for deriving nonconservative pollutant allowable headworks loadings from sludge-based criteria/standards:

$$L_{IN} = L_{INF} \times \frac{C_{CRIT}}{C_{SLDG}}$$

or

$$L_{IN} = \frac{C_{CRIT}}{C_{SLDG}/L_{INF}}$$

where:

L_{IN} = Allowable headworks loading, lbs/day

L_{INF} = POTW influent loading, lbs/day

C_{CRIT} = Sludge criterion/standard, mg/l

C_{SLDG} = Pollutant level in sludge, mg/l.

In the above expression, the factor C_{SLDG}/L_{INF} is a partitioning factor relating the pollutant level in the POTW sludge (C_{SLDG}) to the headworks loading of the pollutant (L_{INF}). The partitioning factor enables calculation of an allowable headworks loading (L_{IN}) from a sludge criterion/standard (C_{CRIT}) for a nonconservative pollutant. To determine the partitioning factor for a particular pollutant, the POTW's influent and sludge must be routinely monitored for that pollutant.

It is important to recognize that the factor C_{SLDG}/L_{INF} expresses nonconservative pollutant removals to sludge. Nonconservative pollutant removals to sludge are highly variable, and are dependent on such factors as wastewater temperature, ambient air temperature, biodegradation rates (which are temperature dependent), aeration rates, and POTW influent flow. Since nonconservative pollutant removals to sludge are highly variable, the resulting variability in nonconservative pollutant sludge partitioning factors should be addressed as part of the local limits development process.

The procedures and recommendations provided in this manual for addressing removal efficiency variability for conservative pollutants (e.g., the calculation of mean removals and the decile approach) can be extended without modification to addressing variability in nonconservative pollutant sludge partitioning factors. In calculating sludge quality headworks loadings (see Section 2.4), the sludge partitioning factor should be used in place of the removal efficiency for nonconservative pollutants. This sludge partitioning factor can be entered into .

2.7 SUMMARY REMARKS

In this document the following three methods for removal efficiency estimation have been defined and illustrated:

- Average daily removal efficiency
- Mean removal efficiency
- Decile approach.

The first two methods provide single point estimates of POTW removal efficiency. The average daily removal is simply the average over available daily removal efficiencies derived from paired influent and effluent wastewater samples. The mean removal efficiency is the sum of effluent loadings divided by the sum of the influent loadings. The mean removal efficiency weights influent/effluent pairs with a higher flow more than influent/effluent pairs with a lower flow.

In general, these two methods of estimating removal efficiencies yield different results. Of the two, the mean removal efficiency is preferred because it is less sensitive to extreme daily removal efficiencies.

The decile approach is more comprehensive than the first two methods because it yields an estimate of the entire frequency distribution of daily removal efficiencies. Using the decile approach permits the explicit incorporation of the variability of daily removal efficiencies into the local limits development process. Actual removal efficiencies derived from actual paired influent and effluent wastewater sampling data demonstrate that daily removal efficiencies are not constant over time. Daily removal efficiencies demonstrate considerable variability; a single value approach to estimation of removal efficiency can only provide an individual measure of the actual process.

Computationally, the decile approach is more data intensive than both of the other two methods. For example, the decile approach requires a minimum of nine daily removal efficiencies; whereas the other two methods can be applied to less data. From the standpoint of statistical precision (difference between the estimated removal efficiency and the unknown true value), the mean removal efficiency is the most precise. Decile approach estimates can be less precise than either of the mean value estimates. These statements regarding statistical precision apply to the respective estimates derived from the same number of daily removal efficiencies.

In cases for which removal efficiencies are consistently large (e.g., greater than 80 percent) or are consistently small (e.g., less than 20 percent), the acceptable statistical precision can be obtained with a small number of daily removal efficiency values. Even in these instances, no less than five daily removal efficiency values should be applied. The data set size should, however, be increased to a larger number whenever the daily removal efficiencies exhibit more variation. In most cases, more than the minimum number of daily values should be used in the estimation process.

APPENDIX A

ADDITIONAL RESIDENTIAL/COMMERCIAL DATA

A.1 RESIDENTIAL/COMMERCIAL TRUNK LINE MONITORING DATA

CITY	STATE	REGION	COMBINED TOTAL DOMESTIC FLOW (MGD)	DOMESTIC CONTRIBUTION (%)	NUMBER OF DETECTIONS	NUMBER OF OBSERVATIONS	AVERAGE POLLUTANT LEVEL (MG/L)	MINIMUM POLLUTANT LEVEL (MG/L)	MAXIMUM POLLUTANT LEVEL (MG/L)	MEDIAN POLLUTANT LEVEL (MG/L)
PORTLAND	ME	1	11.6	94						
ZINC					38	38	0 0940	0.063	0.273	0.082
COPPER					38	38	0.0880	0 036	0.29	0 077
LEAD					38	38	0.0360	0 001	0.275	0 014
SILVER					38	38	0.0230	0 001	0.078	0.0175
CHROMIUM (T)					38	38	0.0180	0 001	0.218	0.007
NICKEL					38	38	0.0080	0.001	0.124	0.003
CADMIUM					38	38	0.0020	0 001	0.01	0.001
WARWICK	RI	1								
ZINC					2	2	0.1380	0.128	0.144	0 136
COPPER					2	2	0 1000	0.09	0 11	0.1
NICKEL					2	2	0.0800	0.06	0 07	0.08
CADMIUM					1	2	0.0080	<0.006	0.011	0.008
BUFFALO	NY	2	180							
TOTAL PHOSPHORUS					1	1	0.7000	0 7	0 7	0 7
ZINC					5	6	0 0811	0 06	0 1675	0.078
COPPER					5	6	0 0807	0 03	0 08	0.0736
LEAD					6	6	0 0474	0 0078	0.1	0.01
NICKEL					6	6	0.0436	0 0016	0.1	0 01
1,2,4-TRICHLOROBENZENE					1	3	0.0130	<0 002	0.036	<0.002
CHROMIUM (T)					4	6	0.0098	0 0045	0.02	0.01
BIS(2-ETHYLHEXYL)PHTHALATE					5	5	0.0085	0 00002	0 022	0.006
CADMIUM					4	4	0 0063	0 0008	0 01	0 0063
SILVER					4	4	0 0062	0 0002	0 01	0 0062
CHLOROFORM					4	4	0 0022	0 00001	0 004	0.0024
TOTAL ENDOSULFAN					3	3	0 0020	0 002	0 002	0 002
TOTAL BHC					3	3	0 0010	0 001	0.001	0 001
FLUORANTHENE					2	6	0 0008	0 00001	<0 001	<0 001
4,4'-DDD					3	3	0.0003	0.00026	0.0004	0.00026
PYRENE					2	3	0 0002	0 00001	<0 0006	0 00001
PHENOLS					2	2	0.00003	0 00002	0.00003	0.000025
METHYLENE CHLORIDE					3	3	0.00001	0 000008	0 00002	0.00001
TETRACHLOROETHENE					2	2	0.00001	0 00001	0 00001	0 00001

