Chapter 3: Establishing treatment system performance requirements

3.1 Introduction

This chapter outlines essential steps for characterizing wastewater flow and composition and provides a framework for establishing and measuring performance requirements. Chapter 4 provides information on conventional and alternative systems, including technology types, pollutant removal effectiveness, basic design parameters, operation and maintenance, and estimated costs. Chapter 5 describes treatment system design and selection processes, failure analysis, and corrective measures.

This chapter also describes methods for establishing and ensuring compliance with wastewater treatment performance requirements that protect human health, surface waters, and ground water resources. The chapter describes the characteristics of typical domestic and commercial wastewaters and discusses approaches for estimating wastewater quantity and quality for residential dwellings and commercial establishments. Pollutants of concern in wastewaters are identified, and the fate and transport of these pollutants in the receiving environment are discussed. Technical approaches for establishing performance requirements for onsite systems, based on risk and environmental sensitivity assessments, are then presented. Finally, the chapter discusses performance monitoring to ensure sustained protection of public health and water resources.

3.2 Estimating wastewater characteristics

Accurate characterization of raw wastewater, including daily volumes, rates of flow, and associated pollutant load, is critical for effective treatment system design. Determinating treatment system performance requirements, selecting appropriate treatment processes, designing the treatment system, and operating the system depends on an accurate assessment of the wastewater to be treated.

There are basically two types of onsite system wastewaters—residential and nonresidential. Single-family households, condominiums, apartment houses, multifamily households, cottages, and resort residences all fall under the category of residential dwellings. Discharges from these dwellings consist of a number of individual waste streams generated by water-using activities from a variety of plumbing fixtures and appliances. Wastewater flow and quality are influenced by the type of plumbing fixtures and appliances, their extent and frequency of use, and other factors such as the characteristics of the residing family, geographic location, and water supply (Anderson and Siegrist, 1989; Crites and Tchobanoglous, 1998; Siegrist, 1983).

A wide variety of institutional (e.g., schools), commercial (e.g., restaurants), and industrial establishments and facilities fall into the nonresidential wastewater category. Wastewater-generating activities in some nonresidential establishments are similar to those of residential dwellings. Often, however, the wastewater from nonresidential establishments is quite different from that from of residential dwellings and should be characterized carefully before Onsite Wastewater Treatment System (OWTS) design. The characteristics of wastewater generated in some types of nonresidential establishments might prohibit the use of conventional systems without changing wastewater loadings through advanced pretreatment or accommodating elevated organic loads by increasing the size of the subsurface wastewater infiltration system (SWIS). Permitting agencies should note that some commercial and large-capacity septic systems (systems serving 20 or more people, systems serving commercial facilities such as automotive repair shops) might be regulated under USEPA's Class V Underground Injection Control Program (see **http://www.epa.gov/safewater/uic/classv.html**).

In addition, a large number of seemingly similar nonresidential establishments are affected by subtle and often intangible influences that can cause significant variation in wastewater characteristics. For example, popularity, price, cuisine, and location can produce substantial variations in wastewater flow and quality among different restaurants (University of Wisconsin, 1978). Nonresidential wastewater characterization criteria that are easily applied and accurately predict flows and pollutant loadings are available for only a few types of establishments and are difficult to develop on a national basis with any degree of confidence. Therefore, for existing facilities the wastewater to be treated should be characterized by metering and sampling the current wastewater stream. For many existing developments and for almost any new development, however, characteristics of nonresidential wastewaters should be estimated based on available data. Characterization data from similar facilities already in use can provide this information.

3.3 Estimating wastewater flow

The required hydraulic capacity for an OWTS is determined initially from the estimated wastewater flow. Reliable data on existing and projected flows should be used if onsite systems are to be designed properly and cost-effectively. In situations where onsite wastewater flow data are limited or unavailable, estimates should be developed from water consumption records or other information. When using water meter readings or other water use records, outdoor water use should be subtracted to develop wastewater flow estimates. Estimates of outdoor water use can be derived from discussions with residents on car washing, irrigation, and other outdoor uses during the metered period under review, and studies conducted by local water utilities, which will likely take into account climatic and other factors that affect local outdoor use.

