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4. DRINKING WATER INTAKE

4.1 INTRODUCTION

Drinking water is a potential source of human exposure to toxic substances among children. Contamination of drinking water may occur by, for example, percolation of toxics through the soil to ground water that is used as a source of drinking water; runoff or discharge to surface water that is used as a source of drinking water; intentional or unintentional addition of substances to treat water (e.g., chlorination); and leaching of materials from plumbing systems (e.g., lead). Estimating the magnitude of the potential dose of toxics from drinking water requires information on the quantity of water consumed. The purpose of this section is to describe key published studies that provide information on drinking water consumption (Section 4.2) among children and to provide recommendations of consumption rate values that should be used in exposure assessments (Section 4.3).

Currently, the U.S. EPA uses the quantity 1 L per day for infants (individuals of 10 kg body mass or less) and children as a default drinking water intake rates (U.S. EPA, 1980; 1991). This rate includes drinking water consumed in the form of juices and other beverages containing tapwater. The National Academy of Sciences (NAS, 1977) estimated that daily consumption of water may vary with levels of physical activity and fluctuations in temperature and humidity. It is reasonable to assume that children engaging in physically-demanding activities or living in warmer regions may have higher levels of water intake.

Two studies cited in this chapter have generated data on drinking water intake rates. In general, these sources support EPA's use of 1 L/day as an upper-percentile tapwater intake rate for children under 10 years of age. The studies have reported intake rates for direct and indirect ingestion of water. *Direct intake* is defined as direct consumption of water as a beverage, while *indirect intake* includes water added during food preparation, but not water intrinsic to purchased foods. Data for consumption of various sources (i.e., the community water supply, bottled water, and other sources) are also presented. For the purposes of exposure assessments involving site-specific contaminated drinking water, intake rates based on the community supply are most appropriate. Given the assumption that bottled water, and other purchased foods and beverages are widely distributed and less likely to contain source-specific water, the use of total water intake rates may overestimate the potential exposure to toxic substances present only in local water

supplies; therefore, tapwater intake of community water, rather than total water intake, is emphasized in this section.

The studies on drinking water intake that are currently available are based on short-term survey data. Although short-term data may be suitable for obtaining mean intake values that are representative of both short- and long-term consumption patterns, upper-percentile values may be different for short-term and long-term data because more variability generally occurs in short-term surveys. It should also be noted that most drinking water surveys currently available are based on recall. This may be a source of uncertainty in the estimated intake rates because of the subjective nature of this type of survey technique.

The distribution of water intakes is usually, but not always, lognormal. Instead of presenting only the lognormal parameters, the actual percentile distributions are presented in this handbook, usually with a comment on whether or not it is lognormal. To facilitate comparisons between studies, the mean and the 90th percentiles are given for all studies where the distribution data are available. With these two parameters, along with information about which distribution is being followed, one can calculate, using standard formulas, the geometric mean and geometric standard deviation and hence any desired percentile of the distribution. Before doing such a calculation one must be sure that one of these distributions adequately fits the data.

Other studies based on older data were presented in the *Exposure Factors Handbook* (U.S. EPA, 1997a).

4.2 DRINKING WATER INTAKE STUDIES

U.S. EPA Office of Water (2000) - Estimated Per Capita Water Ingestion in the United States - The U.S. EPA used data from a U.S. Department of Agriculture (USDA) survey from 1994 through 1996 to estimate drinking water ingestion rates by the U.S. population. The Continuous Study of Food Intakes by Individuals (CSFII) is a continuing survey of food consumption habits in the U.S. Over 15,000 persons responded to the study conducted between 1994 and 1996 on what they ate and drank over two non-consecutive days (USDA, 1998). The U.S. EPA used the drinking water ingestion data to derive estimates of consumption rates by age groups, gender, water source, vulnerable subsets of the population (i.e., lactating and pregnant women) (U.S. EPA, 2000). The ingestion rates are expressed in both volume (milliliters [ml]) per day per person and volume per kilogram (kg) body weight (BW) per day. The purpose of the

report was to provide data to assist in estimating human health risks from the ingestion of contaminated or potentially-contaminated drinking water (U.S. EPA, 2000).

In the study, the U.S. EPA reported that community water (i.e., tapwater-public water supply) accounts for approximately 75 percent of the mean ingested water (U.S. EPA, 2000). The total water consumption consists of community water supply, bottled water, other sources, and missing sources. Other sources include household wells or cisterns or a spring, either household or community. In addition to these sources, the data also distinguish between direct and indirect water consumption. Direct consumption is water consumed directly from the tap while indirect consumption is water added during final food or beverage preparation in the home or food establishment (e.g., restaurants, school cafeterias). Indirect water does not include water added by the food manufacturer during food processing. Table 4-1 provides the estimates for the mean total direct and indirect water consumption by water source for 1994 to 1996 per person combined for all ages. The estimates also include consumption rates for the 90th percentile and the 95th percentile plus the upper and lower bounds for each percentile. Table 4-2 shows the estimated total direct and indirect water ingestion by all sources by broad age groups (i.e., <1 year, 1-10 years, 11-19 years) and percentiles.