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CITY	STATE	REGION	COMBINED TOTAL DOMESTIC FLOW (MGD)	DOMESTIC CONTRIBUTION (%)	NUMBER OF DETECTIONS	NUMBER OF OBSERVATIONS	AVERAGE POLLUTANT LEVEL (MG/L)	MINIMUM POLLUTANT LEVEL (MG/L)	MAXIMUM POLLUTANT LEVEL (MG/L)	MEDIAN POLLUTANT LEVEL (MG/L)
ALLENTOWN	PA	3	33	87						
COPPER					42	42	0.0882	0.032	0.2	0.08
ZINC					42	42	0.0828	0.01	0.831	0.088
LEAD					7	42	0.0308	<0.026	0.12	<0.026
CHROMIUM (T)					42	42	0.0278	0.01	0.073	0.0246
NICKEL					14	42	0.0081	<0.007	0.02	<0.007
HAMPTON ROADS	VA	3								
ZINC					75	75	0.3144	0.18	1.28	0.28
COPPER					42	42	0.1460	0.06	0.37	0.13
LEAD					28	28	0.0215	0.0063	0.080	0.0186
CADMIUM					61	60	0.0028	0.00078	0.018	0.00236
ROCKFORD	IL	5								
IRON					10	10	0.8800	0.3	3.4	0.86
ZINC					10	10	0.3300	0.1	0.8	0.3
COPPER					10	10	0.1600	0.1	0.4	0.1
LEAD					10	10	0.1000	0.1	0.1	0.1
NICKEL					1	1	0.1000	0.1	0.1	0.1
INDIANAPOLIS	IN	5								
ZINC					12	12	0.1308	0.04	0.27	0.125
CYANIDE					7	7	0.1067	0.01	0.37	0.06
COPPER					12	12	0.0758	0.01	0.118	0.085
NICKEL					8	8	0.0186	0.007	0.041	0.0186
LEAD					10	10	0.0188	0.007	0.04	0.0166
CHROMIUM (T)					8	8	0.0117	0.006	0.022	0.008
CADMIUM					2	2	0.0015	0.001	0.002	0.0015
SILVER					6	6	0.0014	0.001	0.0022	0.0013
MERCURY					2	2	0.0003	0.0003	0.0003	0.0003

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CITY	STATE	REGION	COMBINED TOTAL DOMESTIC FLOW (MGD)	DOMESTIC CONTRIBUTION (%)	NUMBER OF DETECTIONS	NUMBER OF OBSERVATIONS	AVERAGE POLLUTANT LEVEL (MG/L)	MINIMUM POLLUTANT LEVEL (MG/L)	MAXIMUM POLLUTANT LEVEL (MG/L)	MEDIAN POLLUTANT LEVEL (MG/L)
HOLLAND	MI	5	1.3	38						
ZINC					39	39	0.1046	0.048	0.378	0.182
COPPER					39	39	0.0879	0.011	0.242	0.072
NICKEL					33	40	0.0086	<0.001	0.046	0.0086
LEAD					23	38	0.0040	<0.001	0.023	0.0036
CHROMIUM (T)					21	39	0.0040	<0.001	0.040	0.002
CADMIUM					21	38	0.0024	<0.001	0.007	0.002
MILWAUKEE	WI	5	0.81							
ZINC					140	140	0.2286	0.08	0.78	0.2
LEAD					91	140	0.2136	<0.1	0.57	0.18
COPPER					139	140	0.1483	<0.006	0.81	0.12
NICKEL					12	140	0.0619	<0.06	0.12	<0.06
CHROMIUM (T)					7	140	0.0617	0.06	0.14	<0.06
CADMIUM					60	140	0.0084	<0.006	0.04	<0.006
GREELEY	CO	8								
ZINC					3	3	0.0730	0.049	0.09	0.08
LEAD					1	3	0.0703	<0.006	<0.2	0.008
NICKEL					1	3	0.0603	<0.02	0.081	<0.06
COPPER					3	3	0.0420	0.02	0.07	0.038
CHROMIUM (T)					1	3	0.0180	0.002	<0.06	<0.006
CADMIUM					1	3	0.0041	<0.001	<0.01	0.0012
MERCURY					1	2	0.0021	0.0002	<0.004	0.0021
IRON					1	1	0.0002	0.0002	0.0002	0.0002
LOUISVILLE	CO	8	1.2	90						
IRON					2	2	1.8600	1.6	2.4	1.86
NICKEL					2	2	0.7000	0.64	0.78	0.7
ZINC					2	2	0.7000	0.62	0.88	0.7
COPPER					2	2	0.4800	0.22	0.74	0.48
BORON					2	2	0.2000	0.1	0.3	0.2
MANGANESE					2	2	0.1100	0.08	0.18	0.11
MERCURY					1	2	0.0271	<0.0001	0.054	0.0271
SILVER					2	2	0.0176	0.008	0.028	0.0176
LEAD					2	2	0.0166	0.014	0.017	0.0156

A.1 RESIDENTIAL/COMMERCIAL TRUNK LINE MONITORING DATA

CITY	STATE	REGION	COMBINED TOTAL DOMESTIC FLOW (MGD)	DOMESTIC CONTRIBUTION (%)	NUMBER OF DETECTIONS	NUMBER OF OBSERVATIONS	AVERAGE POLLUTANT LEVEL (MG/L)	MINIMUM POLLUTANT LEVEL (MG/L)	MAXIMUM POLLUTANT LEVEL (MG/L)	MEDIAN POLLUTANT LEVEL (MG/L)
CHROMIUM (T)					2	2	0.0075	0.007	0.008	0.0075
CHROMIUM (III)					1	2	0.0080	<0.006	0.007	0.008
CADMIUM					2	2	0.0040	0.001	0.007	0.004
ARSENIC					1	2	0.0040	0.003	<0.005	0.004
SELENIUM					2	2	0.0035	0.002	0.005	0.0035
LOS ANGELES	CA	9	72.3	84						
PHOSPHATE					2	2	28.8000	27.4	30.2	28.8
IRON					2	2	0.4100	0.08	0.74	0.41
BORON					2	2	0.4000	0.38	0.42	0.4
FLUORIDE					2	2	0.2550	0.24	0.27	0.255
ZINC					2	2	0.0800	0.06	0.11	0.08
BARIUM					2	2	0.0650	0.04	0.09	0.065
COPPER					1	1	0.0620	0.062	0.062	0.062
MANGANESE					1	1	0.0400	0.04	0.04	0.04
LITHIUM					2	2	0.0305	0.03	0.031	0.0305
PHENOLS					1	1	0.0280	0.028	0.028	0.028
SAN FRANCISCO	CA	9	83	60						
ZINC					242	242	0.2294	0.015	1.159	0.18
LEAD					282	288	0.1304	0.005	2.04	0.075
COPPER					244	245	0.0828	0.01	0.55	0.07
NICKEL					187	233	0.0816	0.003	1.6	0.06
CHROMIUM (T)					184	218	0.0372	<0.0014	1.2	0.02
SILVER					134	177	0.0182	<0.0007	1.062	0.007
CADMIUM					181	228	0.0127	<0.005	0.11	0.0085
ARSENIC					139	203	0.0089	0.0004	0.088	0.003
MERCURY					214	229	0.0017	0.0001	0.038	0.0008
ORANGE COUNTY	CA	9								
AMMONIA					27	27	43.1111	7	114	38
COPPER					23	26	0.0732	0.03	0.15	0.07
ZINC					23	26	0.0724	<0.01	0.28	0.04
LEAD					17	26	0.0307	<0.001	0.09	0.02
METHYLENE CHLORIDE					4	27	0.0303	0.011	0.065	0.0275
1,1-DICHLOROETHANE					1	28	0.0280	0.028	0.028	0.028
TETRACHLOROETHENE					3	27	0.0153	0.004	0.037	0.006
NICKEL					11	26	0.0153	<0.008	0.06	<0.008

A.1 RESIDENTIAL/COMMERCIAL TRUNK LINE MONITORING DATA

CITY	STATE	REGION	COMBINED TOTAL DOMESTIC FLOW (MGD)	DOMESTIC CONTRIBUTION (%)	NUMBER OF DETECTIONS	NUMBER OF OBSERVATIONS	AVERAGE POLLUTANT LEVEL (MG/L)	MINIMUM POLLUTANT LEVEL (MG/L)	MAXIMUM POLLUTANT LEVEL (MG/L)	MEDIAN POLLUTANT LEVEL (MG/L)
TRANS-1,2-DICHLOROETHENE					1	28	0.0130	0.013	0.013	0.013
CHLOROFORM					17	26	0.0100	<0.002	0.089	0.004
1,1-DICHLOROETHENE					2	29	0.0066	0.006	0.008	0.0066
CHROMIUM (T)					4	26	0.0040	<0.002	0.01	<0.002
CADMIUM					2	26	0.0036	<0.003	0.01	<0.003
UNIFIED SEWER AUTHORITY	OR	10								
IRON					3	3	1.0967	0.8	1.49	1.2
BARIUM					1	1	0.2160	0.216	0.216	0.216
ZINC					3	3	0.0682	0.036	0.086	0.0366
COPPER					3	3	0.0366	0.018	0.0687	0.022
LEAD					1	3	0.0316	0.0166	<0.04	<0.04
CHROMIUM (T)					1	3	0.0070	<0.006	0.008	<0.006
NICKEL					1	3	0.0088	0.0036	<0.006	<0.006

