Technical Support Document:

Derivation of Human Health-Based Criteria and Risk Impact Statement

June 2016

Prepared by:
Florida Department of Environmental Protection
Division of Environmental Assessment and Restoration

Table of Contents

Acknowledgements iii
Executive Summary iv
1 Introduction 1
1.1 Purpose of Document 1
1.2 Background Information 1
1.3 Public Input and Peer Review of FDEP's Approach 3
1.4 Criteria Considered for Criteria Revision or Adoption 5
1.5 The Probabilistic Approach 6
2 Methods Used to Derive Criteria 7
2.1 Basic Equations 7
2.2 Risk Characterization 8
2.3 Exposure Calculations 9
2.4 Targets for the Risk Assessment 10
2.4.1 Carcinogens 10
2.4.2 Non-carcinogens 12
3 Exposure Factors 13
3.1 Body Weight 17
3.2 Drinking Water Consumption 18
3.3 Fish Ingestion Rates 19
3.4 Bioaccumulation and Bioconcentration Factors 25
3.4.1 Organic Content (DOC and POC) 28
3.4.2 Lipid Content 30
3.4.3 Florida BAFs and BCFs 34
3.5 Toxicity Data 42
3.5.1 Reference Dose and Uncertainty Factors 43
3.5.2 Minimal Risk Levels (MRLs) 44
3.5.3 Relative Source Contribution 44
3.5.4 Cancer Slope Factors 47
3.5.5 Toxicity Value Inputs 47
4 Criteria Derivation 55
5 Results 59
5.1 Proposed Criteria 59

- 5.2 Risk Analysis and Risk Impact Statemtent 67
- 5.3 Criteria Duration 70
- 5.4 Uncertainty 75

6 Conclusions 78

7 References 79

Appendix A. Human Health-Based Peer Review Committee Consensus Report 82

Appendix B. Human Health-Based Water Quality Criteria: Chemical Classes and Uses........ 94

Appendix C. List of the most recent oral reference doses and oral slope factors (cancer slope factors). 110

Appendix D: Relative Source Contribution (RSC) Derivation for Non-carcinogenic Parameters Evaluated for Chapter 62-302, FAC, Human Health Criteria Revision 127

Appendix E. Sensitivity Analysis of Monte Carlo Model Inputs. 216

Appendix F. Summary of Probabilistic Risk Analyses of Proposed Criteria. 237

Appendix G. Summary of Probabilistic Risk Analyses of Proposed Carcinogen Criteria for Subsistence Fishers. 248

Acknowledgements

Project Leads

Kenneth Weaver, FDEP, Division of Environmental Assessment and Restoration

Kaitlyn Summerfield, FDEP, Division of Environmental Assessment and Restoration

Contributors

Daryll Joyner, FDEP, Division of Environmental Assessment and Restoration

Technical Support Document

Derivation of Human Health Criteria and Risk Assessment

Executive Summary

This document describes the technical basis for revisions to water quality criteria in Rule 62-302.530, Florida Administrative Code (F.A.C.), that are designed to protect human health from adverse health effects resulting from exposure to environmental contaminants in surface waters (lakes, streams, rivers, and estuaries). It also includes discussion of consideration of the addition of 39 (37 in Class I Waters) new human health-based criteria (HHC). People can be exposed to environmental contaminants in surface waters primarily through: a) drinking water derived from surface water sources, and b) consuming fish and shellfish that may have accumulated contaminants in their tissues. The Florida Department of Environmental Protection (FDEP or department) is proposing criteria that allow Floridians to safely enjoy eating *Fresh from Florida* fish and drink local tap water their entire lives.

Florida's current criteria, which were adopted by FDEP in 1992, need to be updated because they do not reflect current national recommendations or state specific information. FDEP has evaluated all the latest scientific information, including receiving expert input from a peer review panel, to develop accurate and protective human health criteria. The department used:

- A state of the art scientific method for calculating criteria, called the probabilistic approach, that more directly addresses exposure risk;
- The most recent toxicological data recommended by the U.S. Environmental Protection Agency (EPA); and
- Region-specific information on the types and quantities of fish Floridians eat.

This document constitutes the risk impact analysis required under Section 120.81, Florida Statutes (F.S). The human health criteria are designed to protect Floridians from adverse health effects over a lifetime. Laboratory toxicology studies have shown that exposure to these parameters through drinking water or food can cause either an increased risk of developing cancer over a lifetime or other non-carcinogenic adverse health effects, such as kidney failure, liver dysfunction, or neurological effects. The health effects of concern are parameter specific and summarized in **Appendix C**. The department set criteria for carcinogenic compounds at levels that will protect the vast majority of Floridians from an increased lifetime cancer risk. Risk analyses show that most Floridians would only have an extremely low increased risk of cancer (1-in-1,000,000), with many people having a much lower risk. Furthermore, these criteria ensure that even the high consumers of fish and shellfish and community drinking water (90th percentile) will be protected and will only have a very low increased risk (1.9 to 2.4-in-1,000,000) of developing cancer. Individuals who consume seafood on a daily basis for subsistence purposes will also be protected at a very low increased risk (1.3-in-1,000,000 to 2.1-

in-100,000)[1]. Likewise, the department set criteria for non-carcinogen compounds that will protect the vast majority of Floridians from the adverse effects listed in **Appendix C**.

The department formed a Human Health Peer Review Committee (HHPRC) to evaluate FDEP's technical approach. HHPRC panelists included Dr. Elizabeth Doyle (US Environmental Protection Agency Office of Research and Development), Dr. Kendra Goff (Florida Department of Health), Dr. Raymond Harbison (University of South Florida), Dr. Dale Hattis (Clark University), Dr. Charles Jagoe (Florida Agricultural and Mechanical University), Dr. Susan Klasing (California Environmental Protection Agency), and Dr. Chris Teaf (Florida State University). The panel, which was moderated by Dr. Stephen Roberts (University of Florida), met on October 8 and 9, 2012, to discuss and provide responses to a series of technical questions.

Although the HHPRC reviewed and commented on an earlier version of the department's approach, many of the committee's recommendations and conclusions are still relevant, in particular their support for FDEP's use of a probabilistic risk approach. However, new data describing regional fish consumption rates across the United States (U.S.) became available in 2015 after the peer review process. These new fish consumption data included regional rates, the use of which was supported by the HHPRC. FDEP determined that these newer fish consumption rates were superior to the estimation process suggested by the peer review panel, and thus the department has updated its probabilistic approach using the newer fish consumption rates.

The HHPRC endorsed a state of the art approach to determine risk and more accurately derive HHC. FDEP used the probabilistic approach (which involves a Monte Carlo simulation) to evaluate the risk to Florida's entire population and develop criteria to protect Floridians at a pre-specified risk level. For carcinogens, FDEP established the criteria to achieve an extremely low (1-in-1,000,000) incremental increased lifetime cancer risk for the average Floridian and a very low increased risk (1-in-100,000) for virtually all Floridians. FDEP established the water quality criteria for non-carcinogens to ensure that intake of a given contaminant does not exceed a safe dose for virtually all Floridians.