Accurate wastewater characterization data and appropriate factors of safety to minimize the possibility of system failure are required elements of a successful design. System design varies considerably and is based largely on the type of establishment under consideration. For example, daily flows and pollutant contributions are usually expressed on a per person basis for residential dwellings. Applying these data to characterize residential wastewater therefore requires that a second parameter, the number of persons living in the residence, be considered. Residential occupancy is typically 1.0 to 1.5 persons per bedroom; recent census data indicate that the average household size is 2.7 people (U.S. Census Bureau, 1998). Local census data can be used to improve the accuracy of design assumptions. The current onsite code practice is to assume that maximum occupancy is 2 persons per bedroom, which provides an estimate that might be too conservative if additional factors of safety are incorporated into the design.

For nonresidential establishments, wastewater flows are expressed in a variety of ways. Although per person units may also be used for nonresidential wastewaters, a unit that reflects a physical characteristic of the establishment (e.g., per seat, per meat served, per car stall, or per square foot) is often used. The characteristic that best fits the wastewater characterization data should be employed (University of Wisconsin, 1978).

When considering wastewater flow it is important to address sources of water uncontaminated by wastewater that could be introduced into the treatment system. Uncontaminated water sources (e.g., storm water from rain gutters, discharges from basement sump pumps) should be identified and eliminated from the OWTS. Leaking joints, cracked treatment tanks, and system damage caused by tree roots also can be significant sources of clear water that can adversely affect treatment performance. These flows might cause periodic hydraulic overloads to the system, reducing treatment effectiveness and potentially causing hydraulic failure.

3.3.1 Residential wastewater flows

Average daily flow

The average daily wastewater flow from typical residential dwellings can be estimated from indoor water use in the home. Several studies have evaluated residential indoor water use in detail (Anderson and Siegrist, 1989; Anderson et al., 1993; Brown and Caldwell, 1984; Mayer et al., 1999). A summary of recent studies is provided in table 3-1. These studies were conducted primarily on homes in suburban areas with public water supplies. Previous studies of rural homes on private wells generally indicated slightly lower indoor water use values. However, over the past three decades there has been a significant increase in the number of suburban housing units with onsite systems, and it has recently been estimated that the majority of OWTSs in the United States are located in suburban metropolitan areas (Knowles, 1999). Based on the data in table 3-1, estimated average daily wastewater flows of approximately 50 to 70 gallons per person per day (189 to 265 liters per person per day) would be typical for residential dwellings built before 1994.

In 1994 the U.S. Energy Policy Act (EPACT) standards went into effect to improve water use efficiency nationwide. EPACT established national flow rates for showerheads, faucets, urinals, and water closets. In 2004 and again in 2007 energy use standards for clothes washers will go into effect, and they are expected to further reduce water use by those appliances. Homes built after 1994 or retrofitted with EPACT-efficient fixtures would have typical average daily wastewater flows in the 40 to 60 gallons/person/day range. Energy- and water-efficient clothes washers may reduce the per capita flow rate by up to 5 gallons/person/day (Mayer et al., 2000).

Of particular interest are the results of the Residential End Uses of Water Study (REUWS), which was funded by the American Water Works Association Research Foundation (AWWARF) and 12 water supply utilities (Mayer et al., 1999). This study involved the largest number of residential water users ever characterized and provided an evaluation of annual water use at 1,188 homes in 12 metropolitan areas in North America. In addition, detailed indoor water use characteristics of approximately 100 homes in each of the 12 study areas were evaluated by continuous data loggers and computer software that identified fixture-specific end uses of water. Table 3-2 provides the

Table 3-1. Summary of average daily residential wastewater flows[a]

Study	Number of residences	Study duration (months)	Study average (gal/pers/day)[b]	Study range (gal/pers/day)
Brown & Caldwell (1984)	210		66.2 (250.6)[b]	57.3–73.0 (216.9–276.3)[b]
Anderson & Siegrist (1989)	90	3	70.8 (268.0)	65.9–76.6 (249.4–289.9)
Anderson et al. (1993)	25	3	50.7 (191.9)	26.1–85.2 (98.9–322.5)
Mayer et al. (1999)	1188	1[c]	69.3 (262.3)	57.1–83.5 (216.1–316.1)
Weighted Average	153		68.6 (259.7)	

[a] Based on indoor water use monitoring and not wastewater flow monitoring.
[b] Liters/person/day in parentheses.
[c] Based on 2 weeks of continuous flow monitoring in each of two seasons at each home.