A.2 COMMERCIAL SOURCE WASTEWATER MONITORING DATA

SOURCE/CITY	STATE	REGION	TOTAL SOURCE FLOW (GPD)	NUMBER OF SOURCES	NUMBER OF DETECTIONS	NUMBER OF OBSERVATIONS	AVERAGE POLLUTANT LEVEL (MG/L)	MINIMUM POLLUTANT LEVEL (MG/L)	MAXIMUM POLLUTANT LEVEL (MG/L)	MEDIAN POLLUTANT LEVEL (MG/L)
HOSPITALS										
BANGOR	ME	1	184000	2						
SILVER					7	17	0.0863	<0.03	0.17	<0.06
CHROMIUM (T)					3	17	0.0718	<0.06	0.39	<0.06
LEAD					4	18	0.0441	<0.001	0.1	<0.06
CADMIUM					3	17	0.0066	<0.001	0.02	<0.01
ALLENTOWN	PA	3		1						
COPPER					5	5	0.0880	0.07	0.09	0.08
ZINC					4	5	0.0680	<0.001	0.18	0.03
CHROMIUM (T)					5	5	0.0200	0.02	0.02	0.02
NICKEL					3	5	0.0106	<0.007	0.02	0.01
ALTOONA	PA	3	172000	3						
PHOSPHATE					6	6	6.4167	0.5	9.7	6.66
HAMPTON ROADS	VA	3		17						
COD					10	10	399.1000	20	697	484
LEAD					42	64	2.4220	0.06	34	0.16
COPPER					40	61	0.8426	<0.02	10.6	0.14
ZINC					146	148	0.8974	<0.01	8.4	0.4
CHROMIUM (T)					22	62	0.1929	<0.06	1.58	<0.06
NICKEL					21	67	0.0998	0.012	0.88	<0.04
SILVER					263	480	0.0901	<0.01	4.9	<0.06
CADMIUM					28	61	0.0389	<0.006	0.066	0.007
LOUISVILLE	KY	4	743000	6						
IRON					82	82	2.2494	0.22	36.1	1.08
BARIUM					67	82	1.7787	0.086	17.6	0.834
ZINC					82	82	0.2806	0.078	1.5	0.1975
PHENOLS					3	3	0.2443	0.169	0.381	0.204
COPPER					82	82	0.2186	0.036	1.62	0.141
SILVER					59	82	0.1880	0.001	2.24	0.09
CHROMIUM (T)					80	82	0.0880	0.004	2.5	0.013
LEAD					48	82	0.0636	<0.03	0.83	0.04
NICKEL					52	82	0.0306	0.0081	0.86	0.02
SELENIUM					40	82	0.0117	0.0027	0.02	0.01
ARSENIC					36	82	0.0072	0.003	0.06	0.006
CADMIUM					45	82	0.0040	<0.002	0.014	0.003
MERCURY					63	82	0.0017	<0.0002	0.022	0.0008

A.2 COMMERCIAL SOURCE WASTEWATER MONITORING DATA

SOURCE/CITY	STATE	REGION	TOTAL SOURCE FLOW (GPD)	NUMBER OF SOURCES	NUMBER OF DETECTIONS	NUMBER OF OBSERVATIONS	AVERAGE POLLUTANT LEVEL (MG/L)	MINIMUM POLLUTANT LEVEL (MG/L)	MAXIMUM POLLUTANT LEVEL (MG/L)	MEDIAN POLLUTANT LEVEL (MG/L)
NORTH CHARLESTON	SC	4	8000	2						
FORMALDEHYDE					19	36	0.5800	<0.10	1.4	0.38
PHENOL					36	36	0.1366	0.026	0.898	0.108
SILVER					15	36	0.0989	<0.03	1.17	<0.06
BATON ROUGE	LA	6	20000	11						
TDS					12	12	426.5833	331	580	407
COD					86	86	340.6302	20	1346	284
PHOSPHATE					10	10	3.2840	1.60	6.8	3.3
SURFACTANTS					11	11	1.7800	0.62	4.8	1.8
FLUORIDE					9	9	0.6367	0.08	2.7	0.17
ZINC					11	11	0.5367	0.03	4.86	0.13
PHENOL					71	84	0.2267	0.001	1.3	0.16
COPPER					10	11	0.1300	0.02	0.98	0.06
SILVER					20	28	0.0786	0.002	0.602	0.033
ARSENIC					29	36	0.0806	0.001	0.502	0.01
LEAD					36	41	0.0638	0.001	0.502	0.01
NICKEL					7	8	0.0280	0.006	0.1	0.0086
ANTIMONY					1	6	0.0184	0.001	0.04	0.02
CHROMIUM (T)					5	9	0.0181	0.003	0.064	0.007
SELENIUM					2	4	0.0100	0.006	0.02	0.01
MERCURY					3	7	0.0018	0.001	0.002	0.002

A.2 COMMERCIAL SOURCE WASTEWATER MONITORING DATA

SOURCE/CITY	STATE	REGION	TOTAL SOURCE FLOW (GPD)	NUMBER OF SOURCES	NUMBER OF DETECTIONS	NUMBER OF OBSERVATIONS	AVERAGE POLLUTANT LEVEL (MG/L)	MINIMUM POLLUTANT LEVEL (MG/L)	MAXIMUM POLLUTANT LEVEL (MG/L)	MEDIAN POLLUTANT LEVEL (MG/L)
RADIATOR SHOPS										
ONONDAGA COUNTY	NY	2		1						
ZINC					1	1	668.0000	668	668	668
COPPER					1	1	8.6300	8.63	8.63	8.63
LEAD					1	1	3.3100	3.31	3.31	3.31
IRON					1	1	1.7400	1.74	1.74	1.74
CADMIUM					1	1	1.3000	1.3	1.3	1.3
MANGANESE					1	1	1.2300	1.23	1.23	1.23
ALUMINUM					1	1	1.1300	1.13	1.13	1.13
NICKEL					1	1	0.1130	0.113	0.113	0.113
CHROMIUM (T)					1	1	0.0270	0.027	0.027	0.027
HAMPTON ROADS	VA	3		12						
COPPER					462	462	7.8615486726	0.03	183	6.22
CHROMIUM					84	118	0.1431368802	0.06	3.33	0.06
ZINC					446	462	8.2827433628	0.02	888	2.08
LEAD					424	462	15.6872123884	0.08	2280	3.4
NICKEL					88	118	0.1638440678	0.03	3.29	0.076
CADMIUM					106	116	0.0274434783	0.006	0.418	0.018
WSSC		3	4100	4						
LEAD					4	4	78.7000	10.8	224	42.1
ZINC					4	4	22.1000	1.8	38.3	23.75
COPPER					4	4	4.8875	0.81	11.7	3.67
CHICAGO	IL	5		5						
ZINC					18	20	188.2360	<0.2	1720	103
IRON					20	20	87.6860	0.1	770	10.15
COPPER					18	20	29.4236	0.06	386	1.348
LEAD					17	20	18.4730	0.02	126	0.58
NICKEL					8	20	0.3306	0.01	1.4	<0.2
CHROMIUM (T)					16	20	0.1356	0.01	0.86	0.04
CADMIUM					17	20	0.1180	0.01	0.52	0.04
CYANIDE					11	11	0.0302	0.014	0.098	0.022
MERCURY					11	20	0.0003	0.0001	0.0012	<0.0003
BATON ROUGE	LA	6		2						
COD					2	3	7.6667	<3.7	11.3	8
LEAD					4	4	1.9686	0.17	7.06	0.303
ZINC					1	1	0.4800	0.48	0.48	0.48
COPPER					2	2	0.0896	0.049	0.13	0.0896