The department selected the target risk level after considering: a) consistency with national recommendations on target populations; b) confidence in the exposure risk calculations; c) whether the criteria will be protective of highly exposed sub-populations (*e.g.*, subsistence fishers) at low increased cancer risk levels (1-in-10,000), consistent with U.S. EPA methodologies; and d) the substantial safety factors applied to the toxicity data used to derive the criteria, which provide added layers of protection.

The key toxicity data used in the calculation of the human health criteria are the reference doses (RfD) and cancer potency (slope) factors (CSF), and the department used nationally recognized values from IRIS for most parameters. However, for 1,2-dichlorobenzene, 1,3-dichlorobenzene, and 1,4-dichlorobenzene, the department followed the approach used by EPA in the calculation of their 2015 recommended human health criteria by using minimal risk levels (MRLs) derived

---

[1] Risk based on the minimum and maximum mean risk for carcinogens.

by the Agency for Toxic Substances and Disease Registry (ATSDR) as the source of toxicity data .

Safety factors are applied to the RfD to ensure that it is set at a level protective of the entire population, including the most sensitive individuals such as children. Other exposure related variables include the relative source contribution (RSC), which accounts for other, non-water based pathways, and bioaccumulation factors (BAFs) and bioconcentration factors (BCF), which predict how contaminants can get into seafood. These variables are parameter-specific and were entered into the analysis as point values based on the most recent U.S. EPA recommendations, which are summarized in EPA's parameter-specific technical support documents available at https://www.epa.gov/wqc/national-recommended-water-quality-criteria-human-health-criteria-table.

More recent nationally supported and peer reviewed studies have concluded that particular compounds may be more or less toxic than previously thought. The department used all these most recent studies in order to create scientifically sound criteria regardless of its effect on the ultimate criteria values. Changes in toxicity and bioaccumulation factors resulted in some criteria values getting more stringent, and others getting slightly less stringent. The toxicity factors used in the analysis are summarized in **Appendix C**.

As part of the Monte Carlo simulation approach, the most recent locally relevant data and information were used to calculate the exposure component of the risk calculations, including body weight, drinking water consumption rate, fish and shellfish consumption rate, and fat (lipid) content of fish (which relates to how pollutants get into seafood). National or regional recommendations were from the 2011 Exposures Factors Handbook (USEPA, 2011) or the *Estimated Fish Consumption Rates for the U.S. Population and Selected Subpopulations (NHANES 2003-2010)* (USEPA, 2014).

Based on this improved science, FDEP proposes to adopt new or revised human health-based criteria for 80 (79 in Class III waters) parameters. HHC were evaluated for an additional nine parameters [alpha-endosulfan, beta-endosulfan, Endosulfan sulfate, Endrin, Selenium, gamma-Hexachlorocyclohexane (HCH), Toxaphene, Cyanide (Class III only), and Phenol]; however, criteria for these parameters are not being revised because criteria values to protect aquatic biology or for organoleptic effects (phenol) are lower (more stringent) than the HHC. The cyanide HHC for Class III waters was less stringent than the aquatic life criterion, while the Class I HHC was more stringent than the aquatic life criterion. Therefore, the cyanide criterion is only being revised for Class I waters. The aquatic life-based or organoleptic effects criteria are fully protective of all human uses.

Parameters that were considered but are not being added include five banned pesticides (4,4'-DDD; 4,4'-DDE; alpha-BHC; Endrin aldehyde; and Hexachlorobenzene) and three parameters for which current toxicological data does not support criteria revision at this time (Arsenic, Methyl Chloride, and Thallium).

The department has concluded that the proposed criteria are set at levels that are highly protective of human health and that provide for protection of Floridians that drink tap water, recreate in Florida waters, and consume *Fresh from Florida* seafood.

1 Introduction

1.1 *Purpose of Document*

The primary purpose of this document is to describe the technical basis for revisions to surface water criteria listed in Rule 62-302.530, Florida Administrative Code (F.A.C.), for Class I, I-Treated, II, III, and III-Limited waters that are intended to protect human health. The parameters under consideration are known to cause adverse toxicological effects in humans. Humans may be exposed to these parameters through either ingestion of drinking water (after treatment at a public drinking water facility) or consumption of contaminated fish and shellfish. The criteria are intended to be set at levels that will protect against adverse health effects over a lifetime of exposure.

While this document describes the "deterministic" methodology used by EPA to develop human health criteria, the proposed criteria are based on an advanced probabilistic approach (including assumptions and sources of data and information) that better accounts for variability (associated with Florida's population) and reduces compounded conservatism. This approach was supported by the Human Health Peer Review Committee (HHPRC), which was formed to evaluate FDEP's technical approach and to elicit scientific input from expert toxicologists. The department has made several revisions to the methodology over the last two years, and this document also describes the revisions to the approach presented in 2013-2014 that was reviewed by the HHPRC.

Criteria for 88 parameters were evaluated using this probabilistic approach and are presented in this document. In some cases, the HHC were superseded by more sensitive (lower) aquatic life-based criteria to provide full protection of all uses (*i.e.*, aquatic life). For some parameters, the criteria modified in Rule 62-302.530, F.A.C., will include both human health-criteria, expressed as an annual average, and aquatic life-based criteria, expressed as a single sample maximum. This approach is used for human health criteria for which the annual average value is near the aquatic life-based criterion to ensure that a single maximum concentration does not exceed a level that is toxic to aquatic life. These maximum criteria for aquatic life use protection are already listed in the rule, and will not be modified as part of the human health criteria development effort or rulemaking.

This document constitutes the risk impact analysis required under Section 120.81, Florida Statutes (F.S.), and provides risk analyses for the general adult population and sub-populations that consume greater amounts of fish (subsistence fishers). The risk analyses provide risk tables summarizing the probabilities that members of these populations will exceed the criteria thresholds and thus may be subjected to some level of elevated risk of experiencing an adverse health effect (**Appendices E** and **F**).

1.2 *Background Information*

Some chemical contaminants pose a potential threat to human health and ecosystems when discharged to surface waterbodies in the State. In an effort to control release of chemical contaminants into surface waters and limit degradation of Florida's aquatic environments, the

State has established Surface Water Quality Criteria (SWQC) by rule in Chapter 62-302, F.A.C. The criteria in this rule represent numeric concentration limits for specific chemicals in Florida surface waters. Implementation of these criteria is intended to protect the public health and welfare and to enhance the quality of waters of the State.