Table 3-2. Comparison of daily per capita indoor water use for 12 study sites

Study Site	Sample size (number of houses)	Mean daily per capita indoor use (gal/pers/day)[a]	Median daily per capita indoor use (gal/pers/day)[a]	Standard deviation of per capita indoor use (gal/pers/day)[a]
Seattle, WA	99	57.1	54.0	28.6
San Diego, CA	100	58.3	54.1	23.4
Boulder, CO	100	64.7	60.3	25.8
Lompoc, CA	100	65.8	56.1	33.4
Tampa, FL	99	65.8	59.0	33.5
Walnut Valley Water District, CA	99	67.8	63.3	30.8
Denver, CO	99	69.3	64.9	35.0
Las Virgenes Metropolitan Water District, CA	100	69.6	61.0	38.6
Waterloo & Cambridge, ON	95	70.6	59.5	44.6
Phoenix, AZ	100	77.6	66.9	44.8
Tempe & Scottsdale, AZ	99	81.4	63.4	67.6
Eugene, OR	98	83.5	63.8	68.9
12 study sites	1188	69.3 (316.5)[b]	60.5 (289.0)[b]	39.6 (149.9)[b]

[a] Multiply gallons/person/day by 3.875 to obtain liters/person/day.
[b] Liters/person/day in parentheses.

Source: Mayer et al., 1999.

average daily per capita indoor water use by study site for the 1,188 homes. The standard deviation data provided in this table illustrate the significant variation of average daily flow among residences. The median daily per capita flow ranged from 54 to 67 gallons/person/day (204 to 253 liters/person/day) and probably provides a better estimate of average daily flow for most homes given the distribution of mean per capita flows in figure 3-1 (Mayer et al., 2000). This range might be reduced further in homes with EPACT-efficient fixtures and appliances.

Individual activity flows

Average daily flow is the average total flow generated on a daily basis from individual wastewater-generating activities in a building. These activities typically include toilet flushing, showering and bathing, clothes washing and dishwashing, use of faucets, and other miscellaneous uses. The average flow characteristics of several major residential water-using activities are presented in table 3-3. These data were derived from some 1 million measured indoor water use events in 1,188 homes in 12 suburban areas as part of the REUWS (Mayer et al., 1999). Figure 3-2 illustrates these same data graphically.

One of the more important wastewater-generating flows identified in this study was water leakage from plumbing fixtures. The average per capita leakage measured in the REUWS was 9.5 gallons/person/day (35.0 liters/person/day). However, this value was the result of high leakage rates at a relatively small percentage of homes. For example, the average daily leakage per household was 21.9 gallons (82.9 liters) with a standard deviation of 54.1 gallons (204.8 liters), while the median leakage rate was only 4.2 gallons/house/day (15.9 liters/house/day). Nearly 67 percent of the homes in the study had average leakage rates of less than 10 gallons/day (37.8 liters/day), but 5.5 percent of the study homes had leakage rates that averaged more than 100 gallons (378.5 liters) per day. Faulty toilet flapper valves and leaking faucets were the primary sources of leaks in these high-leakage-rate homes. Ten percent of the homes monitored accounted for 58 percent of the leakage measured. This result agrees with a previous end use study where average leakage rates of 4 to 8 gallons/person/day (15.1 to 30.3 liters/person/day) were measured (Brown and Caldwell, 1984). These data point out the importance of leak detection and repair during maintenance or repair of onsite

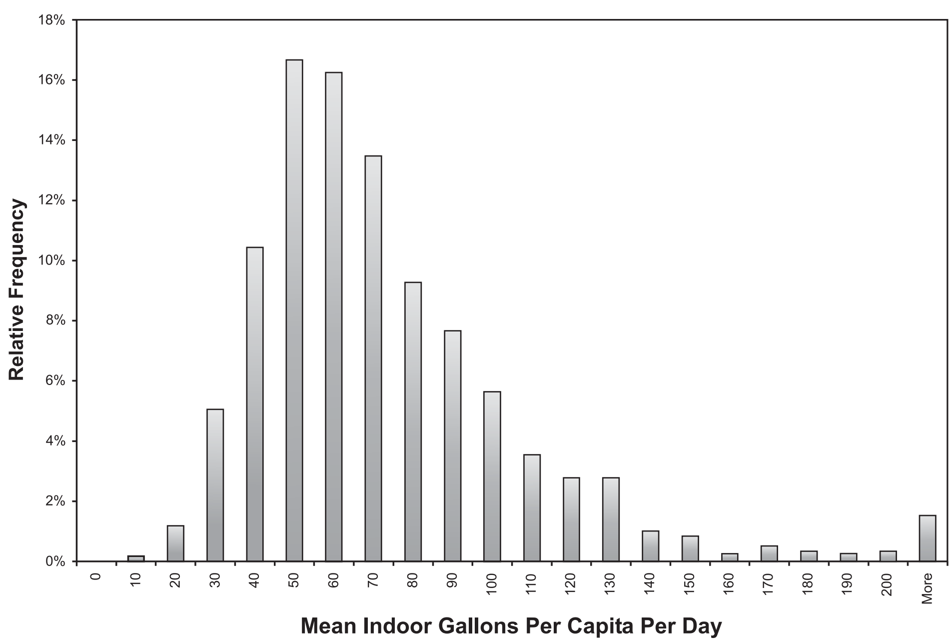
Table 3-3. Residential water use by fixture or appliance[a,b]