A.2 COMMERCIAL SOURCE WASTEWATER MONITORING DATA

SOURCE/CITY	STATE	REGION	TOTAL SOURCE FLOW (GPD)	NUMBER OF SOURCES	NUMBER OF DETECTIONS	NUMBER OF OBSERVATIONS	AVERAGE POLLUTANT LEVEL (MG/L)	MINIMUM POLLUTANT LEVEL (MG/L)	MAXIMUM POLLUTANT LEVEL (MG/L)	MEDIAN POLLUTANT LEVEL (MG/L)
FORT DODGE	IA	7	3000	3						
LEAD					20	20	133.1180	0.09	1180	3.2
ZINC					19	20	82.7380	<0.02	612	39
COPPER					20	20	21.8360	0.12	189	0.94
SAN FRANCISCO	CA	9	3791	6						
ZINC					6	6	217.1636	3.2080	831.3280	36.608
LEAD					6	6	83.1148	1.6800	326.6640	30.0067
COPPER					6	6	20.2774	2.1213	87.0000	28.8681
NICKEL					6	6	0.2140	0.0680	0.3330	0.251
CADMIUM					6	6	0.1347	0.0100	0.3310	0.043
CHROMIUM (T)					6	6	0.1183	0.0180	0.4270	0.040
SILVER					6	6	0.0230	0.0110	0.0440	0.024
ARSENIC					6	6	0.0120	0.0018	0.0361	0.0086
MERCURY					6	6	0.0006	0.0003	0.0011	0.0006

A.2 COMMERCIAL SOURCE WASTEWATER MONITORING DATA

SOURCE/CITY	STATE	REGION	TOTAL SOURCE FLOW (GPD)	NUMBER OF SOURCES	NUMBER OF DETECTIONS	NUMBER OF OBSERVATIONS	AVERAGE POLLUTANT LEVEL (MG/L)	MINIMUM POLLUTANT LEVEL (MG/L)	MAXIMUM POLLUTANT LEVEL (MG/L)	MEDIAN POLLUTANT LEVEL (MG/L)
CAR WASHES										
PORTLAND	ME	1	20800	7						
ZINC					31	31	0.6314	0.13	3	0.48
LEAD					26	32	0.1087	0.002	0.99	0.0795
COPPER					23	27	0.1403	0.04	0.3	0.122
NICKEL					17	28	0.0813	0.02	0.26	0.073
CHROMIUM (T)					14	26	0.0826	<0.02	0.24	<0.05
SILVER					3	12	0.0179	<0.001	<0.05	0.01
CADMIUM					21	33	0.0167	<0.002	0.07	<0.01
MERRIMACK	NH	1	3750	3						
COD					3	3	128.3333	34	260	96
COPPER					2	2	0.2150	0.04	0.39	0.215
ZINC					2	2	0.0980	0.076	0.12	0.098
LEAD					1	2	0.0650	<0.05	0.08	0.065
ALLENTOWN	PA	3		1						
ZINC					4	4	0.0650	0.02	0.13	0.055
COPPER					4	4	0.0325	0.03	0.04	0.03
CHROMIUM (T)					4	4	0.0175	0.01	0.02	0.02
NICKEL					3	4	0.0083	<0.007	0.01	0.01

A.2 COMMERCIAL SOURCE WASTEWATER MONITORING DATA

SOURCE/CITY	STATE	REGION	TOTAL SOURCE FLOW (GPD)	NUMBER OF SOURCES	NUMBER OF DETECTIONS	NUMBER OF OBSERVATIONS	AVERAGE POLLUTANT LEVEL (MG/L)	MINIMUM POLLUTANT LEVEL (MG/L)	MAXIMUM POLLUTANT LEVEL (MG/L)	MEDIAN POLLUTANT LEVEL (MG/L)
TRUCK CLEANERS										
HAMPTON ROADS	VA	3		1						
COD					37	37	81114.3243	480	1766000	3840
ALUMINUM					4	4	7.7000	4.8	13.1	8.46
ZINC					63	63	6.4386	0.08	80.88	2.07
PHENOL					56	56	2.1108	0.04	82	0.48
LEAD					34	57	0.4780	<0.05	8.4	0.12
COPPER					52	54	0.2888	<0.02	1.04	0.14
NICKEL					36	48	0.1722	<0.03	1.06	0.1
CHROMIUM (T)					22	51	0.1236	<0.02	0.98	<0.05
CADMIUM					43	46	0.0321	<0.005	0.427	0.013
BATON ROUGE	LA	6	7000	6						
TDS					5	5	3384.0000	381.000	11700.000	1846.000
COD					28	28	1418.8308	36.300	4740.000	1216.500
CYANIDE					5	9	56.5688	0.005	260.000	0.010
PHOSPHATE					5	5	7.8600	0.080	34.200	2.000
PHENOL					23	28	1.4308	0.005	8.000	0.170
ZINC					20	20	1.2000	0.130	8.800	0.465
NICKEL					18	19	0.1888	0.010	0.940	0.075
COPPER					20	20	0.1808	0.007	1.800	0.080
SILVER					6	24	0.1138	0.001	2.400	0.005
CHROMIUM (T)					24	28	0.1128	0.004	0.870	0.060
LEAD					22	28	0.1033	0.005	0.980	0.036
ANTIMONY					8	17	0.0800	0.010	0.840	0.080
ARSENIC					8	23	0.0882	0.002	0.860	0.010
THALLIUM					2	14	0.0418	0.005	0.130	0.023
CADMIUM					18	25	0.0186	0.001	0.230	0.010
BERYLLIUM					1	15	0.0131	0.001	0.100	0.002
SELENIUM					5	22	0.0124	0.001	0.060	0.010

A.2 COMMERCIAL SOURCE WASTEWATER MONITORING DATA

SOURCE/CITY	STATE	REGION	TOTAL SOURCE FLOW (GPD)	NUMBER OF SOURCES	NUMBER OF DETECTIONS	NUMBER OF OBSERVATIONS	AVERAGE POLLUTANT LEVEL (MG/L)	MINIMUM POLLUTANT LEVEL (MG/L)	MAXIMUM POLLUTANT LEVEL (MG/L)	MEDIAN POLLUTANT LEVEL (MG/L)
DRY CLEANERS										
MERRIMACK	NH	1	660	2						
BUTYL CELLOSOLVE					1	1	1.3000	1.3	1.3	1.3
N-BUTYL BENZENESULFONAMIDE					1	1	1.2000	1.2	1.2	1.2
2-(2-BUTOXYETHOXY) ETHANOL					1	1	0.6800	0.68	0.68	0.68
BIS(2-ETHYLHEXYL) PHTHALATE					1	1	0.3700	0.37	0.37	0.37
DI-N-OCTYL PHTHALATE					1	1	0.0420	0.042	0.042	0.042
STYRENE					1	1	0.0200	0.02	0.02	0.02
TOLUENE					1	1	0.0160	0.016	0.016	0.016
ALLENTOWN	PA	3		1						
ZINC					5	5	0.1740	0.07	0.26	0.17
COPPER					5	5	0.0860	0.05	0.12	0.08
LEAD					2	5	0.0270	<0.025	0.03	<0.025
CHROMIUM (T)					5	5	0.0220	0.02	0.03	0.02
NICKEL					3	5	0.0090	<0.007	0.01	0.01
COBALT					1	5	0.0044	<0.003	0.01	<0.003
BATON ROUGE	LA	6	64000	28						
TDS					1	1	626.0000	626	626	626
COD					82	87	316.5647	1	3866	160
PHOSPHATE					30	31	26.7190	0.1	297	1
IRON					1	1	0.6100	0.61	0.61	0.61
PHENOL					8	8	0.1170	0.008	0.53	0.0625
LEAD					1	2	0.0460	<0.04	0.06	0.046
CADMIUM					1	2	0.0080	0.006	<0.01	0.008