The data are broken down into multiple population subsets including children's age groups: less than 1 year, 1 to 10 years, and 11 to 19 years. The data show that although the quantity of water ingested decreases with age, the quantity consumed per unit mass of body weight (BW) increases (U.S. EPA, 2000). For instance, the mean community water consumption is 342 ml per child per day for under 1 year, 400 ml/child/day for 1 to 10 years, and 683 ml/child/day for 11 to 19 years. The consumption as a function of unit mass, however, is 46 ml/kilogram (kg) BW/day for under 1 year, 19 ml/kg BW/day for 1 to 10 years, and 12 ml/kg BW/day for 11 to 19 years. The significance of this finding is that although children may be encounter lower overall doses, the younger, vulnerable ages (i.e., infants) have significantly higher dose rates per unit of BW. Tables 4-3 and 4-4 show the daily community water consumption rate estimates by fine and broad age groups in units of mL/day and mL per mass of BW per day. Tables 4-5 and 4-6 present the data for bottled water ingestion.

Water consumption rates for other sources of water are compiled in Tables 4-7 and 4-8. These two sources comprise nearly one-quarter of total water consumption. The trend in the data is similar to that shown for community water consumption; that is, the younger ages consume less

of these sources of water, but the quantity consumed per unit mass of BW increases as the age decreases. Missing water sources have not been included in the summary of water sources because of its negligible quantity. Missing water sources comprise only about one percent of water consumption.

The data collected from the CSFII study for the USDA have both strengths and limitations. The strengths lie in the design of the survey in that it was intended to collect a statistically representative sample of the U.S. population (i.e., obtain data from a sufficiently large sample set) and the survey was sufficiently specific in detailing types of food and drink. The large size of the sample population (> 15,000) total and 6,000 children enhances the precision and accuracy of the estimates for the overall population and population subsets. The survey was conducted on non-consecutive days which improves the variance over consecutive days of consumption. In addition, the survey was administered such that an interviewer went through the data collection process for the initial day to show the participants the proper response methodology. The second day of the survey was reported by the participant. The survey also represents the most up-to-date on water consumption and incorporated sufficient parameters to differentiate sources of water, ages, gender, weight, and vulnerable populations. The limitations of the survey involve the short duration of the study and some of the data reporting methods. The short duration (i.e., 2 non-consecutive days), although an advantage over 2 consecutive days, diminishes the precision of an individual's water ingestion rate. The mean for an individual can easily be skewed for numerous reasons. The large number of the sample population would hopefully contribute to greater accuracy, but the precision may still be low. The data reporting did not always support variance estimation for some reported population subsets. As such, the means differences could not always be statistically tested except for the larger population subsets. Therefore, the reported differences were derived empirically instead of statistically.

Myers et al. (1999) - Options for Development of Parametric Probability Distributions for Exposure Factors - Myers et al. (1999) presented a system of procedures to fit distributions to selected data from the draft *Exposure Factors Handbook* (EFH) (U.S. EPA, 1996). The system was based on EPA's Guiding Principles for Monte Carlo Analysis (U.S. EPA, 1997b). The system was applied to the dataset of total tapwater intake reported in Table 3-7 (Ershow and Cantor, 1989) of the EFH. EFH Table 3-7 data summaries analyzed by Myers et al. (1999)

consist of nine estimated percentiles for total daily tapwater intake in mL/kg-day. Only the values for infants, children, and teens are reported here.

The statistical methodology recommended by Myers et al. (1999) incorporates the following elements:

1. a dataset and its underlying experimental design.
2. a family of models, and
3. an approach to inference (e.g., estimation, assessment of fit, and uncertainty analysis).

The system utilizes a twelve-model hierarchy with the most general model being a five-parameter generalized F distribution with a point mass at zero. The point mass at zero represents the proportion of nonconsuming or nonexposed individuals. As described in Myers et al. (1999), the 12 models of the generalized F hierarchy were fit to each of the three tapwater datasets (i.e., three age groups of children) using three different estimation criteria, maximum likelihood estimation (MLE), minimum chi-square estimation (MCS), and weighted least squares (WLS). The Pearson chi-square tests and likelihood ratio tests of goodness-of-fit (GOF) were used. Tables 4-9 and 4-10 present chi-square values and associated p-values for chi-square GOF tests, respectively. As stated in Myers et al. (1999), "In each case the null hypothesis tested is that the data arose from the given type of model. A low p-value casts doubt on the null hypothesis. Clearly, the only model that appears to fit most of the datasets is the five-parameter generalized F distribution with a point mass at zero, referred to as GenF5. According to Table 4-9, the gamma model provides the best fit (smallest chi-square) of the two-parameter models to the data for each individual age groups."

