October 2015

ATTACHMENT H

Part 201 Generic Exposure Assumption Values Update

TECHNICAL SUPPORT DOCUMENT

SUBJECT: Drinking Water Intake Rate

MDEQ Introduction

MDEQ contracted SRC, Inc. to evaluate and update the exposure assumptions and fate and transport values, consistent with the Collaborative Stakeholder Advisory (CSA) recommendations. This work is a component of the DEQ's comprehensive cleanup criteria update and is incorporated in the calculations of health-based cleanup values. The CSA recommendations pertinent to exposure assumptions and fate and transport values are presented in the Decision Framework for Determination of Exposure Values (CSA, 2014). To satisfy the "best available information" requirement of the Framework, SRC followed the Framework's process for evaluating data against the Data Quality Objectives (DQOs) and selecting the values for their recommendations. Refer to the CSA Report (2014) and Cleanup Criteria and Screening Levels Development and Application Resource Materials (Resource Materials) Section 4.3.

The SRC updated values were adopted by the MDEQ except for the drinking water intake value for pregnant workers. The U.S. EPA's (2011) 90th percentile intake rate of 1.8 L/day for pregnant women was used by the MDEQ without adjustment to protect for exposure to developmental and reproductive (DR) toxicants classified as a single event exposure (SE). Refer to the Resource Materials Section 3.2.5 and Attachment F. The SRC value is an adjusted water intake of 0.9 L/day (1/2 × 1.8 L/day) to address work hours.

Background

This Technical Support Document (TSD) describes the process used to update generic exposure assumption values for drinking water intake rate (IRW) for use in the derivation of Michigan Department of Environmental Quality (MDEQ) Part 201 Drinking Water Criteria (DWC). The TSD follows the Decision Framework for Updating the Michigan Part 201 Generic Cleanup Criteria Exposure Assumptions (TAG, 2014). As outlined in the Decision Framework, the update process involves searching for Michigan-specific data pertinent to each exposure assumption, revised U.S. Environmental Protection Agency (EPA) exposure assumptions, and other sources of relevant data (e.g., state and federal government agencies, published

literature), and evaluating both the existing and any new information against the Data Quality Objectives (DQOs) provided in the Decision Framework.

To identify new information pertinent to each exposure assumption, the following search process was followed. First, Michigan government agencies and select research universities were contacted to determine if relevant data could be provided. Second, exposure parameters recommended by U.S. EPA's (2011) most recent Exposure Factors Handbook and U.S. EPA's (2014) Office of Solid Waste and Emergency Response (OSWER) were considered. Third, searches of the published scientific literature for data or analyses specific to Michigan or to the U.S. as a whole were conducted. U.S. EPA (2011) performed comprehensive searches of scientific literature and other data sources, and indicated that the document included published literature through July, 2011. For the purpose of this TSD, searches of the published literature were restricted to papers published in 2009 or later. An earlier date than 2011 was selected to ensure that no papers published near the time of completion of the 2011 document were missed. Fourth, websites for U.S. governmental organizations were searched for readily accessible data relevant to the exposure assumptions. Fifth, selected state (including Illinois, Indiana, Minnesota, Ohio, Wisconsin, California, Oregon, Washington, Texas, and Massachusetts) and international (Health Canada and Environment Canada, Ontario Ministry of the Environment, European Commission Joint Research Centre [ECJRC], and the European Centre for Ecotoxicology and Toxicology of Chemicals [ECETOC]) environmental agency websites were searched to identify default exposure assumptions used by these agencies.

The TSD describes the results of each of the searches and the evaluation of new, relevant information against the DQOs. The DQOs in the framework (TAG, 2014) address the following:

- Relevant and applicable to Michigan;
- Clear and comprehensive;
- Sound and credible;
- Transparent and objective; and
- Certainty.
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The 2004 exposure assumptions and new relevant information were evaluated against the DQOs and given a rating of high, medium, or low; an explanation of the ratings is provided as Appendix A of this document. Based on the ratings, the data or information that best meets the DQOs, are recommended as the basis for updated values.

The algorithms used by MDEQ to derive Part 201 DWC employ a combination of central tendency and upper percentile estimates for exposure parameters. Specifically, in accordance with U.S. EPA guidance (1992), central tendency values are used for life span, body weight, and surface area, while high-end values are used for exposure duration, exposure frequency, drinking water intake rate, soil ingestion rate, and soil adherence factor. Thus, the recommendations for IRW presented in this TSD are based on upper percentile values.