A.2 COMMERCIAL SOURCE WASTEWATER MONITORING DATA

SOURCE/CITY	STATE	REGION	TOTAL SOURCE FLOW (GPD)	NUMBER OF SOURCES	NUMBER OF DETECTIONS	NUMBER OF OBSERVATIONS	AVERAGE POLLUTANT LEVEL (MG/L)	MINIMUM POLLUTANT LEVEL (MG/L)	MAXIMUM POLLUTANT LEVEL (MG/L)	MEDIAN POLLUTANT LEVEL (MG/L)
LAUNDRIES										
BANGOR	ME	1	16000	1						
ZINC					6	6	1.3740	0.77	2.2	1.3
LEAD					6	6	0.4100	0.26	0.88	0.38
BIS(2-ETHYLHEXYL)PHTHALATE					1	1	0.3600	0.36	0.36	0.36
COPPER					6	6	0.3380	0.2	0.62	0.32
CHLOROFORM					4	6	0.2128	0.043	0.82	0.068
TETRACHLOROETHENE					6	6	0.1632	0.088	0.32	0.12
NICKEL					2	6	0.0844	0.042	0.16	0.04
CHROMIUM (T)					6	6	0.0666	0.032	0.081	0.048
CADMIUM					6	6	0.0246	0.013	0.036	0.028
BUTYL BENZYL PHTHALATE					1	1	0.0200	0.02	0.02	0.02
TOLUENE					2	6	0.0184	0.014	0.088	0.006
DI-N-BUTYL PHTHALATE					1	1	0.0120	0.012	0.012	0.012
ETHYLBENZENE					1	6	0.0108	0.033	0.033	0.006
TRANS-1,2-DICHLOROETHENE					1	6	0.0070	0.016	0.016	0.006
METHYLENE CHLORIDE					1	6	0.0082	0.011	0.011	0.006
PORTLAND	ME	1	30126	2						
ZINC					20	20	0.8238	0.16	3.207	0.6336
SILVER					8	9	0.9182	<0.006	4.2	0.028
COPPER					18	18	0.3867	0.09	2.047	0.23
LEAD					20	23	0.2827	<0.02	1.402	0.11
CHROMIUM (T)					8	13	0.1006	<0.01	0.284	0.016
NICKEL					9	18	0.0872	<0.001	0.21	<0.06
CADMIUM					15	18	0.0308	<0.006	0.14	0.0186
BUFFALO	NY	2		1						
PHOSPHATE					6	6	13.2000	4.4	18.4	17.2
LEAD					9	9	2.6000	0.2	16.8	0.3
ZINC					9	9	1.1068	0.84	2.76	0.86
COPPER					9	9	0.6778	0.14	1.9	0.2
1,1,2,2-TETRACHLOROETHANE					2	6	0.0884	<0.001	0.43	<0.001
CHLOROFORM					2	6	0.0862	<0.001	0.184	<0.001
TRANS-1,2-DICHLOROETHENE					2	6	0.0464	<0.001	0.18	<0.001
BROMOFORM					1	6	0.0268	<0.001	0.074	<0.002
1,1,1-TRICHLOROETHANE					1	6	0.0264	<0.001	0.09	<0.01
CARBON TETRACHLORIDE					1	5	0.0098	<0.001	<0.026	<0.001
CHLOROBENZENE					1	6	0.0092	<0.001	<0.026	<0.001
BROMODICHLOROMETHANE					2	6	0.0088	<0.001	<0.026	<0.001

A.2 COMMERCIAL SOURCE WASTEWATER MONITORING DATA

SOURCE/CITY	STATE	REGION	TOTAL SOURCE FLOW (GPD)	NUMBER OF SOURCES	NUMBER OF DETECTIONS	NUMBER OF OBSERVATIONS	AVERAGE POLLUTANT LEVEL (MG/L)	MINIMUM POLLUTANT LEVEL (MG/L)	MAXIMUM POLLUTANT LEVEL (MG/L)	MEDIAN POLLUTANT LEVEL (MG/L)
HAMPTON ROADS	VA	3	300000	8						
COD					258	258	1384.0820	76	20000	1060
ZINC					580	581	2.8238	<0.006	234	1.08
LEAD					422	541	2.4023	0.03	246	0.4
COPPER					424	428	0.8318	<0.02	14.6	0.29
CHROMIUM (T)					147	283	0.3808	0.04	38.8	0.08
PHENOL					206	222	0.2410	<0.01	8.61	0.08
NICKEL					140	277	0.0881	<0.04	0.48	0.04
CADMIUM					228	279	0.0278	<0.006	0.518	0.016
SILVER					8	13	0.0148	<0.006	0.08	0.01
MERCURY					24	26	0.0014	<0.0002	0.00083	0.00087
BOWLING GREEN	KY	4		2						
n-PROPYL ALCOHOL					1	1	74.0000	74	74	74
ISOPROPYL ALCOHOL					2	2	25.0000	12	38	25.5
IRON					26	28	18.8219	<0.01	146	0.24
TOLUENE					1	1	16.0000	16	16	16
ZINC					28	28	2.3886	0.258	8.86	1.758
COPPER					24	24	1.2242	0.18	7.88	0.87
LEAD					18	25	0.9132	<0.1	6.82	0.46
CHROMIUM (T)					25	28	0.2086	<0.05	0.73	0.16
NICKEL					21	25	0.1488	<0.04	0.58	0.12
CADMIUM					24	28	0.0477	<0.006	0.208	0.037
LOUISVILLE	KY	4	368200	6						
IRON					37	37	9.7046	0.26	37.1	9.42
ZINC					37	37	1.2818	0.167	4.42	0.889
LEAD					34	37	0.8824	<0.04	1.74	0.87
COPPER					37	37	0.6786	0.03	2.4	0.676
BARIUM					37	37	0.5055	0.089	1.1	0.460
CHROMIUM (T)					36	37	0.2888	<0.008	5.18	0.162
NICKEL					33	37	0.1837	<0.008	2.83	0.071
CADMIUM					32	37	0.0585	<0.002	0.386	0.024
ARSENIC					27	37	0.0382	<0.006	<0.81	0.01
SELENIUM					16	37	0.0186	<0.002	0.02	<0.02
SILVER					23	37	0.0100	0.0004	0.03	0.007
MERCURY					33	37	0.0023	<0.0007	0.017	0.0016
NORTH CHARLESTON	SC	4		1						
ZINC					6	6	2.2233	0.42	8.8	0.8
COPPER					6	6	0.1883	0.11	0.3	0.13
LEAD					6	6	0.0880	0.03	0.146	0.0836
NICKEL					2	6	0.0367	<0.03	0.06	0.03
CHROMIUM (T)					1	6	0.0333	<0.03	<0.06	0.03
CADMIUM					2	6	0.0128	<0.01	0.027	<0.01