A HHC is the highest concentration of a pollutant in water that is not expected to pose a significant risk to human health over a lifetime. The HHC, like all water quality criteria, are intended and calculated to protect and maintain designated use. HHC are needed to protect the designated uses within five of Florida's waterbody classifications. Specifically, the criteria are designed to protect the potable water supply and fish consumption uses in the five following classifications:

CLASS I	Potable Water Supplies
CLASS I-Treated	Treated Potable Water Supplies
CLASS II	Shellfish Propagation or Harvesting
CLASS III	Fish Consumption; Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife
CLASS III-Limited	Fish Consumption; Recreation or Limited Recreation; and/or Propagation and Limited Maintenance of a Limited Population of Fish and Wildlife

HHC protect the use by directly accounting for pollutant exposures that would occur through the consumption of water as drinking water and consumption of fish and shellfish that have been exposed to the contaminants in the environment. The constituents under consideration can occur in ambient waters; therefore, there is a potential for exposures through the consumption of drinking water. Additionally, these chemicals have been demonstrated to bioaccumulate in the tissues of fish and shellfish, and the contaminated flesh may subsequently be consumed by humans, resulting in exposure to the contaminant and risk of adverse health effects.

Forty-three of the criteria currently listed in Chapter 62-302, F.A.C., are based explicitly on protection of human health from exposure to surface water chemical contaminants via consumption of fish in Class III waters. Class II and III-Limited share the designated use of fish consumption with Class III, and therefore the Class III HHC also apply to these classes of water. Class I and I-Treated waters also share the designated use of fish consumption, but because they have the additional use as Potable Water Supplies, the exposure to these contaminants through drinking the water is also considered.

Development of the HHC followed procedures and recommendations developed by the U.S. EPA. Calculation of the criteria required assumptions regarding the extent of exposure to contaminants in surface water, including drinking water and fish consumption rates. At the time the criteria were first adopted, the U.S. EPA assumed fish consumption and surface water drinking rates of 6.5 g/day and 2.0 L/day, respectively. The HHC currently listed in Rule 62-302.530, F.A.C., were developed based on these point values. However, more recent fish consumption survey information indicates that consumption patterns have changed over time, necessitating a re-evaluation of the criteria.

In 1994, the Florida Department of Environmental Protection (FDEP) funded the Florida Per Capita Fish and Shellfish Consumption Study conducted by Dr. Robert Degner of the University of Florida. Data from this study suggested that Floridians eat significantly more fish than the 6.5 g/day assumed by the U.S. EPA procedure. The average consumption rate from the survey was 47 g/day for all seafood and 28 g/day for Florida-specific seafood species.

FDEP was subsequently petitioned to evaluate the study and consider using a higher fish consumption rate to re-calculate HHC. In response to this petition, FDEP initiated a baseline risk analysis designed to evaluate the risk associated with current criteria and, if necessary, to guide the development of new criteria derived using alternative assumptions regarding fish consumption by Floridians. This analysis was designed to form the basis for the Risk Impact Statement (RIS), which is required under Section 120.81, Florida Statutes (F.S). Section 120.81(6), F.S., requires that the department "prepare a risk impact statement for any rule that is proposed for approval by the Environmental Regulation Commission and that establishes or changes standards or criteria based on impacts to or effects upon human health."

Consistent with guidance provided by the Florida Risk-Based Priority Council in the "Guidelines for Risk Analyses Undertaken in Conjunction with Rule-Making" (FRBPC, 1996), a series of meetings were conducted by FDEP to obtain stakeholder input regarding the conceptual and technical approach to the risk analysis. There was considerable discussion regarding potential risk hypotheses to be addressed, the availability of models and data to support the analysis, and the appropriate scope and limitations. From these discussions, a Risk Impact Analysis Plan for Chapter 62-302, F.A.C., was developed (Halmes *et al*., 1999). It was the consensus of stakeholders that a probabilistic risk assessment should be conducted to more fully characterize the distribution of risks among potentially affected populations and to consider other pathways of exposure, for example, dermal contact with contaminated water.

FDEP contracted with the University of Florida's Center for Environmental and Human Toxicology to conduct the risk impact analysis and prepare the risk impact statement (RIS). Between 1998 and 2001, the Center conducted the baseline risk analysis. The initial Baseline Risk Analysis was presented at an October 30, 2001 Public Workshop at which public comments were requested. This initial report was subsequently submitted for peer review. The Baseline Risk Analysis was updated in response to the peer review and additional public comment. A final Baseline Risk Analysis was submitted to the department in 2008 (CEHT, 2008).

FDEP's current approach utilizes concepts presented in the 2008 Baseline Risk Analysis to assess risks and uses these concepts to derive protective criteria. However, new data and information has become available since the 2008 Baseline Risk Analysis, and the department has received substantial feedback from the public, ERC, and EPA. The analyses and results presented in this document represent the department's efforts to take these changes and feedback into consideration, and to develop criteria based on the most scientifically defensible approach and information available at this time. DEP has relied on the most recent data and information to ensure that the risk analysis is based on the most relevant and accurate information available to characterize exposures and risks.

1.3 *Public Input and Peer Review of FDEP's Approach*

The department distributed an earlier draft of this document to the public in July 2012. The approach was the subject of two sets of public workshops in May and July-August 2012. FDEP's approach was refined slightly between the two workshops in response to stakeholder and expert feedback. A number of concerns were raised by those who commented. Many of the most critical comments revolved around the estimated fish consumption rate and applicability of the 1994 study to contemporary consumption patterns. It was also suggested by numerous individuals that the HHC and FDEP's technical approach should undergo a peer review.

In response to these suggestions, the department formed the Human Health Peer Review Committee (HHPRC), which consisted of seven expert toxicologists. HHPRC panelists included Dr. Elizabeth Doyle (US Environmental Protection Agency Office of Research and Development), Dr. Kendra Goff (Florida Department of Health), Dr. Raymond Harbison (University of South Florida), Dr. Dale Hattis (Clark University), Dr. Charles Jagoe (Florida Agricultural and Mechanical University), Dr. Susan Klasing (California Environmental Protection Agency), and Dr. Chris Teaf (Florida State University). Committee members were provided a slightly revised version of the July draft technical support document (August 2012) along with a list of charge questions, all public comments, and relevant materials submitted to the department.

FDEP subsequently held a peer workshop on October 8 and 9, 2012, which was moderated by Dr. Stephen Roberts (University of Florida). FDEP staff provided the committee with a brief overview of the department's technical approach and a summary of the substantive stakeholder comments. Additionally, several stakeholders addressed the HHPRC and detailed their concerns and suggestions. The meeting concluded with the committee discussing the provided charge questions with the objective of reaching consensus and providing recommendations to the department. Subsequent to the meeting, FDEP staff summarized the HHPRC discussion and recommendations. The staff summary was e-mailed to individual committee members for their review, concurrence, and editing. The final HHPRC report is contained in **Appendix A** of this document.

Based on the feedback received from the HHPRC during the October 2012 Workshop and on technical comments received from stakeholders and technical experts, FDEP revised its approach to the development of HHC. The most substantial change in the approach involved the decision that the 1994 Degner Survey cannot be relied upon as the sole basis for determining fish consumption patterns in the state of Florida. The HHPRC recommended that FDEP use more recent national or regional fish consumption surveys to quantify the amount of fish currently being consumed by Floridians.