Introduction

IRW represents the daily amount of water that individuals consume at their residences or workplaces. This TSD is organized into three sections: (1) residential IRW, (2) nonresidential IRW for adults and pregnant workers (IRWn), and (3) a summary of 2015 updated values. Below is a comparison of the MDEQ (2004) and 2015 updated values for IRW.

Table 1. Summary of 2005 and 2015 updated MDEQ values for drinking water intake rate (L/day)

Parameter	2004 MDEQ Value	2015 Updated Value
$IRW_{ages <2}$ = Water intake rate: ages < 2	NV	0.82
$IRW_{ages 2-<6}$= Water intake rate: ages 2 to <6	NV	0.76
$IRW_{ages birth-<6}$ = Water intake rate: birth to <6	NV	0.78
$IRW_{ages 6->16}$= Water intake rate: ages 6 to <16	NV	1.3
$IRW_{ages 16-<EDr}$= Water intake rate: ages 16 to <EDr[a]	NV	2.3
$IRW_{ages 6-<EDr}$= Water intake rate: ages 6 to <EDr[a]	NV	1.9
IRW_{adult}= Water intake rate: adult	2	2.5
IRWn = Water intake rate: nonresidential adult worker	1	1.3
IRWndev = Water intake rate: nonresidential pregnant adult worker	NV	0.90

[a]EDr is exposure duration for the residential scenario. MDEQ (2004) used 30 years for EDr, while the 2015 updated value for EDr is 32 years.
NV = no value

Section 1. Residential Drinking Water Intake Rate (IRW)

1.1 Introduction

The IRW used by MDEQ is intended to represent the total intake of water (consumed plain and as an ingredient of beverages [e.g., coffee, tea, reconstituted juice] and foods [soups and stews, etc.]) obtained from the tap at home (i.e., from a private domestic or public water supply) among people who consume water (consumers only). For residential exposure scenarios, MDEQ uses IRWs categorized by specific age groups.

1.2 MDEQ (2004) Value

1.2.1 Description of MDEQ (2004) Value

MDEQ (2004) did not recommend an IRW for children. MDEQ (2004) recommended a residential IRW of 2 L/day. MDEQ RRD staff indicated that the value is based on the 90th percentile value from U.S. EPA (1997). U.S. EPA (1997) recommended 90th percentile IRW values of 1.3, 1.7, and 2.3 L/day for ages 1 – 10 years, 11 – 19 years, and adult. The IRW values in U.S. EPA (1997) was based on data reported by Ershow and Cantor (1989); these

authors estimated the total daily intake of tap water consumed directly or indirectly (as an ingredient in beverages or food) using data collected in the 1977-78 U.S. Department of Agriculture (USDA) Nationwide Food Consumption Survey (NFCS).

1.2.2 Evaluation of Data Quality Objectives

The IRW recommended by MDEQ (2004) was evaluated using the Part 201 DQOs. A summary of the evaluation follows.

Relevance and applicability to Michigan (geographic, temporal, and demographic representativeness). The demographics of the participants in the NFCS survey evaluated by Ershow and Cantor (1989) closely mirrored the age, sex, and racial makeup of the U.S. population in 1977 (U.S. EPA, 1997). Data were reported by age-group, gender, season and region in the U.S. (e.g., Northeast, Midwest; Ershow and Cantor, 1989). Michigan-specific data were not provided; however, the 90th percentile value reported for the Midwest was the same as that reported for all regions (2.3 L/day), suggesting that the value recommended by U.S. EPA (1997) is relevant to Michigan. The data used by Ershow and Cantor (1989) were collected in 1977-1978. Tap water intake patterns may have changed significantly since that time due to increased consumption of bottled water and other bottled beverages. Rating: Low.

Clarity and comprehensiveness (completeness of method and data reporting, completeness of literature search). The basis for the IRW_{adult} recommendation is clearly described in U.S. EPA (1997), and the literature considered to be potentially relevant appears to be comprehensive. Ershow and Cantor (1989) provided a detailed summary of their methods and results, reporting summary statistics (including number of subjects and percentiles of the distribution) for IRW by selected demographic characteristics (e.g., age, gender), as well as by U.S. region. Rating: High.

Soundness and credibility (*adequacy of approach; intrinsic sources of bias; sample size*). U.S. EPA (1997) indicated that the sample size (n=26,081 individuals) used by Ershow and Cantor (1989) was sufficient to obtain data representative of the U.S. population. A three-day recall survey was used to collect the data which may introduce bias when used to estimate long-term intake rates. In addition, recall data is subject to error as well as potential bias: subjects may overstate water intake, because water consumption is advocated as a healthy habit. Ershow and Cantor (1989) estimated the total daily intake of tap water consumed directly or indirectly (as an ingredient in beverages or food); however, their analysis did not distinguish between rates for consumers of water and nonconsumers, potentially biasing the statistics low. Rating: Medium.