A.2 COMMERCIAL SOURCE WASTEWATER MONITORING DATA

SOURCE/CITY	STATE	REGION	TOTAL SOURCE FLOW (GPD)	NUMBER OF SOURCES	NUMBER OF DETECTIONS	NUMBER OF OBSERVATIONS	AVERAGE POLLUTANT LEVEL (MG/L)	MINIMUM POLLUTANT LEVEL (MG/L)	MAXIMUM POLLUTANT LEVEL (MG/L)	MEDIAN POLLUTANT LEVEL (MG/L)
CHICAGO	IL	5	1210000	18						
IRON					348	366	1.0834	0.1	78.1	0.7
ZINC					258	364	0.4195	0.1	18.7	<0.2
COPPER					333	362	0.2178	0.01	2.48	0.08
NICKEL					38	364	0.1868	0.1	0.7	0.2
LEAD					238	361	0.1565	0.01	12.5	0.04
CHROMIUM (T)					183	361	0.0832	0.01	8.28	<0.02
CYANIDE					117	117	0.0703	0.002	0.407	0.032
CADMIUM					82	365	0.0200	0.01	0.22	<0.02
MERCURY					185	335	0.0008	0.0001	0.0240	<0.0003
ROCKFORD	IL	5	228000	5						
IRON					10	10	7.2388	1	20.8	5.8
ZINC					10	10	2.1388	0.2	7.3	1.7
LEAD					10	10	1.2032	0.1	4.2	0.9
COPPER					10	10	0.7842	0.1	2.2	0.7
NICKEL					15	10	0.1474	<0.1	0.5	0.1
CHROMIUM (T)					13	10	0.1388	<0.1	0.3	0.1
CADMIUM					7	10	0.0432	<0.01	0.1	<0.01
COLUMBUS	OH	5		4						
ZINC					77	77	2.1871	0.14	5.4	2
LEAD					61	64	1.0668	0.39	3	0.806
COPPER					67	67	0.8888	0.023	8.6	0.75
CHROMIUM (T)					78	81	0.2478	0.073	0.72	0.22
NICKEL					37	79	0.1043	<0.1	0.88	<0.125
CADMIUM					58	81	0.0580	0.018	0.23	0.047
ST. PAUL	MN	5	424000	4						
1-ETHYL-3-METHYL BENZENE					3	4	160.0000	<160	160	160
1-ETHYL-4-METHYL BENZENE					2	3	160.0000	<160	160	160
1-ETHYL-2-METHYL BENZENE					3	4	160.0000	<160	160	160
M-XYLENE					1	4	8.7437	<1.47	22.67	<1.47
TOLUENE					3	4	8.0660	<1.2	12.97	6.025
P-XYLENE					1	4	3.6426	<0.98	11.20	<0.98
ZINC					88	88	3.0821	0.54	13	2.44
ETHYL BENZENE					3	4	2.1250	<1.3	3.16	1.865
LEAD					88	88	1.8484	<0.1	8.47	1.4
COPPER					80	80	1.0787	0.34	2.40	0.98
CYANIDE					7	8	0.5671	<0.01	3.4	0.08
CHROMIUM (T)					49	50	0.2718	0.06	1.13	0.215
NICKEL					22	22	0.1173	0.01	0.43	0.08
CADMIUM					44	44	0.1100	0.018	0.6	0.085

A.2 COMMERCIAL SOURCE WASTEWATER MONITORING DATA

SOURCE/CITY	STATE	REGION	TOTAL SOURCE FLOW (GPD)	NUMBER OF SOURCES	NUMBER OF DETECTIONS	NUMBER OF OBSERVATIONS	AVERAGE POLLUTANT LEVEL (MG/L)	MINIMUM POLLUTANT LEVEL (MG/L)	MAXIMUM POLLUTANT LEVEL (MG/L)	MEDIAN POLLUTANT LEVEL (MG/L)
BATON ROUGE	LA	6	5000	2						
COD					18	18	1852.2778	80	13860	986
LEAD					11	16	9.0431	<0.05	180	0.4
IRON					4	4	6.6075	1.14	14	5.626
SULFIDE					1	3	4.8000	<0.2	14	<0.2
ZINC					11	12	2.1487	<0.01	6.6	2.3466
MANGANESE					3	3	0.6633	0.28	1.08	0.34
COPPER					10	12	0.3417	<0.1	0.83	0.386
PHENOL					9	9	0.3267	0.06	0.9	0.17
NICKEL					3	3	0.3067	0.18	0.48	0.28
CHROMIUM (T)					4	6	0.0787	0.04	0.17	0.06
CADMIUM					12	18	0.0463	0.003	0.07	0.01
SILVER					2	6	0.0200	<0.05	<0.01	0.01
ARSENIC					3	6	0.0187	<0.002	0.034	0.012
SELENIUM					2	4	0.0075	<0.002	0.021	0.0036
MERCURY					1	1	0.0014	0.0014	0.0014	0.0014
WICHITA	KS	7		4						
ZINC					22	22	1.0460	0.17	3.66	1.166
LEAD					38	38	0.6758	0.01	3.3	0.38
GREELEY	CO	8	28825	1						
ZINC					18	18	1.6438	0.630	4.060	1.306
BIS(2-ETHYLHEXYL) PHTHALATE					1	1	1.1000	1.100	1.100	1.100
COPPER					17	17	0.5312	0.180	1.010	0.410
LEAD					16	18	0.4667	0.100	1.680	0.326
NAPHTHALENE					1	1	0.3100	0.310	0.310	0.310
MERCURY					3	10	0.1206	0.001	0.704	0.010
CHROMIUM (T)					16	18	0.0782	0.003	0.140	0.061
DI-N-BUTYL PHTHALATE					1	1	0.0700	0.070	0.070	0.070
DI-N-OCTYL PHTHALATE					1	1	0.0670	0.067	0.067	0.067
BUTYL BENZYL PHTHALATE					1	1	0.0480	0.048	0.048	0.048
NICKEL					12	18	0.0421	0.006	0.120	0.037
SILVER					9	11	0.0378	0.006	0.138	0.031
CADMIUM					18	18	0.0260	0.003	0.082	0.021

A.3 SEPTAGE HAULER MONITORING DATA

CITY	STATE	REGION	AVERAGE FLOW (GPD)	NUMBER OF DETECTIONS	NUMBER OF OBSERVATIONS	AVERAGE POLLUTANT LEVEL (MG/L)	MINIMUM POLLUTANT LEVEL (MG/L)	MAXIMUM POLLUTANT LEVEL (MG/L)	MEDIAN POLLUTANT LEVEL (MG/L)
WARWICK	RI	1	7000						
ZINC				91	91	7.1146	0.037	66.2	6.66
COPPER				91	91	6.2106	0.16	39.76	4.8
LEAD				91	91	1.8482	0.08	39.6	0.91
NICKEL				91	91	0.3600	0.06	3	0.27
CHROMIUM (T)				91	91	0.1421	0.02	0.73	0.1
SILVER				79	91	0.0806	<0.006	0.14	0.02
CADMIUM				91	91	0.0829	0.01	0.78	0.06
ONONDAGA COUNTY	NY	2	60000						
IRON				21	21	297.3429	24.9	2740	288
ZINC				21	21	10.8867	0.7	120	4.1
COPPER				21	21	17.3086	0.5	86	2.4
LEAD				21	21	4.8143	1	36.7	2
CHROMIUM (T)				21	21	4.5406	0.86	19.2	2.9
NICKEL				21	21	1.9881	0.75	9.2	1.5
CADMIUM				21	21	0.5406	0.25	2.1	0.5
CYANIDE				19	21	0.2480	<0.01	1.1	0.15
MERCURY				19	21	0.0332	0.0037	0.164	0.01
ALLENTOWN	PA	3							
COPPER				32	32	22.6719	0.9	280.9	6.475
ZINC				25	27	11.3840	<0.001	48.1	4.66
CHROMIUM (T)				32	32	3.3922	0.86	13	2.86
LEAD				30	32	1.8813	<0.025	7.6	1.275
NICKEL				32	32	1.3368	0.06	8.65	0.675
COBALT				16	32	0.4082	<0.003	3.46	0.0285
TIN				11	26	0.0784	<0.015	1	<0.015
SILVER				2	26	0.0248	<0.003	0.4	<0.003
HAMPTON ROADS	VA	3							
COD				183	183	21247.9608	510	117600	17340
ZINC				183	183	11.0378	0.03	118.02	5.08
COPPER				181	181	2.1527	0.02	80.8	0.04
LEAD				183	183	0.7781	0.1	30.6	0.2
NICKEL				183	183	0.2722	0.04	2.4	0.14
CHROMIUM (T)				183	183	0.2311	0.06	2.61	0.06
CADMIUM				183	183	0.0388	0.006	0.408	0.019
CHICAGO	IL	5							
IRON				434	434	25.1400	0.2	171	15.15
ZINC				436	441	3.7100	0.1	15.3	4
COPPER				434	442	0.6630	0.01	3.80	0.62
NICKEL				282	488	0.4780	0.1	6.2	<0.2
LEAD				434	536	0.4740	0.01	3.2	0.14