Table 4-11 is shown in Myers et al. (1999) and is described there as follows:

> "[This table] summarizes several additional aspects of interest for the tapwater populations. For each age group shown, the first row (SOURCE=data) is basically a data summary. Within the first row, the columns labeled N, MEAN, and SDEV contain the sample size, the sample mean, and the sample standard deviation. Within the first row, the columns labeled P01, P05, ..., P99 contain the nominal

probabilities .01, .05, ..., .99. The values in the first row for MEAN, SDEV, and the nine nominal probabilities can be thought of as 11 targets that the models are trying to hit.

The other rows (2nd through 6th rows) within each age group contain results from fitting four models, including gamma, lognormal and Weibull, using selected estimation criteria. The model and estimation criterion are indicated by the variable SOURCE. For instance, SOURCE = gammle indicates the two-parameter gamma model fit using maximum likelihood estimation. The model gf5 is the five-parameter generalized F with a point mass at zero. The infants group does not contain results from the five-parameter generalized F because the selected model had infinite variance. For the gamma and Weibull models, there was little difference between the three estimation criteria, and the MLE performed best overall. For the lognormal model, results from the WLS estimation criterion are shown in addition to the MLE.

The last three columns contain summary GOF measures. CHIDF is the value of the chi-square statistic divided by its degrees of freedom. The methods are ordered with respect to this CHIDF measure. CHIDF is more comparable across cases involving different degrees of freedom than is the chi-square statistic. PGOF is the p-value for model goodness-of-fit based on the chi-square test. Low-values of PGOF, such as PGOF <0.05, cast doubt on the null hypothesis that the given type of model is correct. Note that maximum likelihood estimation performed much worse for the lognormal model than the WLS method of estimation, as determined by CHIDF and PGOF measures.

If a two-parameter model must be used for tapwater consumption, then the gamma model with parameters estimated by maximum likelihood is recommended. The five-parameter generalized F distribution could be used for sensitivity analyses. The age effect seems sufficiently strong to justify the use of separate age groups in risk assessment."

4.3. PREGNANT AND LACTATING WOMEN

Ershow et al. (1991) - Intake of Tapwater and Total Water by Pregnant and Lactating Women - Ershow et al. (1991) used data from the 1977-78 USDA NFCS to estimate total fluid and total tapwater intake among pregnant and lactating women (ages 15-49 years). Data for 188 pregnant women, 77 lactating women, and 6,201 non-pregnant, non-lactating control women were evaluated. The participants were interviewed based on 24 hour recall, and then asked to record a food diary for the next 2 days. "Tapwater" included tapwater consumed directly as a beverage and tapwater used to prepare food and tapwater-based beverages. "Total water" was defined as all water from tapwater and non-tapwater sources, including water contained in food. Estimated total fluid and total tapwater intake rates for the three groups are presented in Tables 4-12 and 4-13, respectively. Lactating women had the highest mean total fluid intake rate (2.24 L/day) compared with both pregnant women (2.08 L/day) and control women (1.94 L/day). Lactating women also had a higher mean total tapwater intake rate (1.31 L/day) than pregnant women (1.19 L/day) and control women (1.16 L/day). The tapwater distributions are neither normal nor lognormal, but lactating women had a higher mean tapwater intake than controls and pregnant women. Ershow et al. (1991) also reported that rural women (n=1,885) consumed more total water (1.99 L/day) and tapwater (1.24 L/day) than urban/suburban women (n=4,581, 1.93 and 1.13 L/day, respectively). Total water and tapwater intake rates were lowest in the northeastern region of the United States (1.82 and 1.03 L/day) and highest in the western region of the United States (2.06 L/day and 1.21 L/day). Mean intake per unit body weight was highest among lactating women for both total fluid and total tapwater intake. Total tapwater intake accounted for over 50 percent of mean total fluid in all three groups of women (Table 4-13). Drinking water accounted for the largest single proportion of the total fluid intake for control (30 percent), pregnant (34 percent), and lactating women (30 percent) (Table 4-14). All other beverages combined accounted for approximately 46 percent, 43 percent, and 45 percent of the total water intake for control, pregnant, and lactating women, respectively. Food accounted for the remaining portion of total water intake.

This survey has an adequately large size (6,201 individuals) and it is representative of the United States population with respect to age distribution, racial composition, and residential location. The chief limitation of the study is that the data were collected in 1978 and do not reflect the expected increase in the consumption of soft drinks and bottled water or changes in the

diet within the last two decades. Since the data were collected for only a three-day period, the extrapolation to chronic intake is uncertain.