FDEP staff presented proposed HHC to the Environmental Regulation Commission (ERC) for adoption as a change to water quality standards on April 23, 2013. After testimony from the department, stakeholders, and environmental advocates, the ERC voted to continue the rulemaking and asked the department to a) further evaluate regionalized or state-level fish consumption patterns; b) develop parameter-specific relative source contributions (RSC) for non-carcinogens where there is sufficient information and data; and, c) if possible, consider use of the alternative National Cancer Institute (NCI) methodology for estimating fish consumption rates. The current analysis presented within this document attempts to address the ERC’s recommendations where data and information allow at this time. The analysis includes regional fish consumption rates and an analysis of RSC values for some non-carcinogens. The fish consumption distributions were determined using a statistical methodology that closely approximates the National Cancer Institute (NCI) methodology for estimating fish consumption rates.

1.4 *Criteria Considered for Criteria Revision or Adoption*

Using the methodologies described in this document, FDEP is proposing to develop revised HHC for 43[2] (40[3] for Class II and III waters) parameters that are currently listed in Chapter 62-302, F.A.C., and to develop new criteria for an additional 39 (37 for Class I) parameters (not currently listed in Chapter 62-302, F.A.C.) for a total of 80 (79 in Class II and III waters) parameters that are being revised or adopted. Human health-based criteria were calculated for an additional nine parameters [alpha-endosulfan, beta-endosulfan, Endosulfan sulfate[4], Endrin, Selenium, gamma-Hexachlorocyclohexane (HCH), Toxaphene, Cyanide (Class III), and Phenol]; however, the resulting criteria were higher (less stringent) than criteria required to protect aquatic life or organoleptic effects (phenol) and are therefore not proposed for revision. The existing aquatic life-based or organoleptic criteria for these nine parameters are fully protective of all uses, including human health, based on the fact that they were developed to protect the most sensitive endpoint.

FDEP considered new criteria for priority pollutants in response to public comments received during the 2006 Triennial Review of Florida's water quality standards, recommending that FDEP consider adoption of criteria for all priority pollutants. Additionally, the department reviewed and considered all pollutants included in U.S. EPA's National Recommended Human Health Criteria. The parameters reviewed by FDEP are listed in **Appendix B**, which includes brief summaries of the uses specific to each chemical.

The department determined that criteria for several parameters should not be revised or added at this time. Parameters that were considered, but which are not being added include five banned pesticides (4,4'-DDD, 4,4'-DDE, alpha-BHC, Endrin aldehyde, and Hexachlorobenzene), five non-priority pollutants (1,2,4,5-Tetrachlorobenzene, 2,4,5-Trichlorophenol, Bis(Chloromethyl) Ether, Dinitrophenols, and Hexachlorocyclohexane (HCH)- Technical), and three parameters for which there is insufficient toxicological information available (Arsenic, Methyl Chloride, and Thallium). Additional information about the parameters with insufficient toxicological information are provided below.

Arsenic

EPA is currently reassessing the arsenic reference dose (RfD) used for non-carcinogens and cancer slope factor (CSF) used for carcinogens: https://www.epa.gov/iris/inorganic-arsenic-meetings-webinars and https://cfpub.epa.gov/ncea/iris_drafts/recordisplay.cfm?deid=309710. Furthermore, EPA did not update their national recommendation for arsenic in 2015. Therefore, FDEP intends to maintain the current criteria until EPA has completed the toxicity factor review.

---

[2] The tabulation of existing criteria includes individual PAHs, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene, which are currently listed in Rule 62-302.530, F.A.C under Total PAHs. U.S. EPA's latest national recommendations break these parameters out into individual criteria, and FDEP is proposing to do the same.

[3] The parameter counts differ between Class II/III and Class I because Class I currently includes criteria for Chlorophenoxy Herbicide (2,4,5-TP) and Chlorophenoxy Herbicide (2,4-D), which are not currently included in Class II/III. Additionally, the cyanide criterion is only being revised in Class I waters, and not in Class II/III.

[4] Endosulfan sulfate is not currently listed in Rule 62-302.530, F.A.C. It is being proposed for adoption as part of the human health criteria rule making, although the criteria value is based on aquatic life protection.

Methyl Chloride

EPA currently has no national recommendation for methyl chloride (chloromethane). The IRIS database notes that the human carcinogenicity data are inadequate and that the few studies that have examined methyl chloride's potential carcinogenicity in humans have failed to convincingly demonstrate any association, and in one instance even indicated a lower cancer incidence than expected in workers chronically exposed to methyl chloride in a butyl rubber manufacturing plant. The 2002 National Recommended water quality criteria for methyl chloride used the cancer slope factor for chloroform; however, EPA has concluded that the chloroform RfD can be considered protective against increased risk of cancer (U.S. EPA IRIS). A similar demonstration has not been made for methyl chloride, and EPA has not stated that the chloroform RfD can be used for methyl chloride. Given the uncertainty in the appropriate cancer slope factor or RfD to use for methyl chloride, FDEP has determined that there is an insufficient technical basis for updating the existing methyl chloride criterion.

Thallium

The IRIS database concluded that the toxicity database for thallium contains studies that are generally of poor quality. It notes that the principal candidate study suffers from certain critical limitations (*e.g*., high background incidence of alopecia, lack of histopathological examination of skin tissue in low- and mid-dose groups, and inadequate examination of objective measures of neurotoxicity), and there are particular difficulties in the selection of appropriate endpoints. Therefore, even though an RfD would generally be derived with a combined uncertainty factor of 3000, an RfD for soluble thallium salts was not derived in the case of thallium (USEPA, 2009). Further, the 2009 assessment clearly stated it did not recommend a thallium RfD value. FDEP is therefore not revising the existing thallium criteria given the lack of a scientifically justified and peer reviewed RfD. Retention of the existing criteria will maintain the current level of protection until such time as sufficient evidence is available to support revision.

EPA’s 2015 Human Health Criteria did not include updates for four additional parameters (antimony, beryllium, polychlorinated biphenyls (PCBs), and selenium). FDEP included these four parameters in its review and is proposing updates for antimony, beryllium, and polychlorinated biphenyls (PCBs), because Florida’s existing criteria are based on information that predates EPA’s most recent recommendations or current scientific information. EPA last updated its recommendations for antimony, polychlorinated biphenyls (PCBs), and selenium in 2002 (USEPA, 2002). As previously noted, selenium was included in the human health criteria review, but it was ultimately determined that the aquatic life endpoint is more sensitive, and thus the criteria were not revised.

1.5 *The Probabilistic Approach*

The current probabilistic approach was selected to build upon the 2008 Baseline Risk Analysis. The approach directly incorporates risk assessment into the calculations, which facilitates preparation of an impact statement. A risk assessment is inherent to the criteria derivation because the criteria are set at levels necessary to achieve a prescribed target risk level.