Transparency and objectivity (availability of supporting data; funding source; peer-review). U.S. EPA (1997) evaluated the data available on water intake and made the report available on the internet. Prior to publication, the report was reviewed internally by U.S. EPA staff, and also reviewed by a Science Advisory Board Panel and an external Peer Review Panel consisting of scientists from academia, other governmental agencies, industry, and consultants. The key study (Ershow and Cantor, 1989) that forms the basis of the U.S. EPA (1997) recommendation

for IRW was a report of the National Cancer Institute. The report was reviewed by an ad hoc Expert Panel as well as the Life Sciences Research Office of the Federation of American Societies for Experimental Biology (FASEB) prior to release. The rating for transparency of the MDEQ (2004) value is reduced because the value of 2 L/day is slightly different from the values recommended by U.S. EPA (1997) and the discrepancy is not explained. Rating: Medium.

Certainty (number and agreement of studies). Ten relevant IRW studies were identified and described in detail by U.S. EPA (1997). These studies estimated mean water intake rates ranging from 1.04 to 1.63 L/day; 90th percentile values ranged from 1.87 to 2.4, which suggests good agreement between the studies. Rating: High.

1.3 Evaluation of New Information Using Decision Framework

1.3.1 Michigan-Specific Data

The MDEQ Remediation and Redevelopment Division (RRD) and the Michigan Department of Community Health were contacted by email and phone to determine if the agency was aware of research or could provide data pertinent to IRW for Michigan residents; however, neither department was aware of research or data relevant to this exposure parameter. The following research universities were contacted by email and phone to determine if each was aware of research or could provide data: University of Michigan, Michigan State University, Western Michigan University, and Michigan Technological University. Additional research or relevant data were not provided within the time-frame of the development of this TSD.

1.3.2 Most Recent EPA Recommended Value(s)

1.3.2.1 Summary of Search Results

U.S. EPA (2008, 2011) recommended age-specific mean and 95th percentile rates of total (consumed plain and as an ingredient in in beverages and foods) intake of tap water for consumers; these values are shown in Table 2. The IRW values are based on analyses of data obtained from national food consumption surveys from three key studies: Kahn and Stralka (2008); Kahn and Stralka (2009, with supplemental data provided to EPA by the author and cited as Kahn, 2008); and U.S. EPA (2010) (unpublished data, as described by U.S. EPA, 2011). Data from Kahn and Stralka (2009; Kahn, 2008) were used to obtain water intake estimates for children <3 years of age; U.S. EPA's (2010) analysis of National Health and Nutrition Examination Survey (NHANES) data was used to obtain water intake estimates for individuals ≥ 3 years of age. U.S. EPA (2011) selected data from Kahn and Stralka (2009; Kahn 2008) for infants and toddlers because the NHANES data for these subpopulations had limited sample sizes. Finally, U.S. EPA (2011) used data from Kahn and Stralka (2008) to obtain water intake estimates for pregnant and lactating women.

Briefly, Kahn and Stralka (2008, 2009; Kahn 2008) evaluated data collected as part of the U.S. Department of Agriculture's (USDA's) 1994-1996, 1998 Continuing Survey of Food Intakes by Individuals (CSFII). The survey consisted of two in-home, 24-hour recall interviews that

recorded all food and drinks consumed. Approximately 20,000 individuals were surveyed, including 9,000 individuals less than 9 years of age. Participants included 65 pregnant and 34 lactating women.

U.S. EPA (2010) evaluated data from the 2003-2006 cycles of the U.S. Centers for Disease Control and Prevention's (CDC's) National Health and Nutrition Examination Survey (NHANES). NHANES, conducted annually by the CDC National Center for Health Statistics, began in the 1960s to assess the health and nutritional status of children and adults in the U.S. Beginning in 1999, the survey became a continuous program with data collection every 2 years. NHANES is a national survey in which a sample of the U.S. population answers questions regarding health and nutrition and undergoes a medical examination that includes measurement of body weight. NHANES is intended to sample a broad distribution of the population, and subjects include children of all ages as well as pregnant women and other adults.