4.4 RECOMMENDATIONS

The studies described in this section were used in selecting recommended drinking water (tapwater) consumption rates for children. The mean and upper-percentile estimates reported in these studies are reasonably similar. The surveys described here are based on short-term recall which may be biased toward excess intake rates. However, Cantor et al. (1987) noted that retrospective dietary assessments generally produce moderate correlations with "reference data from the past." A summary of the recommended values for drinking water intake rates is presented in Table 4-15.

The intake rates, as expressed as liters per day, generally increase with age, and the data are consistent across ages for the studies.

A characterization of the overall confidence in the accuracy and appropriateness of the recommendations for drinking water is presented in Table 4-16. The Exposure Factors Handbook (U.S. EPA, 1997a) gave this factor a medium confidence rating. However, the confidence score of the overall recommendations has been increased to high for this report because of the addition of the newer U.S. EPA (2000) study.

4.4 REFERENCES FOR CHAPTER 4

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Table 4-1. Estimated Direct and Indirect Community Total Water Ingestion By Source for U.S. Population

		Mean (ml/person/day)			90th Percentile (ml/person/day)			95th Percentile (ml/person/day)		
			90% CI			90% CI			90% CI	
Source	Sample Size	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound	Estimate	Lower Bound	Upper Bound
Community Water Supply	15,303	927	902	951	2,016	1,991	2,047	2,544	2,485	2,576
Bottled Water	15,303	161	147	176	591	591	632	1,036	1,006	1,065
Other Sources	15,303	128	101	155	343	305	360	1,007	947	1,074
Missing Sources	15,303	16	13	20	-	-	-	-	-	-
All Sources	15,303	1,232	1,199	1,265	2,341	2,308	2,366	2,908	2,840	2,960

- Denotes zero.

(1) Source of Data - USDA Continuing Survey of Food Intakes by Individuals (1994-1996)
(2) Estimates are based on 2-day averages for non-consecutive days.

Source: U.S. EPA (2000)

Table 4-2. Estimate of Total Direct and Indirect Water Ingestion, All Sources By Broad Age Category for U.S. Children

		Quantity, Percentiles (ml/person-day)									
Age (years)	Sample Size	Mean	1th	5th	10th	25th	50th	75th	90th	95th	99th
< 1	359	484	-	-	-	124	449	747	949	1,182	1,645[a]
1 - 10	3,980	528	4	75	133	254	444	710	1,001	1,242	1,891
11 - 19	1,641	907	-	118	219	395	715	1,188	1,780	2,185	3,805
		Quantity, Percentiles (ml/kg-day)									
< 1	359	67	-	-	-	16	57	101	156	170	218a
1 - 10	3,980	25	-	4	6	12	21	33	49	64	98
11 -19	1,641	16	-	2	4	7	13	20	30	39	64

Source of Data: 1994-96 USDA Survey of Food Intakes by Individuals (CSFII)
- Denotes zero.
a - Sample size was insufficient for minimum reporting requirements according to “Third Report on Nutritional Monitoring in the U.S. (1994-96)”

Source: U.S. EPA (2000)

Table 4-3. Estimate of Direct and Indirect Community Water Ingestion By Fine Age Category for U.S. Children

			Quantity, Percentile (ml/person-day)								
Age (years)	Sample Size	Mean	1th	5th	10th	25th	50th	75th	90th	95th	99th
< 0.5	199	280	-	-	-	-	35	552	861	945[a]	1,286[a]
0.5 - 0.9	160	412	-	-	-	36	322	712	884	1,101[a]	1,645[a]
1 - 3	1,834	313	-	-	-	74	236	469	691	942	1,358
4 - 6	1,203	420	-	-	22	133	330	591	917	1,165	1,902[a]
7 - 10	943	453	-	-	29	139	355	671	978	1,219	1,914[a]
11 - 14	816	594	-	-	27	181	435	801	1,365	1,722	2,541[a]
15 - 19	825	760	-	-	25	201	540	1,030	1,610	2,062	3,830[a]
			Quantity, Percentile (ml/kg-day)								
< 0.5	191	47	-	-	-	-	5	90	139	170[a]	217[a]
0.5 - 0.9	153	45	-	-	-	4	36	79	103	122[a]	169[a]
1 - 3	1,752	23	-	-	1	6	17	33	51	67	109[a]
4 - 6	1,113	21	-	-	1	6	16	29	44	64	91[a]
7 - 10	879	15	-	-	1	5	11	21	32	39	60[a]
11 - 14	790	12	-	-	1	4	9	17	26	34	54[a]
15 -19	816	12	-	-	-	3	9	16	25	32	61[a]

Source of Data: 1994-96 USDA Survey of Food Intakes by Individuals (CSFII)
- Denotes zero.
a - Sample size was insufficient for minimum reporting requirements according to "Third Report on Nutritional Monitoring in the U.S. (1994-96)"
Source: U.S. EPA (2000)