Human health water quality criteria are established at the highest concentration of a pollutant in water that protects against a significant risk of adverse health effects over a lifetime. The criteria should provide adequate protection to the general population over a lifetime of exposures and to special subpopulations (those with high water or fish intake rates or higher sensitivities), which have an increased risk of receiving a dose that would elicit adverse effects. EPA’s default HHC calculations use a number of conservative values meant to capture both the toxicity and exposure to pollutants through typical exposure routes. Under the probabilistic approach, one or more of the exposure variables are inserted into the equation as probability distributions based on variability in the target population. The analysis treats the exposure distributions as random variables and allows for an evaluation of risk to both the entire population and to higher risk sub-populations.

In contrast, the default deterministic approach relies on point estimates of key variables (*e.g.*, body weight, fish consumption rate, drinking water intake). Point estimates are generally established at an upper percentile (*e.g.*, 90th) under the assumption that these will protect high-end consumers or high risk individuals. However, the deterministic approach is often criticized as being rudimentary and inaccurate due to compounded levels of conservatism, resulting in criteria that are unrealistic. The selection of point value estimates such as fish consumption rate are based on best professional judgment and are often the focus of much disagreement and contention. Reliance on point values discards valuable information on variability within populations. Furthermore, use of the deterministic approach has led to a focus on the wrong endpoints. The focus of criteria development should not be selection of a fish consumption rate or any other point value, but rather on setting criteria at the concentration of a pollutant in water that is not expected to pose a significant risk to human health over a lifetime. The probabilistic approach allows the focus to be shifted back to the true concern, specifically, the risk of exceeding the reference dose (RfD) or Cancer Slope Factor (CSF or q1*). Therefore, after receiving support from the HHPRC, FDEP’s selected approach uses Monte Carlo analysis to solve for the parameter-specific concentration (protective criteria) necessary to ensure that a specified percentile of the population will not exceed the RfD for non-carcinogens or the CSF for carcinogens.

2 Methods Used to Derive Criteria

2.1 *Basic Equations*

EPA provides written guidance on procedures for the calculation of human health criteria (USEPA, 2000A). As previously stated, the recommended equations use inputs that represent conservative estimates of both exposure and toxicity. The default equations for non-carcinogens (*i.e.*, those based on a threshold reference dose) are given as:

For consumption of water and organisms:

$$\mathrm{SWQC}(\mu\mathrm{g/L}) = \frac{\left[\mathrm{RfD}\ \left({}^{\mathrm{mg}}/_{\mathrm{kg\cdot d}}\right) \mathrm{x\ RSC}\right] \times\ \mathrm{BW\ (kg)}\ \times\ 1{,}000\ (\mu\mathrm{g/mg})}{\mathrm{DI\ (L/d)}\ +\ \Sigma_{i=2}^{4}\left[\mathrm{FCR_i}\left({}^{\mathrm{kg}}/_{\mathrm{d}}\right) \times\ \mathrm{BAF_i}\ \left({}^{\mathrm{L}}/_{\mathrm{kg}}\right)\right]} \qquad \text{(Equation 2-1)}$$

For consumption of organisms only:

$$\mathrm{SWQC}(\mu g/L) = \frac{\left[\mathrm{RfD}\ \left({}^{mg}/_{kg\cdot d}\right) \mathrm{x\ RSC}\right] \times\ \mathrm{BW\ (kg)}\ \times\ 1{,}000\ (\mu g/mg)}{\Sigma_{i=2}^{4}[\mathrm{FCR_i}\left({}^{kg}/_{d}\right) \times\ \mathrm{BAF_i}\ \left({}^{L}/_{kg}\right)]} \qquad \text{(Equation 2-2)}$$

The default equation for a carcinogenic compound is given as:

For consumption of water and organisms:

$$\mathrm{SWQC}(\mu g/L) = \frac{[\mathrm{Risk/CSF}\ \left({}^{mg}/_{kg\cdot d}\right)] \times\ \mathrm{BW\ (kg)}\ \times\ 1{,}000\ (\mu g/mg)}{\mathrm{DI\ (L/d)}\ +\ \Sigma_{i=2}^{4}[\mathrm{FCR_i}\left({}^{kg}/_{d}\right) \times\ \mathrm{BAF_i}\ \left({}^{L}/_{kg}\right)]} \qquad \text{(Equation 2-3)}$$

For consumption of organisms only:

$$\mathrm{SWQC}(\mu g/L) = \frac{[\mathrm{Risk/CSF}\ \left({}^{mg}/_{kg\cdot d}\right)] \times\ \mathrm{BW\ (kg)}\ \times\ 1{,}000\ (\mu g/mg)}{\Sigma_{i=2}^{4}[\mathrm{FCR_i}\left({}^{kg}/_{d}\right) \times\ \mathrm{BAF_i}\ \left({}^{L}/_{kg}\right)]} \qquad \text{(Equation 2-4)}$$

Where:

SWQC = surface water quality criterion (mg/L)
RfD = parameter-specific reference dose (mg/kg-day)
RSC = Relative source contribution factor to account for non-water sources of exposure (not used for linear carcinogens) and may be either a percentage (multiplied) or amount subtracted.
BW = body weight (kg)
CSF = Cancer slope factor (mg/kg-day)
Risk = Incremental life-time increased cancer risk (10^{-6} to 10^{-5})
FCR_i = fish consumption rate for aquatic TLs 2, 3, and 4 (kg/day)
BAF_i = bioaccumulation factor for aquatic TLs 2, 3, and 4 (L/day)
$\Sigma^4_{i=2}$ = summation of values for aquatic trophic levels (TLs), where the letter *i* stands for the TLs to be considered, starting with TL2 and proceeding to TL4

2.2 *Risk Characterization*

The equations may be used with national recommend values or with statewide or site-specific values representative of the target population of concern. Use of the equations in this manner will provide deterministically-based surface water criteria. Alternatively, the equations can be algebraically reordered to evaluate risk of either exceeding the RfD or for calculating an incremental increase in cancer risk. Exposures through other routes, such as dermal absorption, can be added to the equation if these are of potential concern.