Fixture/use	Gal/use: Average range	Uses/person/day: Average range	Gal/person/ day: Average range[c]	% Total: Average range
Toilet	3.5 2.9–3.9	5.05 4.5–5.6	18.5 15.7–22.9	26.7 22.6–30.6
Shower	17.2[d] 14.9–18.6	0.75[d] 0.6–0.9	11.6 8.3–15.1	16.8 11.8–20.2
Bath	See shower	See shower	1.2 0.5–1.9	1.7 0.9–2.7
Clothes washer	40.5 —	0.37 0.30–0.42	15.0 12.0–17.1	21.7 17.8–28.0
Dishwasher	10.0 9.3–10.6	0.10 0.06–0.13	1.0 0.6–1.4	1.4 0.9–2.2
Faucets	1.4[e] —	8.1[f] 6.7–9.4	10.9 8.7–12.3	15.7 12.4–18.5
Leaks	NA	NA	9.5 3.4–17.6	13.7 5.3–21.6
Other Domestic	NA	NA	1.6 0.0–6.0	2.3 0.0–8.5
Total	NA	NA	69.3 57.1–83.5	100

[a] Results from AWWARF REUWS at 1,188 homes in 12 metropolitan areas. Homes surveyed were serve by public water supplies, which operate at higher pressures than private water sources. Leakage rates might be lower for homes on private water supplies.
[b] Results are averages over range. Range is the lowest to highest average for 12 metropolitan areas.
[c] Gal/person/day might not equal gal/use multiplied by uses/person/day because of differences in the number of data points used to calculate means.
[d] Includes shower and bath.
[e] Gallons per minute.
[f] Minutes of use per person per day.

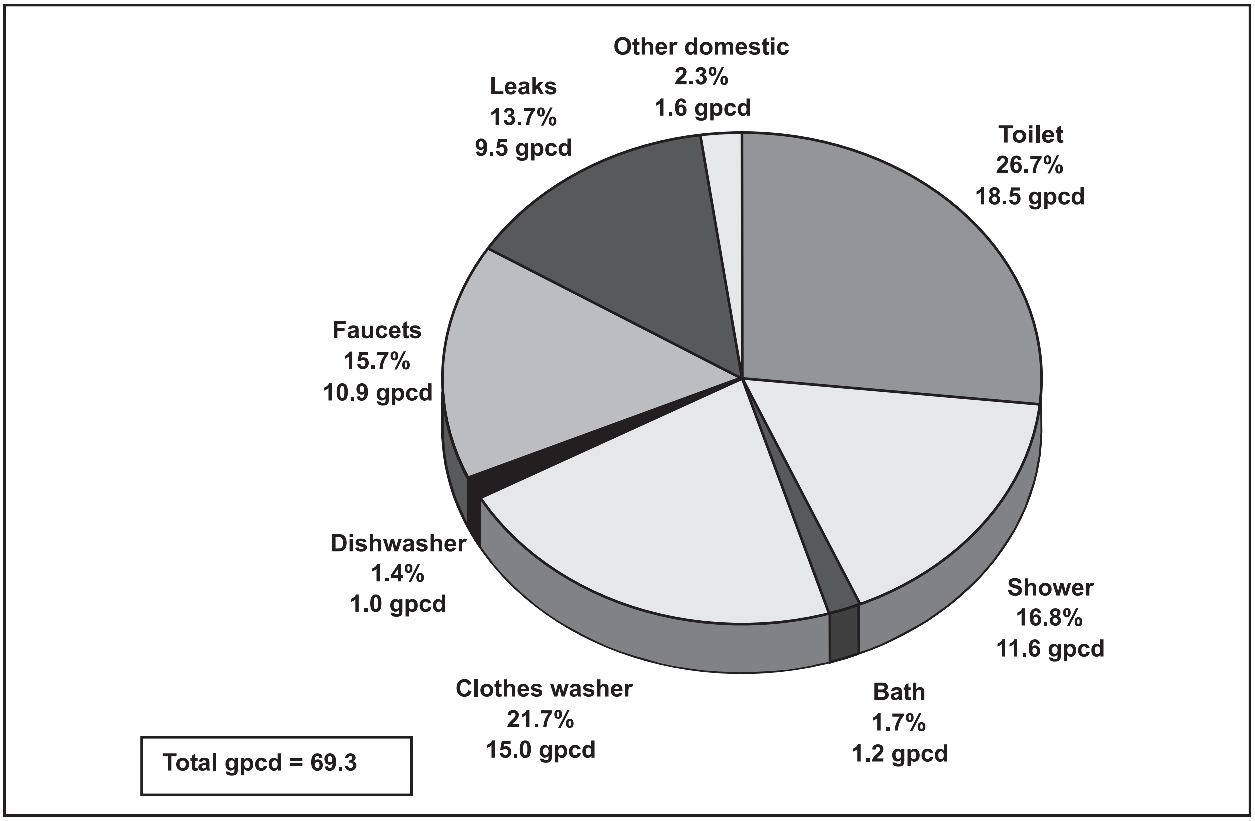
Source: Mayer et al., 1999.