Table 4-4. Estimate of Direct and Indirect Community Water Ingestion By Broad Age Category for U.S. Children

			Quantity, Percentile (ml/person-day)								
Age (years)	Sample Size	Mean	1th	5th	10th	25th	50th	75th	90th	95th	99th
< 1	344	342	-	-	-	-	173	652	878	1,040	1,438[a]
1 - 10	3,744	400	-	-	12	118	302	571	905	1,118	1,731
11 - 19	1,606	683	-	-	26	191	473	937	1,533	1,946	3,671
			Quantity, Percentile (ml/kg-day)								
< 1	344	46	-	-	-	-	19	82	127	156	205[a]
1 - 10	3,744	19	-	-	-	5	15	27	42	56	91
11 - 19	1,606	12	-	-	1	3	9	16	26	33	59

Source of Data: 1994-96 USDA Survey of Food Intakes by Individuals (CSFII)
- Denotes zero.
a - Sample size was insufficient for minimum reporting requirements according to "Third Report on Nutritional Monitoring in the U.S. (1994-96)."
Source: U.S. EPA (2000)

Table 4-5. Estimate of Direct and Indirect Bottled Water Ingestion By Fine Age Category for U.S. Children

			Quantity, Percentile (ml/person-day)								
Age (years)	Sample Size	Mean	1th	5th	10th	25th	50th	75th	90th	95th	99th
< 0.5	199	110	-	-	-	-	-	38	519	809	1,045[a]
0.5 - 0.9	160	113	-	-	-	-	-	5	496	727[a]	1,006[a]
1 - 3	1,834	62	-	-	-	-	-	-	235	411	820
4 - 6	1,203	73	-	-	-	-	-	-	279	521	915[a]
7 - 10	943	76	-	-	-	-	-	-	271	497	917[a]
11 - 14	816	100	-	-	-	-	-	-	344	679	1,415[a]
15 - 19	825	130	-	-	-	-	-	-	468	867	1,775[a]
			Quantity, Percentile (ml/kg-day)								
< 0.5	191	20	-	-	-	-	-	6	81	152[a]	170[a]
0.5 - 0.9	153	14	-	-	-	-	-	2	51	92[a]	125[a]
1 - 3	1,752	5	-	-	-	-	-	-	17	30	61
4 - 6	1,113	4	-	-	-	-	-	-	13	24	49[a]
7 - 10	879	2	-	-	-	-	-	-	8	14	26[a]
11 - 14	790	2	-	-	-	-	-	-	7	13	27[a]
15 -19	816	2	-	-	-	-	-	-	7	12	28[a]

Source of Data: 1994-96 USDA Survey of Food Intakes by Individuals (CSFII)
- Denotes zero.
a - Sample size was insufficient for minimum reporting requirements according to "Third Report on Nutritional Monitoring in the U.S. (1994-96)"
Source: U.S. EPA (2000)

Table 4-6. Estimate of Direct and Indirect Bottled Water Ingestion By Broad Age Category for U.S. Children

			Quantity, Percentile (ml/person-day)								
Age (years)	Sample Size	Mean	1th	5th	10th	25th	50th	75th	90th	95th	99th
< 1	359	111	-	-	-	-	-	23	522	793	1,083[a]
1 - 10	3,980	71	-	-	-	-	-	-	264	472	906
11 - 19	1,641	116	-	-	-	-	-	-	414	764	1,648
			Quantity, Percentile (ml/kg-day)								
< 1	344	17	-	-	-	-	-	5	76	123	169[a]
1 - 10	3,744	3	-	-	-	-	-	-	12	22	49
11 - 19	1,606	2	-	-	-	-	-	-	7	13	28

Source of Data: 1994-96 USDA Survey of Food Intakes by Individuals (CSFII)
- Denotes zero.
a - Sample size was insufficient for minimum reporting requirements according to "Third Report on Nutritional Monitoring in the U.S. (1994-96)."
Source: U.S. EPA (2000)

Table 4-7. Estimate of Direct and Indirect Other Water Ingestion By Fine Age Category for U.S. Children

			Quantity, Percentile (ml/person-day)								
Age (years)	Sample Size	Mean	1th	5th	10th	25th	50th	75th	90th	95th	99th
< 0.5	199	18	-	-	-	-	-	-	-	86[a]	468[a]
0.5 - 0.9	160	30	-	-	-	-	-	-	23	202[a]	554[a]
1 - 3	1,834	35	-	-	-	-	-	-	8	295	710
4 - 6	1,203	43	-	-	-	-	-	-	32	322	830[a]
7 - 10	943	67	-	-	-	-	-	-	206	554	1,049[a]
11 - 14	816	106	-	-	-	-	-	-	341	800	1,811[a]
15 - 19	825	77	-	-	-	-	-	-	234	552	1,411[a]
			Quantity, Percentile (ml/kg-day)								
< 0.5	191	3	-	-	-	-	-	-	-	15[a]	86[a]
0.5 - 0.9	153	3	-	-	-	-	-	-	5	24[a]	63[a]
1 - 3	1,752	3	-	-	-	-	-	-	2	21	48
4 - 6	1,113	2	-	-	-	-	-	-	2	15	42[a]
7 - 10	879	2	-	-	-	-	-	-	7	18	37[a]
11 - 14	790	2	-	-	-	-	-	-	7	16	36[a]
15 -19	816	1	-	-	-	-	-	-	4	9	21[a]