A.3 SEPTAGE HAULER MONITORING DATA

CITY	STATE	REGION	AVERAGE FLOW (GPD)	NUMBER OF DETECTIONS	NUMBER OF OBSERVATIONS	AVERAGE POLLUTANT LEVEL (MG/L)	MINIMUM POLLUTANT LEVEL (MG/L)	MAXIMUM POLLUTANT LEVEL (MG/L)	MEDIAN POLLUTANT LEVEL (MG/L)
CYANIDE				436	436	0.4710	0.007	1.633	0.6
CHROMIUM (T)				434	520	0.1080	0.01	0.67	0.13
CADMIUM				327	600	0.0720	0.01	0.87	<0.02
MERCURY				434	563	0.0022	0.0001	0.0636	0.0007
DALLAS	TX	6							
ZINC				131	131	16.5100	0.06	444	3.2
METHYL ALCOHOL				117	117	15.8400	1	386	1
ISOPROPYL ALCOHOL				117	117	14.0647	1	391	1
ACETONE				118	118	10.8883	0	210	1
COPPER				131	131	9.9067	0.01	302	0.94
BARIUM				128	128	6.7681	0.002	202	0.836
METHYL ETHYL KETONE				116	116	3.8504	1	240	1
LEAD				132	132	2.4846	0.03	118	0.24
CHROMIUM (T)				131	131	0.6744	0.01	34	0.12
NICKEL				131	131	0.6438	0.01	37	0.25
CYANIDE				121	121	0.5022	0.001	4.2	0.3
CADMIUM				130	130	0.1868	0.01	8.1	0.06
TOLUENE				113	113	0.1704	0.006	1.86	0.06
ARSENIC				126	126	0.1480	0	3.6	0.02
SILVER				129	129	0.1240	0.01	6	0.06
METHYLENE CHLORIDE				116	116	0.1009	0.006	2.2	0.01
ETHYL BENZENE				116	116	0.0873	0.006	1.7	0.01
BENZENE				112	112	0.0818	0.006	3.1	0.01
XYLENE				87	87	0.0611	0.006	0.72	0.01
MERCURY				129	129	0.0142	0.001	0.742	0.002
WICHITA	KS	7							
ZINC				5	5	18.3740	0.86	86.2	5.88
MANGANESE				5	5	6.0880	0.66	17.06	3.62
CHROMIUM (T)				5	5	6.8080	0.02	15.12	0.37
COPPER				5	5	5.4200	0.48	21.2	1.47
LEAD				5	5	1.8680	0.24	3.21	2.33
NICKEL				5	5	0.6800	0.09	1.87	0.44
CADMIUM				5	5	0.1320	0.06	0.21	0.14
SILVER				5	5	0.0340	0.01	0.1	0.02
WATERLOO	IA	7	3300						
ZINC				60	60	34.7286	2.02	130	20
COPPER				60	60	18.1483	0.39	160	8.6
LEAD				57	60	3.5615	<0.2	21	2.3
CHROMIUM (T)				57	60	0.7948	<0.06	6.88	0.34

A.3 SEPTAGE HAULER MONITORING DATA

CITY	STATE	REGION	AVERAGE FLOW (GPD)	NUMBER OF DETECTIONS	NUMBER OF OBSERVATIONS	AVERAGE POLLUTANT LEVEL (MG/L)	MINIMUM POLLUTANT LEVEL (MG/L)	MAXIMUM POLLUTANT LEVEL (MG/L)	MEDIAN POLLUTANT LEVEL (MG/L)
NICKEL				50	50	0.7741	0.07	2.8	0.58
CADMIUM				50	50	0.1841	0.03	1	0.12
SILVER				13	13	0.0946	0.01	0.29	0.06
ARSENIC				16	17	0.0661	0.004	0.28	0.06
SANTA ROSA	CA	9	11000						
IRON				9	9	119.3333	34	246	100
ZINC				9	9	35.3889	25	48	36
COPPER				9	9	9.4444	3.6	18	8
LEAD				9	9	2.0667	1.1	3.6	1.7
CHROMIUM (T)				9	9	0.6744	0.37	0.9	0.6
NICKEL				9	9	0.4344	0.2	0.9	0.38
CADMIUM				9	9	0.1067	0.06	0.18	0.11
SILVER				9	9	0.0411	0.02	0.08	0.03

A.4 LANDFILL LEACHATE MONITORING DATA

CITY	STATE	REGION	NUMBER OF DETECTIONS	NUMBER OF OBSERVATIONS	AVERAGE POLLUTANT LEVEL (MG/L)	MINIMUM POLLUTANT LEVEL (MG/L)	MAXIMUM POLLUTANT LEVEL (MG/L)	MEDIAN POLLUTANT LEVEL (MG/L)
PORTLAND	ME	1						
ZINC			189	189	13.7488	0.070	58.000	11.1
PHENOLS			2	2	2.6500	1.700	3.600	2.650
CHROMIUM (T)			187	187	0.7210	0.010	12.000	0.387
NICKEL			174	186	0.6772	0.003	12.080	0.42
COPPER			183	186	0.4478	<0.01	10.870	0.11
LEAD			140	178	0.1671	<0.01	2.110	0.08
ARSENIC			2	2	0.0805	0.031	0.130	0.081
CADMIUM			138	191	0.0331	<0.001	1.260	0.008
ANTIMONY			1	1	0.0080	0.008	0.008	0.008
LAWRENCE	MA	1						
IRON			3	3	70.0333	57.300	85.000	67.8000
MANGANESE			4	4	22.6250	3.040	73.200	7.13
ZINC			7	7	1.8843	0.050	10.600	0.18
1,2-DICHLOROETHANE			2	8	1.7017	<0.005	8.8	<0.1
PHENOL			6	7	1.0818	0.008	2.8	0.8
TOLUENE			7	7	0.8388	0.220	1.600	0.78
XYLENE			4	8	0.4636	<0.001	1.100	0.32
BARIUM			5	5	0.4040	0.200	0.660	0.44
ETHYLBENZENE			7	8	0.2338	<0.1	0.640	0.18
BENZOIC ACID			2	4	0.1800	0.020	<0.4	<0.2
NICKEL			5	6	0.1800	<0.04	0.360	0.16
ANTIMONY			2	7	0.1614	<0.03	0.300	<0.2
2,4-DIMETHYLPHENOL			1	5	0.1288	<0.005	<0.4	0.018
NAPHTHALENE			2	8	0.1132	<0.01	<0.4	0.0285
1,4-DICHLOROBENZENE			6	11	0.1012	<0.005	<0.4	0.02
VINYL CHLORIDE			3	8	0.0740	<0.002	0.210	<0.1
4-METHYLPHENOL			1	1	0.0850	0.085	0.085	0.085
CYANIDE			2	2	0.0450	0.04	0.05	0.045
LEAD			5	8	0.0382	<0.002	0.280	0.01
COPPER			6	9	0.0368	<0.02	0.120	0.03
BENZENE			8	9	0.0318	<0.002	0.031	0.02
1,2-DICHLORETHENE			3	7	0.0287	<0.001	<0.1	0.021
TRICHLOROETHENE			1	5	0.0277	<0.001	<0.1	<0.005
CHROMIUM (T)			5	5	0.0275	<0.02	0.060	<0.05
CHLOROETHANE			1	8	0.0213	<0.001	<0.1	<0.01
SILVER			2	6	0.0200	<0.01	0.060	<0.01
ARSENIC			7	9	0.0198	<0.005	0.038	0.018
SELENIUM			1	7	0.0108	<0.002	<0.04	<0.005
CADMIUM			2	10	0.0070	<0.001	0.022	<0.002
1,1-DICHLOROETHANE			3	6	0.0065	<0.001	0.010	<0.005
MERCURY			2	7	0.0004	<0.0002	0.002	0.0002