Figure 3-1. Distribution of mean household daily per capita indoor water use for 1,188 data-logged homes



Source: Mayer et al., 1999.

Figure 3-2. Indoor water use percentage, including leakage, for 1,188 data logged homes[a]



[a] gpcd = gallons per capita (person) per day
Source: Mayer et al. 1999.

systems. Leakage rates like those measured in the REUWS could significantly increase the hydraulic load to an onsite wastewater system and might reduce performance.

Maximum daily and peak flows

Maximum and minimum flows and instantaneous peak flow variations are necessary factors in properly sizing and designing system components. For example, most of the hydraulic load from a home occurs over several relatively short periods of time (Bennett and Lindstedt, 1975; Mayer et al., 1999; University of Wisconsin, 1978). The system should be capable of accepting and treating normal peak events without compromising performance. For further discussion of flow variations, see section 3.3.3.

3.3.2 Nonresidential wastewater flows

For nonresidential establishments typical daily flows from a variety of commercial, institutional, and recreational establishments are shown in tables 3-4 to 3-6 (Crites and Tchobanoglous, 1998; Tchobanoglous and Burton, 1991). The typical values presented are not necessarily an average of the range of values but rather are weighted values based on the type of establishment and expected use. Actual monitoring of specific wastewater flow and characteristics for nonresidential establishments is strongly recommended. Alternatively, a similar establishment located in the area might provide good information. If this approach is not feasible, state and local regulatory agencies should be consulted for approved design flow guidelines for nonresidential establishments. Most design flows provided by regulatory agencies are very conservative estimates based on peak rather than average daily flows. These agencies might accept only their established flow values and therefore should be contacted before design work begins.

Table 3-4. Typical wastewater flow rates from commercial sources[a,b]

Facility	Unit	Flow, gallons/unit/day Range	Flow, gallons/unit/day Typical	Flow, liters/unit/day Range	Flow, liters/unit/day Typical
Airport	Passenger	2–4	3	8–15	11
Apartment house	Person	40–80	50	150–300	190
Automobile service station[c]	Vehicle served	8–15	12	30–57	45
	Employee	9–15	13	34–57	49
Bar	Customer	1–5	3	4–19	11
	Employee	10–16	13	38–61	49
Boarding house	Person	25–60	40	95–230	150
Department store	Toilet room	400–600	500	1,500–2,300	1,900
	Employee	8–15	10	30–57	38
Hotel	Guest	40–60	50	150–230	190
	Employee	8–13	10	30–49	38
Industrial building (sanitary waste only)	Employee	7–16	13	26–61	49
Laundry (self-service)	Machine	450–650	550	1,700–2,500	2,100
	Wash	45–55	50	170–210	190
Office	Employee	7–16	13	26–61	49
Public lavatory	User	3–6	5	11–23	19
Restaurant (with toilet)	Meal	2–4	3	8–15	11
Conventional	Customer	8–10	9	30–38	34
Short order	Customer	3–8	6	11–30	23
Bar/cocktail lounge	Customer	2–4	3	8–15	11
Shopping center	Employee	7–13	10	26–49	38
	Parking space	1–3	2	4–11	8
Theater	Seat	2–4	3	8–15	11

[a] Some systems serving more than 20 people might be regulated under USEPA's Class V Underground Injection Control (UIC) Program. See http://www.epa.gov/safewater/uic.html for more information.
[b] These data incorporate the effect of fixtures complying with the U.S. Energy Policy Act (EPACT) of 1994.
[c] Disposal of automotive wastes via subsurface wastewater infiltration systems is banned by Class V UIC regulations to protect ground water. See http://www.epa.gov/safewater/uic.html for more information.