Source of Data: 1994-96 USDA Survey of Food Intakes by Individuals (CSFII)
- Denotes zero.
a - Sample size was insufficient for minimum reporting requirements according to "Third Report on Nutritional Monitoring in the U.S. (1994-96)"
Source: U.S. EPA (2000)

Table 4-8. Estimate of Direct and Indirect Other Water Ingestion By Broad Age Category for U.S. Children

			Quantity, Percentile (ml/person-day)								
Age (years)	Sample Size	Mean	1th	5th	10th	25th	50th	75th	90th	95th	99th
< 1	359	23	-	-	-	-	-	-	-	148	556[a]
1 - 10	3,980	50	-	-	-	-	-	-	103	405	920
11 - 19	1,641	90	-	-	-	-	-	-	286	666	1,710
			Quantity, Percentile (ml/kg-day)								
< 1	344	3	-	-	-	-	-	-	-	21	66[a]
1 - 10	3,744	2	-	-	-	-	-	-	5	18	43
11 - 19	1,606	2	-	-	-	-	-	-	5	11	29

Source of Data: 1994-96 USDA Survey of Food Intakes by Individuals (CSFII)
- Denotes zero.
a - Sample size was insufficient for minimum reporting requirements according to "Third Report on Nutritional Monitoring in the U.S. (1994-96)."
Source: U.S. EPA (2000)

Table 4-9. Chi-square GOF statistics for 12 Models, Tapwater Data, Based on Maximum Likelihood Method of Parameter Estimation

Age Group (years)	CHI Gam2	CHI Log2	CHI Tic2	CHI Wei2	CHI Ggam3	CHI GenF4	CHI Gam3	CHI Log3	CHI Tic3	CHI Wei3	CHI Ggam4	CHI GenF5
Infants (<1)	19.8	26.6	39.4	20.6	18.1	10.6	19.8	13.7	10.8	20.6	18.1	8.10
Children (1-10)	84.5	315	295	198	84.7	40.3	46.6	129	195	198	27.5	15.2
Teens (11-19)	89.5	606	557	125	81.4	38.4	23.4	286	377	110	23.1	7.88

Legend: Prefix indicates model type, Gam = gamma, Log = lognormal, Tic = log-logistic, Wei = Weibull, Ggam = generalized gamma, GenF = generalized F.

Model suffix indicates number of free or adjustable parameters.

Table 4-10. P-Values for Chi-Square GOF Tests of 12 Models, Tapwater Data

Age Group (years)	PGOF Gam2	PGOF Log2	PGOF Tic2	PGOF Wei2	PGOF Ggam3	PGOF GenF4	PGOF Gam3	PGOF Log3	PGOF Tic3	PGOF Wei3	PGOF Ggam4	PGOF GenF5
Infants (<1)	0.001	0.000	0.000	0.000	0.000	0.005	0.000	0.003	0.013	0.000	0.000	0.013
Children (1-10)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004
Teens (11-19)	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.096

Legend: Prefix indicates model type, Gam = gamma, Log = lognormal, Tic = log-logistic, Wei = Weibull, Ggam = generalized gamma, GenF = generalized F.

Model suffix indicates number of free or adjustable parameters.

Table 4-11. Results of Statistical Modeling of Tapwater Data (intake Rates in dL/kg-day) Using 5-Parameter Generalized F and 2-Parameter Gamma, Lognormal and Weibull Modles