Table 2. Water intake rates[a] reported in U.S. EPA (2011)

	Mean IRW (L/day)	90th Percentile[b] IRW (L/day)	95th Percentile IRW (L/day)
Ages 0 to <1 mo	0.470	0.849[c]	0.858
Ages 1 to <3 mo	0.552	0.943[c]	1.053
Ages 3 to <6 mo	0.556	1.021[c]	1.171
Ages 6 to <12 mo	0.467	0.971[c]	1.147
Ages 1 to <2 yr	0.308	0.674[c]	0.893
Ages 2 to <3 yr	0.356	0.700[c]	0.912
Ages 3 to <6 yr	0.382	0.778[d]	0.999
Ages 6 to <11 yr	0.511	1.072[d]	1.404
Ages 11 to <16 yr	0.637	1.535[d]	1.976
Ages 16 to <18 yr	0.702	1.571[d]	1.883
Ages 18 to <21 yr	0.816	1.921[d]	2.818
Ages ≥ 21 yr	1.227	2.546[d]	3.092
Ages >65 yr	1.288	2.395[d]	2.960
All ages	1.033	2.318[d]	2.881
Pregnant women	0.872	1.844[e]	2.589
Lactating women	1.665	2.959[e]	3.588

[a]Direct and indirect (direct refers to water consumed as a beverage; indirect is defined as water added in the preparation of food or beverages such as coffee, tea, and reconstituted soups) intake of water from community (public) water supply among water consumers only.
[b]U.S. EPA (2011) did not provide 90th percentile values in its table of recommendations (Table 3-1). Values for 90th percentile intake rates were obtained from the same studies as the mean and 95th percentile values used by U.S. EPA (2011), as noted in footnote for each individual value.
[c]Kahn and Stralka (2009; Kahn 2008), Table 3-15 in U.S. EPA (2011).
[d]U.S. EPA (2010), Table 3-33 in U.S. EPA (2011).
[e]Kahn and Stralka (2008), Table 3-82 in U.S. EPA (2011).

Ninetieth percentile IRWs for the age ranges used by MDEQ can be estimated from the data above by weighting the 90th percentile IRW for each age group by the duration of time spent in that age group (for example, assuming that one year is spent in the 2 to <3 year age group and three years are spent in the 3 to <6 year age group to estimate a IRW for the 2 to 6 year age group); Table 3 below shows the resulting values.

Table 3. 90th Percentile water intake rates for MDEQ age ranges based on U.S. EPA (2011)

	Age-weighted IRW (L/day)
Ages < 2	0.82
Ages 2 to < 6	0.76
Ages birth to < 6	0.78
Ages 6 to <16	1.3

Table 3. 90th Percentile water intake rates for MDEQ age ranges based on U.S. EPA (2011)

Ages 16 to <EDr	2.3
Ages 6 to <EDr	1.9
Adult	2.5
Pregnant women	1.8

U.S. EPA (2014) used the 90th percentile IRW data (consumer-only, community water source, direct and indirect intake) from the key studies recommended by U.S. EPA (2011) to obtain a 90th percentile value of 0.78 L/day for children up to 6 years of age and 2.5 L/day for adults.

1.3.2.2 Evaluation of Data Quality Objectives

The IRW values recommended by U.S. EPA (2008, 2011, 2014) were evaluated using the Part 201 DQOs. A summary of the evaluation follows.

Relevance and applicability to Michigan (geographic, temporal, and demographic representativeness). The IRW estimates recommended by U.S. EPA (2008, 2011, 2014) are based on data collected from two national surveys (CFSII and NHANES). Each survey sampled individuals from all 50 states and Washington, D.C. The data may be considered representative of the general U.S. population. The surveys were conducted in 1994-1998 and 2003-2006, respectively. Tap water intake rates may have changed since these time periods. Rating: Medium.

Clarity and comprehensiveness (completeness of method and data reporting, completeness of literature search). The information considered by U.S. EPA (2008, 2011, 2014) as potentially relevant to the selection of IRW values appears to be comprehensive, and the documents provide a thorough discussion of the basis for the values recommended. The sampling design, data collection, and data analysis methods of NHANES[1] and CFSII[2] surveys are well described. Rating: High.

Soundness and credibility (adequacy of approach; intrinsic sources of bias; sample size). U.S. EPA (2011) described the approach used by Kahn and Stralka (2008, 2009; Kahn 2008) and the CSFII survey; these data were used to estimate IRW for children under 3 years of age. In the CSFII survey, participants were asked during an in-person interview to recall their total water intake by source (tap, bottled, and other sources) in the previous 24 hours; this interview was repeated 3 to 10 days later for a second measure of water intake. A total of 18,509 individuals participated in the survey and provided water intake estimates. Children under the age of 11 years were oversampled (n = 9,643) to ensure adequate sample sizes for these age groups. Kahn and Stralka (2009, 2008; Kahn 2008) analyzed the intake estimates by source, by age, and by consumer or per capita (the latter includes subjects reporting no water intake).