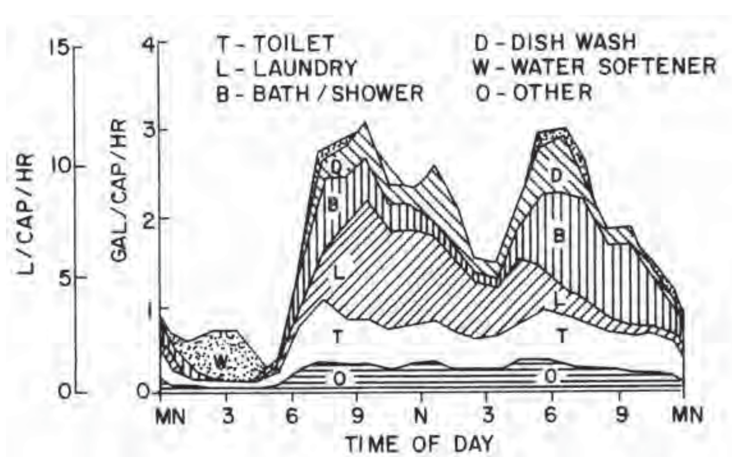
Source: Crites and Tchobanoglous, 1998.

3.3.3 Variability of wastewater flow

Variability of wastewater flow is usually characterized by daily and hourly minimum and maximum flows and instantaneous peak flows that occur during the day. The intermittent occurrence of individual wastewater-generating activities can create large variations in wastewater flows from residential or nonresidential establishments. This variability can affect gravity-fed onsite systems by potentially causing hydraulic overloads of the system during peak flow conditions. Figure 3-3 illustrates the routine fluctuations in wastewater flows for a typical residential dwelling.

Wastewater flow can vary significantly from day to day. Minimum hourly flows of zero are typical for

Figure 3-3. Daily indoor water use pattern for single-family residence



Source: University of Wisconsin, 1978.

Table 3-5. Typical wastewater flow rates from institutional sources[a]

Facility	Unit	Flow, gallons/unit/day Range	Flow, gallons/unit/day Typical	Flow, liters/unit/day Range	Flow, liters/unit/day Typical
Assembly hall	Seat	2–4	3	8–15	11
Hospital, medical	Bed	125–240	165	470–910	630
	Employee	5–15	10	19–57	38
Hospital, mental	Bed	75–140	100	280–530	380
	Employee	5–15	10	19–57	38
Prison	Inmate	80–150	120	300–570	450
	Employee	5–15	10	19–57	38
Rest home	Resident	50–120	90	190–450	340
	Employee	5–15	10	19–57	38
School, day-only:					
With cafeteria, gym, showers	Student	15–30	25	57–110	95
With cafeteria only	Student	10–20	15	38–76	57
Without cafeteria, gym, or showers	Student	5–17	11	19–64	42
School, boarding	Student	50–100	75	190–380	280

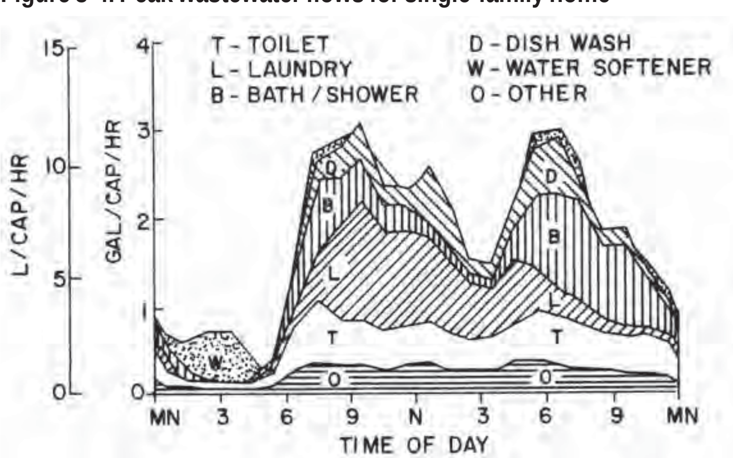
[a] Systems serving more than 20 people might be regulated under USEPA's Class V UIC Program. See http://www.epa.gov/safewater/uic.html for more information.