Source	N	P01	P05	P10	P25	P50	P75	P90	P95	P99	MEAN	SDEV	CHIDF	PGOF
INFANTS (Age <1)														
data	403	0.010	0.050	0.100	0.250	0.500	0.750	0.900	0.950	0.990	0.435	0.425		
gammle					0.252	0.526	0.702	0.908	0.951	0.996	0.448	0.410	40.945	0.0006
weimle					0.260	0.526	0.699	0.906	0.950	0.996	0.447	0.412	50.145	0.0004
logmle					0.227	0.561	0.735	0.903	0.937	0.984	0.470	0.548	60.660	0.0000
logwls					0.216	0.559	0.738	0.908	0.942	0.986	0.462	0.512	60.974	0.0000
CHILDREN (Ages 1-10)														
data	5605	0.010	0.050	0.100	0.250	0.500	0.750	0.900	0.950	0.990	0.355	0.229		
gammle		0.010	0.047	0.106	0.250	0.495	0.752	0.900	0.952	0.989	0.356	0.234	30.792	0.0044
gf5mle		0.004	0.052	0.118	0.263	0.492	0.738	0.895	0.953	0.993	0.355	0.224	120.07	0.0000
weimle		0.000	0.024	0.091	0.266	0.529	0.765	0.895	0.943	0.984	0.356	0.250	270.18	0.0000
logmle		0.011	0.070	0.134	0.264	0.474	0.721	0.894	0.959	0.997	0.355	0.218	280.34	0.0000
logwls		0.000	0.036	0.113	0.288	0.532	0.750	0.878	0.929	0.977	0.366	0.286	450.07	0.0000
TEENS (Ages 11-19)														
data	5801	0.010	0.050	0.100	0.250	0.500	0.750	0.900	0.950	0.990	0.182	0.108		
gf5mle		0.010	0.048	0.103	0.253	0.498	0.747	0.953	0.953	0.989	0.182	0.110	10.969	0.0962
gammle		0.002	0.046	0.110	0.274	0.511	0.740	0.947	0.947	0.989	0.182	0.111	120.79	0.0000
weimle		0.006	0.061	0.122	0.267	0.487	0.725	0.957	0.957	0.995	0.182	0.106	170.86	0.0000
logmle		0.000	0.017	0.076	0.270	0.544	0.768	0.942	0.942	0.981	0.182	0.119	450.35	0.0000
logwls		0.000	0.032	0.108	0.303	0.548	0.747	0.920	0.920	0.968	0.189	0.144	860.56	0.0000

Table 4-12. Total Fluid Intake of Women 15-49 Years Old

Reproductive Status[a]	Mean	Standard Deviation	Percentile Distribution 5	10	25	50	75	90	95
mL/day									
Control	1940	686	995	1172	1467	1835	2305	2831	3186
Pregnant	2076	743	1085	1236	1553	1928	2444	3028	3475
Lactating	2242	658	1185	1434	1833	2164	2658	3169	3353
mL/kg/day									
Control	32.3	12.3	15.8	18.5	23.8	30.5	38.7	48.4	55.4
Pregnant	32.1	11.8	16.4	17.8	17.8	30.5	40.4	48.9	53.5
Lactating	37.0	11.6	19.6	21.8	21.8	35.1	45.0	53.7	59.2

[a] Number of observations: nonpregnant, nonlactating controls (n = 6,201); pregnant (n = 188); lactating (n = 77).

Source: Ershow et al., 1991.

Table 4-13. Total Tapwater Intake of Women 15-49 Years Old

Reproductive Status[a]	Mean	Standard Deviation	Percentile Distribution 5	10	25	50	75	90	95
mL/day									
Control	1157	635	310	453	709	1065	1503	1983	2310
Pregnant	1189	699	274	419	713	1063	1501	2191	2424
Lactating	1310	591	430	612	855	1330	1693	1945	2191
mL/kg/day									
Control	19.1	10.8	5.2	7.5	11.7	17.3	24.4	33.1	39.1
Pregnant	18.3	10.4	4.9	5.9	10.7	16.4	23.8	34.5	39.6
Lactating	21.4	9.8	7.4	9.8	14.8	20.5	26.8	35.1	37.4
Fraction of daily fluid intake that is tapwater (%)									
Control	57.2	18.0	24.6	32.2	45.9	59.0	70.7	79.0	83.2
Pregnant	54.1	18.2	21.2	27.9	42.9	54.8	67.6	76.6	83.2
Lactating	57.0	15.8	27.4	38.0	49.5	58.1	65.9	76.4	80.5

[a] Number of observations: nonpregnant, nonlactating controls (n = 6,201); pregnant (n = 188); lactating (n = 77).

Source: Ershow et al., 1991.

Table 4-14. Total Fluid (mL/Day) Derived from Various Dietary Sources by Women Aged 15-49 Years[a]

	Control Women			Pregnant Women			Lactating Women		
		Percentile			Percentile			Percentile	
Sources	Mean[b]	50	95	Mean[b]	50	95	Mean[b]	50	95
Drinking Water	583	480	1440	695	640	1760	677	560	1600
Milk and Milk Drinks	162	107	523	308	273	749	306	285	820
Other Dairy Products	23	8	93	24	9	93	36	27	113
Meats, Poultry, Fish, Eggs	126	114	263	121	104	252	133	117	256
Legumes, Nuts, and Seeds	13	0	77	18	0	88	15	0	72
Grains and Grain Products	90	65	257	98	69	246	119	82	387
Citrus and Noncitrus Fruit Juices	57	0	234	69	0	280	64	0	219
Fruits, Potatoes, Vegetables, Tomatoes	198	171	459	212	185	486	245	197	582
Fats, Oils, Dressings, Sugars, Sweets	9	3	41	9	3	40	10	6	50
Tea	148	0	630	132	0	617	253	77	848
Coffee and Coffee Substitutes	291	159	1045	197	0	955	205	80	955
Carbonated Soft Drinks[c]	174	110	590	130	73	464	117	57	440
Noncarbonated Soft Drinks[c]	38	0	222	48	0	257	38	0	222
Beer	17	0	110	7	0	0	17	0	147
Wine Spirits, Liqueurs, Mixed Drinks	10	0	66	5	0	25	6	0	59
All Sources	1940	NA	NA	2076	NA	NA	2242	NA	NA