[1]See more information online at http://www.cdc.gov/nchs/nhanes/survey_methods.htm.
[2]See more information online at http://www.ars.usda.gov/SP2UserFiles/Place/80400530/pdf/csfii9498_documentationupdated.pdf.

U.S. EPA (2011) also described the NHANES data used as the basis for IRW values for individuals ≥ 3 years of age. Two interviews were conducted in which subjects were asked to recall their total water intake by source in the preceding 24 hours. In the NHANES survey, the first interview was in-person and the second conducted by telephone. As described by U.S. EPA (2011), the NHANES 2003-2006 survey sampled 15,940 participants who reported water intake, including 4,181 children under the age of 11 years. Intake rates were weighted by demographic data in order to ensure that the resulting water intakes were representative of the entire U.S. population. U.S. EPA (2010) analyzed the intake estimates by source, by age, and by consumer or per capita.

Intrinsic sources of bias in the data used by U.S. EPA (2008, 2011, 2014) include the use of short-term intake data to estimate long-term intake rates, and the use of recall data, which is subject to error as well as potential bias (e.g., subjects may overstate water intake to appear more healthy). Rating: Medium to High.

Transparency and objectivity (availability of supporting data; funding source; peer-review. The U.S. EPA (2011) report is available on the internet. Prior to publication, the report was reviewed internally by U.S. EPA staff, and also reviewed by a Science Advisory Board Panel and an external Peer Review Panel consisting of scientists from academia, other governmental agencies, industry, and consultants. Funding for the NHANES data used by U.S. EPA (2010, as cited in U.S. EPA, 2011) was provided by the CDC. The Kahn and Stralka (2008, 2009) studies were funded under a cooperative agreement between the U.S. EPA Office of Research and Development and the Science Applications International Corporation and were published in peer-reviewed journals. Rating: High.

Certainty (number and agreement of studies). The water intake rate recommendations provided by U.S. EPA (2008, 2011, 2014) are based on three key studies and supported by a large number (20) of relevant studies. The key studies were generally in very good agreement; 90th percentile values for all ages were 2.3 L/day (U.S. EPA 2010 as cited in U.S. EPA 2011) and 2.1 L/day (Kahn and Stralka, 2009; Kahn 2008). Rating: High.

1.3.3 New Scientific Literature

1.3.3.1 Summary of Search Results

A search of the open scientific literature (PubMed and ToxLine) for data on IRW since 2009 was conducted. Table 4 below summarizes the studies identified in the searches. As the table shows, there were seven studies that had potentially relevant data for estimating IRW. Meliker et al. (2006) provided water intake data for Michigan residents; however, the participants in the study were controls in a bladder cancer case-control study and matched to the cases on age, race, and gender. As a result, 80% of the participants were elderly (more than 60 years of age), 87% was male, and 92% was white; thus, these data would not necessarily be representative of the entire population of Michigan, and this study was not considered further.

Moreover, none of the new studies collected the specific data needed for IRW (an upper percentile estimate of total intake of tap water used as a beverage or in the preparation of a food or beverage among persons who consume water). Because the studies identified in the literature search did not report relevant water intake data, DQOs were not evaluated for these studies.

Table 4. Studies of IRW published since 2009

Geographic Location	Population	Water intake rate (L/day)	Comments	Reference
Southeastern Michigan	440 adults selected as controls (age-, gender-, and race-matched) in bladder cancer case-control study; 80% were ≥ 60 years of age and 87% were male	Participants reported intake of water from home and beverages (but not food) made with water from home. The median intake was 2.01 L/day;	Population not representative of Michigan as a whole. Only central tendency value reported.	Meliker et al. 2006
U.S. 25% of participants were from the Midwest	2950 participants in 1320 households; 16% <13 yrs old, 6.7% teenage, 34.5% adults ≥ 50 yrs old. Proportion female not reported. 90% white. Participants filled out 2-day intake diary	Total intake of water (all sources) as a plain beverage (not including use in preparing beverages or food) was evaluated. The mean across all ages for consumers was 1.14 L/day[a]; for Midwest participants only, the mean was 1.05 L/day[a].	Does not distinguish between tap and bottled water; does not include water used in preparing beverages or food. Only central tendency value reported.	Barraj et al. 2009
U.S. NHANES (1999-2006)	15,395 participants (12,283 from 1999-2004, and 4,112 from 2005-2006). Demographics not reported.	Total intake of water (all sources) as a beverage and as an ingredient of beverages and food, was evaluated. Adjusted mean intakes were 3.30, 3.39, and 2.65 for ages 20-39, 40-59, and ≥ 60 years, respectively. Intakes adjusted for covariates including sex, race, age, education, income, activity, BMI, disease state, and smoking.	Does not distinguish between tap and bottled water; estimates include consumers and nonconsumers. Only central tendency value reported.	Kant et al. 2009
U.S. NHANES (2003-06)	8,347 individuals ≥1 year of age who completed one day dietary recall in NHANES 2005-2006.	Intake of plain drinking water (not including use as an ingredient of beverages and food) from the tap for consumers and non-consumers. Mean across all ages was 0.56 L/day.	Does not include water used in preparing beverages or food; estimates include consumers and nonconsumers. Only central tendency value reported.	Sebastian et al. 2012
U.S. NHANES (2005-2010)	4,766 children (ages 4-13 years old), and 15,702 adults (≥20 years) who completed 24-hour recall surveys.	Intake of plain drinking water (not including use as an ingredient of beverages and food) from the tap for consumers and non-consumers. Mean across all children was 0.2572 L/day; mean across all adults was 0.644 L/day.	Does not include water used in preparing beverages or food; estimates include consumers and nonconsumers. Only central tendency value reported.	Drewnowski et al. 2013a, b