The equation for non-carcinogens can be reordered such that it is expressed as exposure divided by toxicity; thus, yielding the hazard or risk (termed hazard quotient, or HQ) of exceeding the body weight adjusted reference dose. HQ values less than 1.0 indicate that the *RSC* adjusted reference dose is not exceeded, while HQ values greater than 1.0 indicate that the *RSC* adjusted reference dose is exceeded. The HQ equation is given as:

$$HQ = \frac{I_{w+}I_f}{BW \times (RSC \times RfD)} \qquad \text{(Equation 2-5)}$$

Where:

I_w = exposure through drinking water consumption (mg/day).
I_f = exposure through fish consumption (mg/day)
RfD = parameter specific reference dose (mg/kg-day)
RSC = Relative source contribution factor expressed as percentage of *RfD* apportioned to surface water exposures
BW = body weight (kg)

The equation for calculating the incremental increase in cancer risk is similar to the hazard quotient equation used for non-carcinogens. However, because the cancer slope is expressed as the proportion of the population affected per mg contaminant per kg body weight-day, the CSF is in the numerator of the equation. The equation provides the lifetime incremental risk of cancer event (*e.g.*, 10^{-6}, 10^{-5}) due to exposure to the contaminant and is given as:

$$Risk = \frac{(I_{w+}I_f) \times CSF}{BW} \qquad \text{(Equation 2-6)}$$

Where:

I_w = exposure through drinking water consumption (mg/day)
I_f = exposure through fish consumption (mg/day)
CSF = cancer slope factor $(\text{mg/kg-day})^{-1}$
BW = body weight (kg)

2.3 *Exposure Calculations*

Exposures through drinking water were only applied to Class I and I-Treated waters (*i.e.*, potable water supplies) and were not included in the calculation of hazard quotients for Class II, III, and III-Limited criteria. Exposures from fish consumption apply to all water classifications except Class IV and V, which are not under consideration.

Exposure through drinking water is a function of drinking water intake (*DI*) in mL/day and the surface water concentration (*SWC*) of contaminant in mg/L:

$$I_w = SWQC \cdot DI \qquad \text{(Equation 2-7)}$$

Similarly, the exposure through fish consumption is a function of the trophic level specific fish consumption rates (FCR), surface water concentration, and the trophic level-specific bioaccumulation rates, and is given as:

$$I_f = \Sigma_{\mathrm{i=2}}^{4}(\mathrm{FCR_i} \times \ \mathrm{BAF_i} \ \times \mathrm{SWC}) \qquad \text{(Equation 2-8)}$$

Where: *SWC* = surface water concentration (mg/L).
FCR_i = fish consumption rate for aquatic TLs 2, 3, and 4 (kg/day)
BAF_i = bioaccumulation factor for aquatic TLs 2, 3, and 4 (L/day)

The bioaccumulation factor (BAF) describes the rate at which a contaminant diffuses into fish tissue and accumulates through the fish's diet via the food chain, thus providing a translation factor between surface water concentration to fish tissue concentration. For compounds with only a single bioconcentration factor (BCF), the total FCR across all three trophic levels was used and Equation 2-8 is rewritten as:

$$I_f = (\Sigma_{\mathrm{i=2}}^{4}\mathrm{FCR_i}) \times \ \mathrm{BCF} \ \times \mathrm{SWC} \qquad \text{(Equation 2-9)}$$

The BCF accounts for accumulation via diffusion only.

2.4 *Targets for the Risk Assessment*

Use of the probabilistic approach to set HHC requires the establishment of *a priori* risk management targets. These targets represent a policy decision intended to protect the majority of the target population from excess risk of cancer or other health effects through the exposure to contaminants in the environment. Because the standard EPA criteria derivation methodology for carcinogens already includes an explicit consideration of increased risk (*i.e.*, 10^{-4} to 10^{-6}), the incorporation of a risk target into the probabilistic approach is straightforward. However, for non-carcinogens the consideration of risk is implicit in the criteria derivation; that is, the equations for deriving non-carcinogenic human health criteria do not include a risk factor. Therefore, the risk targets for the two different endpoints were set in different ways, although the objective for both is to protect the general population from increased health risks over a lifetime.

2.4.1 Carcinogens

For carcinogens, protective criteria were derived by iteratively conducting the probabilistic risk analysis until the target risk was achieved at the arithmetic mean of the distribution (**Figure 2-1**). The target risk for carcinogens was based on a no greater than one-in-a-million (10^{-6}) incremental excess risk of developing cancer over a life-time (assumed to be 70 years). The goal of the risk assessment is to set the individual criteria at the level necessary to protect individuals or groups within the population who eat fish caught from local waters as well as individuals or groups who ingest water obtained from local drinking water source (Class I waters). Additionally, the resulting risks associated with calculated criteria were carefully assessed to ensure none of the criteria values produced risks exceeding 10^{-5} (1 in 100,000) at the 90th percentile or 10^{-4} at the extreme upper end of the distribution (*e.g.*, 95th, 99th percentiles).

Selection of a protective risk level is a risk-based policy decision. The USEPA (2000) states "EPA believes that both 10^{-6} and 10^{-5} may be acceptable for the general population and that highly exposed populations should not exceed a 10^{-4} risk level." Florida's current human health-based criteria for carcinogens are based on a risk level of 10^{-6} and developed from a national average fish consumption rate (6.5 g/day). Thus, the use of an average risk level is consistent with the current level of protection. Further, the Florida Department of Health (DOH) issues fish consumption advisories based on a risk level of 10^{-5} to protect individuals who consume at least one fish meal per week (32 g/day). DOH considers the 10^{-5} level to be a "very low increased risk." FDEP's approach ensures that average Floridians will be protected at greater than 10^{-6} (extremely low increased risk) level, regular (weekly) consumers of Florida fish will be protected at the 10^{-5} level consistent with DOH policy, and that all Floridians, including subsistence fishers, will be protected at better than 10^{-4} (low increased risk). It should be noted that because the risk distributions are lognormal and skewed, the mean value represents greater than 50 percent of the population.

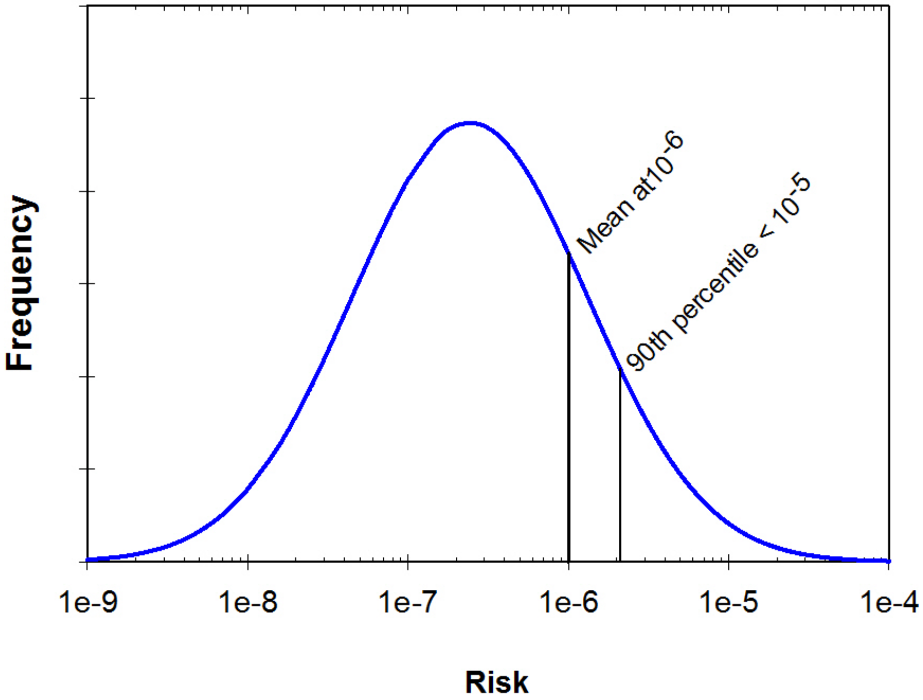


Figure 2-1. Theoretical probability distribution of risk for a carcinogen. Surface water quality criteria were set at the level necessary to achieve a 10^{-6} ($1 \cdot 10^{-6}$ or 1E-6) risk at the mean of the risk distribution and no greater than a 10^{-5} risk at the 90^{th} percentile. Note: x-axis is on a log scale. The mean risk is to the right of the median (curve peak) because the distribution is lognormal. The mean and median will be equal for normal distributions.