[a] Number of observations: nonpregnant, nonlactating controls (n = 6,201); pregnant (n = 188); lactating (n = 77).
[b] Individual means may not add to all-sources total due to rounding.
[c] Includes regular, low-calorie, and noncalorie soft drinks.
NA: Not appropriate to sum the columns for the 50th and 95th percentiles of intake.
Source: Ershow et al., 1991.

Table 4-15. Summary of Recommended Community Drinking Water Intake Rates

Age Group/ Population	Mean	Percentiles 50th	90th	95th	Multiple	Fitted Distributions
<1 year[a]	0.34 L/day 46 mL/kg-day	0.17 L/day 19 mL/kg-day	0.88 L/day 127 mL/kg-day	1.0 L/day 156 mL/kg-day	Tables 4-4	Table 4-11[c]
1-3 years[a]	0.31 L/day 23 mL/kg-day	0.24 17 mL/kg-day	0.69 L/day 51 mL/kg-day	0.94 L/day 67 mL/kg-day	Table 4-3	
1-10 years[a]	0.40 L/day 19 mL/kg-day	0.30 L/day 15 mL/kg-day	0.90 L/day 42 mL/kg-day	1.1 L/day 56 mL/kg-day	Table 4-4	Table 4-11[c]
11-19 years[a]	0.68 L/day 12 mL/kg-day	0.47 L/day 9 mL/kg-day	1.5 L/day 26 mL/kg-day	1.9 L/day 33 mL/kg-day	Tables 4-4	Table 4-11[c]
Pregnant[b] Women	1.2 L/day 18.3 mL/kg-day	1.1 L/day 16 mL/kg-day	2.2 L/day 35 mL/kg-day	2.4 L/day 40 mL/kg-day	Table 3-25	
Lactating[b] Women	1.3 L/day 21.4 mL/kg-day	1.3 L/day 21 mL/kg-day	1.9 L/day 35 mL/kg-day	2.2 L/day 37 mL/kg-day	Table 3-25	

[a]Source: U.S. EPA (2000).
[b]Source: Ershow et al. (1991).
[c]Source: Myers et al. (1999).

Table 4-16. Confidence in Tapwater Intake Recommendations

Considerations	Rationale	Rating
Study Elements		
• Level of peer review	The U.S. EPA (2000) and Ershow and Cantor (1989) studies had thorough expert panel review. Review procedures were not reported in the Canadian study; it was a government report. Other reports presented are published in scientific journals.	High
• Accessibility	The two monographs are available from the sponsoring agencies; the others are library-accessible.	High
• Reproducibility	Methods are well-described.	High
• Focus on factor of interest	The studies are directly relevant to tapwater. In addition, for U.S. EPA (2000) study included consumption for other drinking water sources	High
• Data pertinent to U.S.	See "representativeness" below.	NA
• Primary data	The three monographs used recent primary data (less than one week) on recall of intake.	High
• Currency	Data collected for USDA (1998) used by U.S. EPA (2000) are current. The Ershow and Cantor (1989) and Canadian surveys used data from 1978 era.	High
• Adequacy of data collection period	These are one- to three-day intake data. However, long term variability may be small. Their use as a chronic intake measure can be assumed.	Medium
• Validity of approach	The approach was competently executed.	High
• Study size	The two U.S. monographs (U.S. EPA, 2000; Ershow and Cantor, 1989) each sufficiently sample populations (i.e., 6,000 and 11,000, respectively) for their studies	High
• Representativeness of the population	The U.S. EPA (2000), Ershow and Cantor (1989), and Canadian surveys were validated as demographically representative.	High
• Characterization of variability	The full distributions were given in the main studies.	High
• Lack of bias in study design (high rating is desirable)	Bias was not apparent.	High
• Measurement error	No physical measurements were taken. The method relied on recent recall of standardized volumes of drinking water containers, and was not validated.	Medium
Other Elements		
• Number of studies	There were three key studies for the child recommendations.	High for adult and children. Medium for the other recommended subpopulation values.
• Agreement between researchers	This agreement was good.	High
Overall Rating	The data are excellent and current.	**High**