[a]Values were converted from ounces to liters (1 oz. = 0.0295735 L)

1.3.4 New Federal Data Sources

A search of federal sources of data on IRW was conducted. The search included evaluating publicly available databases, reports, data briefs, and publications from federal agencies

including CDC and NHANES. Using data from NHANES (2005 to 2008), USDA (2011) reported the intake of plain drinking water (not including use as a constituent of beverages and food) from the tap for consumers and non-consumers to be 0.54 L/day (2.3 cups/day) across all ages; however, this value does not reflect the target intake rate (total intake, including consumption of plain water as well as use in the preparation of beverages or food, for consumers only); thus, no further evaluation of these data was performed. Analyses of the most recent NHANES data (after 2010) were not identified in the searches.

The U.S. Institute of Medicine (IOM, 2005) provided recommended water intake values for children and adults; however, these are recommended intake values to ensure hydration, rather than estimates of the quantity of tap water that is actually ingested; thus, no further evaluation of the data was performed.

1.3.5 State and International Data Sources

State and international agencies listed in the introduction to this TSD were searched for recommended IRW values. Table 5 below summarizes the recommended IRW values identified in the searches. As shown in the table, values for IRW are, with a few exceptions, based on values reported by U.S. EPA (1989, 1991, 1997, 2008, 2011, 2014). The state of Texas (TCEQ, 2009) recommended an IRW of 0.64 for children under the age of 6; the basis for this value was not reported. The Ontario Ministry of the Environment and Climate Change (MOE, 2011) uses IRW values based on Ershow and Cantor (1989). The ECETOC reported IRW values for children ages one to four years, children ages one to eleven years, and adults, based on a 1980 dietary survey in Great Britain (Hopkins and Ellis, 1980). Because the state and international values were either based on U.K. data or data considered in previous U.S. EPA (1989, 1991, 1997, 2008, 2011, 2014) assessments, further evaluation of DQOs for these values was not conducted.

The World Health Organization (WHO, 2003) provided recommended water intake values for children and adults in temperate climates; however, these are recommended total water intake values to ensure hydration, rather than estimates of the quantity of tap water that is actually ingested; thus, no further evaluation of these data was performed.

Table 5. Comparison of default state and international residential drinking water intake rates (L/day)

Exposure Parameter	MI	IL	CA	MA	MN	WA	WI	IN	OH	OR	TX	Ontario, Canada[d]	EU JRC	EU ECETOC[e]
$IRW_{ages\ <2}$	-	-	-	-	-	-	-	-	-	-	-	1.2	-	-
$IRW_{ages\ 2-<6}$	-	-	-	-	-	-	-	-	-	-	-	-	-	-
$IRW_{ages\ birth-<6}$	-	-	0.78	1[a]	-	1[a]	-	0.78	1[b]	1.5[c]	0.64[a]	1.3	2	0.47 0.5
$IRW_{ages\ 6-<16}$	-	-	-	-	-	-	-	-	-	-	-	1.7	-	-
$IRW_{ages\ 16-<EDr}$	-	-	-	-	-	-	-	-	-	-	-	-	-	-
$IRW_{ages\ 6-<EDr}$	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IRW_{adult}	2	2	2.5	2	-	2	-	2.5	2	2	2	2.3	2	1.1