2.4.2 Non-carcinogens

For non-carcinogens, the criteria were derived by running the probabilistic analysis (Monte Carlo) to calculate surface water criteria (Equations 2-1 and 2-2), and then setting the criterion at the 10th percentile of the Monte Carlo calculated results (**Figure 2-2**). Additionally, 31 of the carcinogenic parameters considered by FDEP have non-carcinogenic RfDs in addition to CSFs. For these 31 parameters, FDEP used the probabilistic approach to derive criteria for both endpoints (carcinogenic and non-carcinogenic) and set the final criteria at the more sensitive, lower endpoint. Use of the 10th percentile for non-carcinogens ensures that at least 90 percent of Floridians will be protected at the criteria levels, and is consistent with U.S. EPA's implicit protection goals. The 10th percentile balances protection of high risk segments of the population with a consideration of the fact that exposure distributions become increasingly uncertain at lower percentiles (*e.g.*, 5th, 1st) because there are few observed data points in this range in the underlying data sets used to derive these distributions. Finally, even the more robust probabilistic approach incorporates conservatism into the criteria due to uncertainty factors applied by EPA to the derivation of reference dose calculations, as well as implicit assumption in the criteria calculations, such as 70 year exposures and the assumption that the tissue of all fish consumed is contaminated at the level of the surface water quality criterion.

Although the EPA equation does not include an explicit factor for risk, the equation and its application provide an implicit assumption that the majority (approximately 90%) of the target population will not be exposed to contaminant levels that exceed the reference dose (RfD). EPA defines the RfD as *an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to humans (including sensitive subgroups) that is likely to be without an appreciable risk of adverse effects over a lifetime*. FDEP's approach to setting criteria provides the same level of implicit protection (risk management target) as EPA's, and ensures that the risk assessment goal is attained.

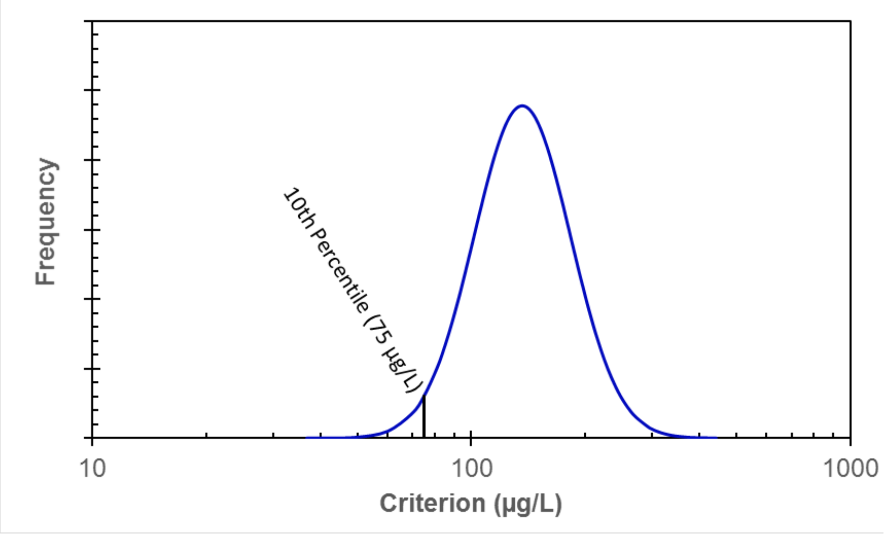


Figure 2-2. Theoretical probability distribution of protective criteria for a non-carcinogen calculated using the probabilistic approach. Surface water quality criteria were set at the 10th percentile. Note: x-axis is on a log scale and the risk distribution is lognormal.

As a check, and as a component of the analysis supporting the risk impact statement, FDEP additionally evaluated the hazard quotient (HQ) for non-carcinogens. The HQ is calculated as the total intake from fish and drinking water (for Class I waters), assuming the surface water is contaminated at the criterion, divided by the RfD, and then multiplied by body weight (Equation 2-5). Thus, the HQ represents RfD fractional exposure. A HQ value in excess of 1.0 indicates the fraction by which the RSC adjusted RfD has been exceeded; for example, a HQ value of 1.2 indicates that the RSC adjusted RfD has been exceeded by 20%. The target risk for the HQ was set to 1.0 to be attained at the 90th percentile of the HQ risk distribution (**Figure 2-3**). The HQ values are reported in **Appendix F** in support of the risk impact statement.