Source: Crites and Tchobanoglous, 1998.

residential dwellings. Maximum hourly flows as high as 100 gallons (380 L/hr) (Jones, 1976; Watson et al., 1967) are not unusual given the variability of typical fixture and appliance usage characteristics and residential water use demands. Hourly flows exceeding this rate can occur in cases of plumbing fixture failure and appliance misuse (e.g., broken pipe or fixture, faucets left running).

Wastewater flows from nonresidential establishments are also subject to wide fluctuations over time and are dependent on the characteristics of water-using fixtures and appliances and the business characteristics of the establishment (e.g., hours of operation, fluctuations in customer traffic).

Figure 3-4. Peak wastewater flows for single-family home



Source: University of Wisconsin, 1978.

The peak flow rate from a residential dwelling is a function of the fixtures and appliances present and their position in the plumbing system configuration. The peak discharge rate from a given fixture or appliance is typically around 5 gallons/minute (19 liters/minute), with the exception of the tank-type toilet and possibly hot tubs and bathtubs. The use of several fixtures or appliances simultaneously can increase the total flow rate above the rate for isolated fixtures or appliances. However, attenuation occurring in the residential drainage system tends to decrease peak flow rates observed in the sewer pipe leaving the residence. Although field data are limited, peak discharge rates from a single-family dwelling of 5 to 10 gallons/minute (19 to 38 liters/minute) can be expected. Figure 3-4 illustrates the variability in peak flow from a single home.

3.4 Wastewater quality

The qualitative characteristics of wastewaters generated by residential dwellings and nonresidential establishments can be distinguished by their physical, chemical, and biological composition. Because individual water-using events occur intermittently and contribute varying quantities of

Table 3-6. Typical wastewater flow rates from recreational facilities[a]

Facility	Unit	Flow, gallons/unit/day Range	Flow, gallons/unit/day Typical	Flow, liters/unit/day Range	Flow, liters/unit/day Typical
Apartment, resort	Person	50–70	60	190–260	230
Bowling alley	Alley	150–250	200	570–950	760
Cabin, resort	Person	8–50	40	30–190	150
Cafeteria	Customer	1–3	2	4–11	8
	Employee	8–12	10	30–45	38
Camps:					
Pioneer type	Person	15–30	25	57–110	95
Children's, with central toilet/bath	Person	35–50	45	130–190	170
Day, with meals	Person	10–20	15	38–76	57
Day, without meals	Person	10–15	13	38–57	49
Luxury, private bath	Person	75–100	90	280–380	340
Trailer camp	Trailer	75–150	125	280–570	470
Campground-developed	Person	20–40	30	76–150	110
Cocktail lounge	Seat	12–25	20	45–95	76
Coffee Shop	Customer	4–8	6	15–30	23
	Employee	8–12	10	30–45	38
Country club	Guests onsite	60–130	100	230–490	380
	Employee	10–15	13	38–57	49
Dining hall	Meal served	4–10	7	15–38	26
Dormitory/bunkhouse	Person	20–50	40	76–190	150
Fairground	Visitor	1–2	2	4–8	8
Hotel, resort	Person	40–60	50	150–230	190
Picnic park, flush toilets	Visitor	5–10	8	19–38	30
Store, resort	Customer	1–4	3	4–15	11
	Employee	8–12	10	30–45	38
Swimming pool	Customer	5–12	10	19–45	38
	Employee	8–12	10	30–45	38
Theater	Seat	2–4	3	8–15	11
Visitor center	Visitor	4–8	5	15–30	19