[a]Basis not reported.
[b]Cites U.S. EPA (1989).
[c]Reported as the 90the percentile value for 3-5 year olds from U.S. EPA (1997) Table 3-30.
[d]Values for children ages 6 mo-4 yrs (1.2 L/day), 5 to 11 yrs (1.3 L/day), 12 to 19 yrs (1.7 L/day) and adult (2.3 L/day) based on Ershow and Cantor (1989); (MOE, 2011)
[e]Values are for children ages 1-4 (0.47 L/day) and 1-11 years (0.5 L/day) and adults (1.1 L/day) based U.K. survey reported by Hopkins and Ellis (1980); (ECETOC, 2001)

1.4 Comparison of Results of DQO Evaluations

Table 6 provides a comparison of the DQO evaluations for the MDEQ (2004) IRW values and the alternative estimates from U.S. EPA (2011, 2014) and published sources. In keeping with the use of the 90th percentile IRW used by MDEQ (2004), only the 90th percentile IRW values are shown in this table. For each DQO, the assessments have been rated from low to high.

Table 6. Summary of DQO evaluation for residential drinking water intake rate ((L/day)

Parameter	MDEQ (2004)	New Michigan data	U.S. EPA (2008, 2011, 2014) 90th percentile
$IRW_{ages\ <2}$	NV	ND	0.82
$IRW_{ages\ 2-<6}$	NV		0.76
$IRW_{ages\ birth-<6}$	NV		0.78
$IRW_{ages\ 6-<16}$	NV		1.3
$IRW_{ages\ 16-<EDr}$	NV		2.3
$IRW_{ages\ 6-<EDr}$	2 (90th)		1.9
IRW_{adult}	NV		2.5
Relevance and applicability to Michigan	L	NA	M
Clarity and comprehensiveness	H		H
Soundness and credibility	M		M-H
Transparency and objectivity	M		H
Certainty	H		H

NV = no value; ND = no data; NA = not applicable; L = Low, M = Medium, M-H = Medium-High, H = High

1.5 Conclusion

The U.S. EPA (2008, 2011, 2014) recommendations best meet the Part 201 DQOs. Thus, it is recommended that weighted averages of the U.S. EPA (2011) 90th percentile IRW estimates be used for the residential scenario age ranges of interest to MDEQ (see Table 3 and Table 6).

Section 2. Nonresidential Drinking Water Intake Rate (IRWn)

2.1 Introduction

The nonresidential water intake rate (IRWn) used by MDEQ is intended to represent the total intake of water (consumed plain and as an ingredient of beverages [e.g., coffee, tea, reconstituted juice] and foods [soups and stews, etc.]) obtained from the tap at the workplace (i.e., from a private domestic or public water supply) among persons who consume water (consumers only).

2.2 MDEQ (2004) Value

MDEQ (2004) recommended an IRWn value of 1 L/day, calculated as one-half the total daily intake for adults (reported as 2 L/day). The basis for this assumption is not explained; thus an evaluation of DQOs cannot be conducted.

2.3 Evaluation of New Information

Few data relevant to water intake by workers in industrial/commercial settings in the U.S. were located. U.S. EPA (1989, 1997, 2011, 2014) did not provide a recommendation for water intake in a nonresidential scenario. In a review primarily focused on fluid requirements in hot and humid environments, WHO (2005) summarized a few studies of water requirements for persons engaged in physical activities in hot weather. However, these studies examined total water needs (not actual intake) under specific conditions (hot weather, strenuous physical activity) that would not necessarily apply to all workers in Michigan.

State and international agencies listed in the background to this TSD were searched for recommended IRWn values. Table 7 below summarizes the IRWn values identified in the searches. As the table shows, all states other than Oregon use IRWn values based on U.S. EPA assessments (1989, 1997, 2011) for residential scenarios or do not report a basis for their IRWn values. The state of Oregon (ODEQ, 2011) calculated an IRWn value of 0.7 L/day by time weighting (i.e., by time spent at work, 8/24 hours) the 2.0 L/day total adult water intake value recommended by U.S. EPA (1997). Because the available state default values were based on previous U.S. EPA (1989, 1997, 2011) exposure factors for residential scenarios (rather than for nonresidential scenarios) evaluation of DQOs for these values was not conducted.

Table 7. Comparison of default state and international IRWn values (L/day)

Exposure Parameter	MI	IL	CA	MA	MN	WA	WI	IN	OH	OR	TX	Ontario, Canada	EU JRC	EU ECETOC
IRW_n	1	1[a]	2	-	-	-	-	-	-	0.7[b]	1.4[a]	-	-	-

[a]Source not reported.
[b]Calculated as 2.0 L/day × 8 hours at work/24 hours per day (ODEQ, 2011).
ND = No data

2.4 Conclusion

In the absence of data on water intake for workers, it is recommended that the current MDEQ policy of adopting one-half of the IRW_{adult} be used to estimate IRWn. Although an 8-hour work day is one-third of a full 24-hour day, water consumption occurs only during waking hours; thus, assuming that 8 hours per day are spent sleeping, a plausible adjustment for water intake during working hours would use 8/16 non-sleeping hours or 1/2. The updated IRWn value (rounded to two significant digits) is therefore 1.3 L/day (1/2 × 2.5 L/day).