A.4 LANDFILL LEACHATE MONITORING DATA

CITY	STATE	REGION	NUMBER OF DETECTIONS	NUMBER OF OBSERVATIONS	AVERAGE POLLUTANT LEVEL (MG/L)	MINIMUM POLLUTANT LEVEL (MG/L)	MAXIMUM POLLUTANT LEVEL (MG/L)	MEDIAN POLLUTANT LEVEL (MG/L)
ONEIDA COUNTY	NY	2						
IRON			*	*	369.0000	30	4600	*
METHYL ETHYL KETONE			3	3	13.6333	5.3	29	6.6
ZINC			*	*	3.5300	0.16	18	*
ACETONE			1	3	2.8000	2.8	2.8	2.8
METHYL ISOBUTYL KETONE			3	3	0.4300	0.02	0.74	0.53
LEAD			*	*	0.4100	*	9.8	*
NICKEL			*	*	0.3800	0.14	1	*
METHYLENE CHLORIDE			3	3	0.3100	0.21	0.42	0.3
VINYL ACTETATE			1	3	0.2600	0.26	0.26	0.26
COPPER			*	*	0.1800	0.04	1.6	*
DIETHYL PHTHALATE			1	1	0.1100	0.11	0.11	0.11
METHYL BUTYL KETONE			2	3	0.0940	0.028	0.16	0.084
CHROMIUM (T)			*	*	0.0700	0.02	0.61	*
VINYL CHLORIDE			1	3	0.0480	0.048	0.048	0.048
XYLENES			1	3	0.0460	0.046	0.046	0.046
1,1-DICHLOROETHANE			2	3	0.0330	0.014	0.052	0.033
1,1,1-TRICHLOROETHANE			1	3	0.0220	0.022	0.022	0.022
SILVER			6	6	0.0200	0.01	0.04	*
TRICHLOROETHENE			1	3	0.0180	0.018	0.018	0.018
P-CHLORO-M-CRESOL			1	1	0.0180	0.018	0.018	0.018
ETHYLBENZENE			1	3	0.0170	0.017	0.017	0.017
PENTACHLOROPHENOL			1	1	0.0160	0.016	0.016	0.016
N-NITROSODIPHENYLAMINE			1	1	0.0110	0.011	0.011	0.011
CADMIUM			*	*	0.0100	*	0.09	*
2,4-DIMETHYLPHENOL			1	1	0.0089	0.0089	0.0089	0.0089
BENZENE			1	3	0.0079	0.0079	0.0079	0.0079
1,2-DICHLOROETHANE			1	3	0.0061	0.0061	0.0061	0.0061
DIMETHYL PHTHALATE			1	1	0.0049	0.0049	0.0049	0.0049
DI-N-BUTYL PHTHALATE			1	1	0.0044	0.0044	0.0044	0.0044
ONONDAGA COUNTY	NY	2						
PHENOLS			1	1	2.0000	2	2	2
ZINC			1	1	1.6000	1.6	1.6	1.6
IRON			1	1	1.6000	1.6	1.6	1.6
COPPER			1	1	0.4000	0.4	0.4	0.4
NICKEL			1	1	0.2700	0.27	0.27	0.27
LEAD			1	1	0.2000	0.2	0.2	0.2
ETHYLBENZENE			1	1	0.0750	0.075	0.075	0.075
BENZENE			1	1	0.0168	0.0168	0.0168	0.0168
CHLOROBENZENE			1	1	0.0110	0.011	0.011	0.011
1,1,1-TRICHLOROETHANE			1	1	0.0110	0.011	0.011	0.011
TOLUENE			1	1	0.0062	0.0062	0.0062	0.0062

* - Could not be determined from data provided

A.4 LANDFILL LEACHATE MONITORING DATA

CITY	STATE	REGION	NUMBER OF DETECTIONS	NUMBER OF OBSERVATIONS	AVERAGE POLLUTANT LEVEL (MG/L)	MINIMUM POLLUTANT LEVEL (MG/L)	MAXIMUM POLLUTANT LEVEL (MG/L)	MEDIAN POLLUTANT LEVEL (MG/L)
AUBURN	NY	2						
IRON					**7.6000			
ZINC					0.1600			
NICKEL					0.0800			
LEAD					0.0400			
COPPER					0.0300			
SILVER					0.0200			
CADMIUM					0.0100			
CHROMIUM (T)					0.0070			
MERCURY					0.0020			
ARSENIC					0.0020			
TONAWANDA TREATMENT PLANT	NY	2						
IRON			3	3	8.3333	5.06	12.1	7.86
MANGANESE			3	3	0.6800	0.63	0.78	0.65
ALUMINUM			3	3	0.3400	0.14	0.6	0.14
ZINC			3	3	0.0487	0.042	0.064	0.043
CYANIDE			1	1	0.0410	0.041	0.041	0.041
COPPER			3	3	0.0100	0.007	0.013	0.01
CHROMIUM (T)			3	3	0.0067	0.006	0.008	0.006
CADMIUM			3	3	0.0060	0.005	0.007	0.006
LEAD			3	3	0.0058	0.005	0.0075	0.005
MERCURY			3	3	0.0010	0.0009	0.0012	0.0009
W.CAROLINA SEWER AUTHORITY	SC							
CHROMIUM (T)			7	8	0.2770	<0.02	1.07	0.13
LEAD			2	5	0.1000	<0.1	0.1	<0.1
ZINC			2	6	0.0700	<0.02	0.12	<0.02
COPPER			6	6	0.0600	0.01	0.1	0.06
NICKEL			5	5	0.0600	0.04	0.07	0.06
SILVER			2	4	0.0300	<0.03	0.03	0.03
CADMIUM			2	5	0.0200	<0.02	0.02	<0.02
CYANIDE			1	5	0.0200	<0.02	0.02	<0.02
NORTH CHARLESTON	SC	4						
COD			11	11	34.5455	7	80	20
ZINC			8	10	0.2820	<0.01	1.8	0.08
BARIUM			3	11	0.1091	<0.1	0.2	<0.1
LEAD			2	11	0.0827	<0.05	0.6	<0.05
ARSENIC			8	11	0.0636	<0.005	0.1	0.007
CHROMIUM (T)			4	11	0.0427	<0.02	0.12	<0.02
PHENOLS			1	11	0.0104	<0.005	0.13	<0.005
COPPER			6	10	0.0140	<0.01	0.04	0.01
SILVER			2	11	0.0127	<0.01	0.01	<0.01
CADMIUM			1	11	0.0100	<0.01	0.01	<0.01
SELENIUM			3	11	0.0081	<0.005	0.02	<0.005

** - Only average pollutant levels were provided

APPENDIX B

DECILE ESTIMATION WORKSHEET

DECILE ESTIMATION WORKSHEET

DECILES	COL. #1 CALCULATE DECILE POSITION FOR ORDERED LIST OF REMOVALS*	COL. #2 WRITE THE WHOLE NUMBER GIVEN IN COL. #1	COL. #3 RECORD THE ORDERED REMOVAL FOR THE COL. #2 ENTRY**	COL. #4 RECORD THE ORDERED REMOVAL FOLLOWING THE COL. #3 ENTRY**	COL. #5 COL. #4 ENTRY MINUS COL. #3 ENTRY	COL. #6 LIST THE DECIMAL IN COL. #1	COL. #7 MULTIPLY COL. #5 ENTRY BY COL. #6 ENTRY	COL. #8 ADD COL. #3 AND COL. #7 ENTRIES ================ ESTIMATED DECILES
1st								
2nd								
3rd								
4th								
5th								
6th								
7th								
8th								
9th								

*Numbers in column defined as multiples of (N+1)/10, where N = the number of data pairs used.
**Uses the list of ordered removals.