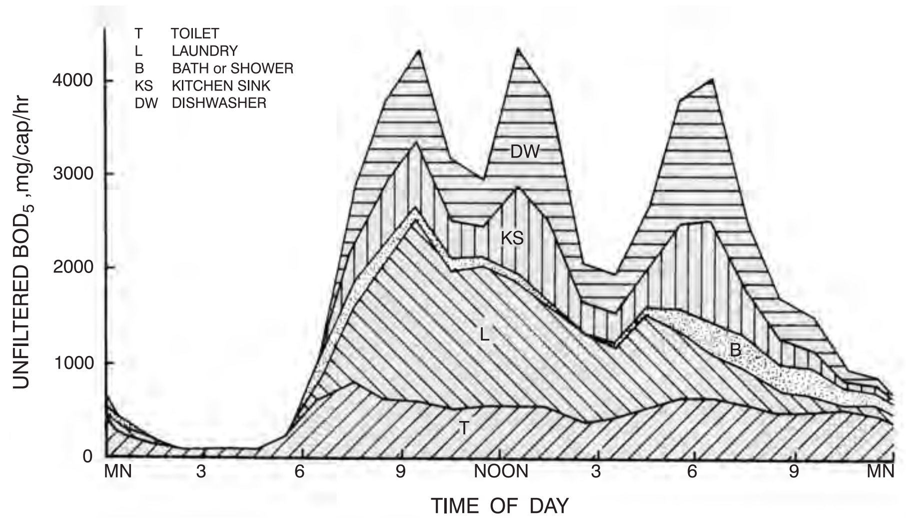
[a] Some systems serving more than 20 people might be regulated under USEPA's Class V UIC Program.

Source: Crites and Tchobanoglous, 1998.

pollutants, the strength of residential wastewater fluctuates throughout the day (University of Wisconsin, 1978). For nonresidential establishments, wastewater quality can vary significantly among different types of establishments because of differences in waste-generating sources present, water usage rates, and other factors. There is currently a dearth of useful data on nonresidential wastewater organic strength, which can create a large degree of uncertainty in design if facility-specific data are not available. Some older data (Goldstein and Moberg, 1973; Vogulis, 1978) and some new information exists, but modern organic strengths need to be verified before design given the importance of this aspect of capacity determination.

Wastewater flow and the type of waste generated affect wastewater quality. For typical residential sources peak flows and peak pollutant loading rates do not occur at the same time (Tchobanoglous and Burton, 1991). Though the fluctuation in wastewater quality (see figure 3-5) is similar to the water use patterns illustrated in figure 3-3, the fluctuations in wastewater quality for an individual home are likely to be considerably greater than the multiple-home averages shown in figure 3-5.

Figure 3-5. Average hourly distribution of total unfiltered BOD_5



Source: University of Wisconsin, 1978.

OWTSs should be designed to accept and process hydraulic flows from a residence (or establishment) while providing the necessary pollutant removal efficiency to achieve performance goals. The concentrations of typical pollutants in raw residential wastewaters and average daily mass loadings are summarized in table 3-7. Residential water-using activities contribute varying amounts of pollutants to the total wastewater flow. Table 3-8 contains a summary of the average mass loading of several key pollutants from the sources identified in table 3-7.

If the waste-generating sources present at a particular nonresidential establishment are similar to those of a typical residential dwelling, an approximation of the pollutant mass loadings and concentrations in the wastewater can be derived using the residential wastewater quality data for those categories presented in tables 3-7 and 3-8. However, the results of previous studies have demonstrated that in many cases nonresidential wastewater is considerably different from residential wastewater. Restaurant wastewater, for example, contains substantially higher levels of organic matter, solids, and grease compared to typical residential wastewater (Siegrist et al., 1984; University of Wisconsin, 1978). Restaurant wastewater BOD_5 concentrations reported in the literature range from values similar to those for domestic waste to well over 1,000 milligrams/liter, or 3.5 to 6.5 times higher than residential BOD_5. Total suspended solids and grease concentrations in restaurant wastewaters were reported to be 2 to 5 times higher than the concentrations in domestic wastewaters (Kulesza, 1975; Shaw, 1970). For shopping centers, the average characteristics determined by one study found BOD_5 average concentrations of 270 milligrams/liter, with suspended solids concentrations of 337 milligrams/liter and grease concentrations of 67 milligrams/liter (Hayashida, 1975).

More recent characterizations of nonresidential establishments have sampled septic tank effluent, rather than the raw wastewater, to more accurately identify and quantify the mass pollutant loads delivered to the components of the final treatment train (Ayres Associates, 1991; Siegrist et al., 1984). Because of the variability of the data, for establishments where the waste-generating sources are significantly different from those in a residential dwelling or where more refined characterization data might be appropriate, a detailed review of the pertinent literature, as well as wastewater sampling at the particular establishment or a similar establishment, should be conducted.

3.5 Minimizing wastewater flows and pollutants

Minimizing wastewater flows and pollutants involves techniques and devices to (1) reduce water use and resulting wastewater flows and (2) decrease the quantity of pollutants discharged to the waste stream. Minimizing wastewater volumes and pollutant concentrations can improve the efficiency of onsite treatment and lessen the risk of hydraulic or treatment failure (USEPA, 1995). These meth-