Women are generally encouraged to consume more water during pregnancy and lactation. MDEQ (2004) did not report a water intake value for pregnant workers, nor did U.S. EPA (2014). It is recommended that the 90th percentile IRW of 1.8 L/day for pregnant women reported by U.S. EPA (2011) be adjusted for water intake during working hours (as described above) to estimate IRWndev. The IRWndev value is therefore 0.9 L/day (1/2 × 1.8 L/day).

Section 3. Summary of 2015 Updated Values

Table 8 summarizes the recommended IRW values for residential and nonresidential scenarios, based on the DQO evaluations described in this TSD.

Table 8. Summary of 2015 updated MDEQ values for IRW (L/day)

Parameter	2015 Updated Value
$IRW_{ages <2}$ = Water intake rate: ages < 2	0.82
$IRW_{ages 2-<6}$= Water intake rate: ages 2 to <6	0.76
$IRW_{ages birth-<6}$ = Water intake rate: ages birth to <6	0.78
$IRW_{ages 6-<16}$= Water intake rate: ages 6 to <16	1.3
$IRW_{ages 16-<EDr}$= Water intake rate: ages 16 to <EDr[a]	2.3
$IRW_{ages 6-<EDr}$= Water intake rate: ages 6 to <EDr[a]	1.9
IRW_{adult}= Water intake rate: adult	2.5
IRWn = Nonresidential water intake rate for adult workers	1.3
IRWndev = Nonresidential water intake rate for pregnant workers	0.90

[a]EDr is exposure duration for the residential scenario; the 2015 updated value for EDr is 32 years.
NV = no value

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APPENDIX A

EXPLANATION OF RELATIVE DQO RATINGS

This appendix provides a broad outline of how the DQO ratings were applied. To some extent, professional judgment was used in the application of the ratings, as a set of rating characteristics that would apply to the many different data sources used to develop exposure assumptions was not feasible. The ratings should be considered relative rather than absolute. In other words, the ratings may be compared across sources of data for a single exposure assumption, but a rating of high for one exposure assumption may not be equivalent to a rating of high for another exposure assumption.

Relevance and applicability to Michigan (g*eographic, temporal, and demographic representativeness*).

High: Based on recent data obtained in Michigan, in members of its population, or developed based on data specific to Michigan (e.g., exposure frequency based on climate conditions in Michigan).

Medium: Based on recent data obtained outside Michigan or its population, but in an area or population with comparable geographic, temporal, and demographic conditions.

Low: Based on data obtained outside Michigan or its population, in an area or population with different geographic, temporal, and demographic conditions, or with unknown geographic, temporal, and demographic conditions.

Clarity and comprehensiveness (completeness of method and data reporting, completeness of literature search).

High: Derived value with complete documentation of the selection process, and based on known or apparently thorough literature search, OR, single study with thorough description of methods and results.

Medium: Derived value with incomplete documentation of the selection process, and/or based on limited literature search, OR, single study with some noncritical information missing from methods and results.

Low: Derived value with little or no documentation of the selection process, and/or without accompanying literature search, OR, single study lacking critical information from method or results.

Soundness and credibility (adequacy of approach; intrinsic sources of bias; sample size).

High: Using an established method to estimate the parameter, without intrinsic sources of bias, and with adequate sample size(s).

Medium: Using an established method to estimate the parameter, with some known or expected intrinsic sources of bias, and with adequate sample size(s).

Low: Using a novel or uncertain method to estimate the parameter, with or without intrinsic sources of bias, and with inadequate sample size(s).

Transparency and objectivity (availability of supporting data; funding source; peer-review).

High: Based on peer-reviewed study(s) performed by researcher(s) without demonstrable conflict of interest and supported by other studies.

Medium: Based on peer-reviewed study(s) performed by researcher(s) without demonstrable conflict of interest but without support from other studies.

Low: Based on unpublished study(s) and/or performed by researcher(s) with potential conflict of interest and/or based on professional judgment, without support from other studies.

Certainty (number and agreement of studies).

High: Based on > 3 studies with values ranging up to ±50% from the selected value.

Medium: Based on at least 2 or 3 studies with values ranging up to ±100% from the selected value.

Low: Based on a single study or more than one study with variability ranging >±100% from the selected value, or based on professional judgment.