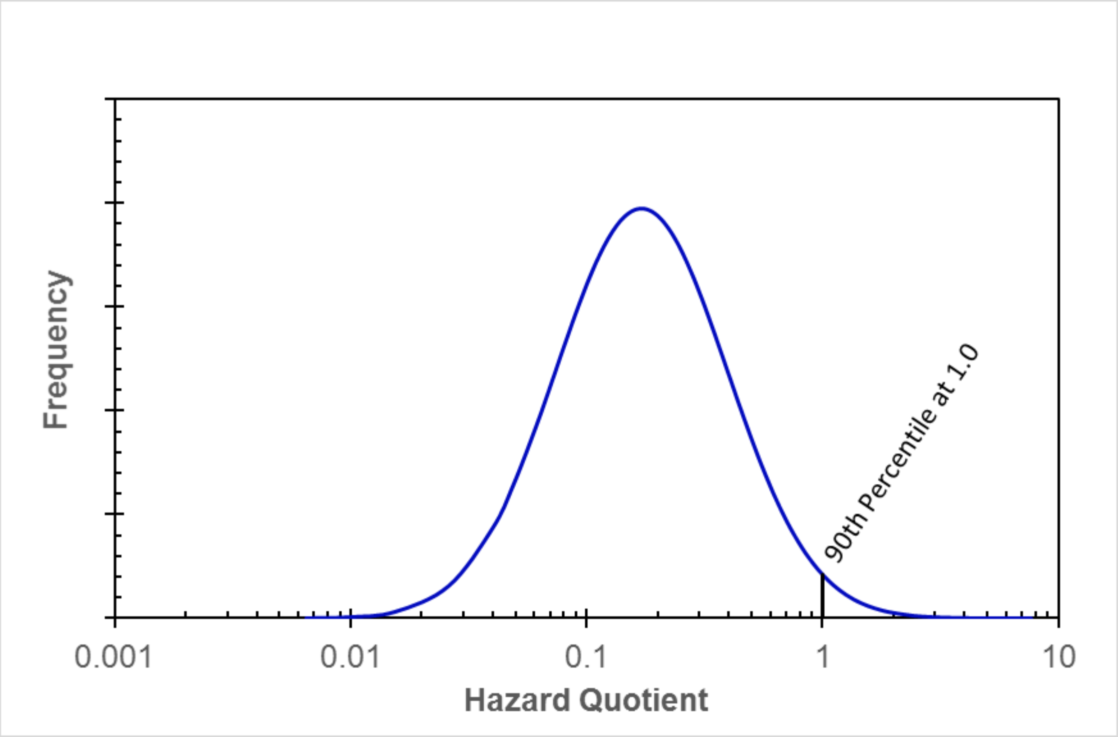


Figure 2-3. Theoretical probability distributions of risk for a non-carcinogen. Surface water quality criteria were set at the level necessary to achieve the target risk at the 90% certainty level; that is, at the 90th percentile that the HQ will equal 1. Note: x-axis is on a log scale, and the risk distribution is lognormal.

3 Exposure Factors

To implement the probabilistic risk-based approach, three of the exposure inputs (*e.g.*, fish consumption rate, drinking water consumption, and body weight) were selected as distributions rather than point measurements. These factors define time, frequency, and duration of exposures. Use of distributions allows FDEP to assess risk levels across the population and ultimately set criteria at levels necessary to achieve the target risk levels and protect Floridians who consume fish obtained from local waters and/or ingest water from Class I waters.

For the calculation of HHC, the most recent and most locally relevant distributions were used [see **Tables 3-1** and **3-2** for a summary of the bases, source, and percentiles (between the 5th and 95th) of the distributions used in the probabilistic analyses]. National recommendations, primarily from the 2011 Exposures Factors Handbook (USEPA, 2011), were used unless regional-specific data were available. The 2011 Handbook represents the most current summary and EPA recommendations of exposure factors related to human behaviors. In addition to the 2011 Exposure Factors Handbook, the department used EPA' *Estimated Fish Consumption Rates for the U.S. Population and Selected Subpopulations* (USEPA 2014) as the basis for fish consumption rates. USEPA (2014) represents a more current analysis of consumption rates; used a methodology that better accounts for usual consumption patterns than previous data sources; and, includes regional rates that are more relevant to Florida than the national rates available from other sources.

To establish distributions for fish consumption, FDEP used nine separate fish consumption distributions across three geographic regions of Florida (Atlantic Coast, Gulf Coast, and Inland South) and three trophic levels. Consumption rates for the three regions were used in conjunction with a custom distribution that described the probability of an individual residing within a given region based on the percentage of the Florida population residing within that geographic region. The percent of the population residing within the Atlantic Coast, Gulf Coast, and Inland South geographic regions are 44.8, 31.6, and 23.6 percent, respectively, based on the 2010 U.S. Census. The custom geographic regional distribution was used to select a single region (*e.g.*, Atlantic Coast) for each Monte Carlo iteration. The trophic level 2, 3, and 4 fish consumption distributions were then used for that iteration as the basis of determining the fish consumption rate.

Additional information on each distribution is provided in the subsequent text, which is organized by input parameter beginning with **Section 3.1. Section 3.5** provides background on the toxicity inputs (*i.e.*, CSF, RfD, MRL and RSC) used in the analyses, which are summarized in **Table 3-9**. All toxicity inputs were entered as fixed parameter-specific values, with the exception of the CSF for benzene. Benzene was entered into the probabilistic analysis as a uniform distribution based on the range of CSFs[5] recommended by EPA (USEPA 2000B). Benzene toxicity (CSF) was handled differently from the other chemicals being considered because benzene is the only chemical for which EPA recommends a range of CSFs. Additionlly, benzene is is the only human health-based parameter for which EPA recommends a range of criteria (*i.e.*, Consumption of Water + Organism: 0.58-2.1 µg/L; Consumption of Organism only: 16-58 µg/L)[6], based on the range of CSFs.

---

[5] EPA recommends a CSF range of $1.5 \cdot 10^{-2}$ per mg/kg-d (0.015 per mg/kg-d) to $5.5 \cdot 10^{-2}$ per mg/kg-day (0.055 per mg/kg-day) for benzene based on a 2000 EPA IRIS assessment. EPA's IRIS program derived the CSF range using principal studies by Rinsky et al. (1981; 1987), Paustenbach et al. (1993), Crump (1994), and USEPA (1998A; 1999) based on the development of leukemia in humans with occupational inhalation exposure to benzene. EPA (2000B) determined that all CSFs within the range were equally valid.

[6] This criterion is based on carcinogenicity of 10^{-6} risk. Alternate risk levels may be obtained by moving the decimal point (e.g., for a risk level of 10-^{5}, move the decimal point in the recommended criterion one place to the right).

Table 3-1. List of fish consumption input distributions used in probabilistic risk analyses, including the source of information and the type of statistical distribution used. Additional information on the data sources and fit parameters are included in Section 3.3. Percentiles are based on the results of 100,000 Monte Carlo iterations. The total fish consumption rate was calculated during each model iteration as the sum of consumption across trophic level 2, 3, and 4. Note: all probabilistic risk calculations were based on the full range of these distributions. Distributions were not truncated below or above the 5th and 95th percentiles, respectively.

Statistics	Atlantic TL2 (g/day)	Atlantic TL3 (g/day)	Atlantic TL4 (g/day)	Gulf TL2 (g/day)	Gulf TL4 (g/day)	Gulf TL3 (g/day)	Inland S. TL2 (g/day)	Inland S. TL3 (g/day)	Inland S. TL4 (g/day)	Total FCR (g/day)
Source	Table E-13 (USEPA, 2014)	Table E-14 (USEPA, 2014)	Table E-15 (USEPA, 2014)	Table E-13 (USEPA, 2014)	Table E-15 (USEPA, 2014)	Table E-14 (USEPA, 2014)	Table E-15 (USEPA, 2014)	Table E-13 (USEPA, 2014)	Table E-15 (USEPA, 2014)	Calculated
Distribution	Lognormal	Lognormal	Lognormal	Lognormal	Lognormal	Lognormal	Lognormal	Lognormal	Lognormal	Sum of TL2, TL3, and TL4
Mean	5.16	5.69	2.64	4.59	2.45	5.23	3.34	3.88	2.75	12.28
Std. Dev.	8.00	6.94	7.71	7.96	7.68	6.78	6.08	5.66	9.68	13.07
5th percentile	0.45	0.74	0.06	0.33	0.05	0.63	0.22	0.38	0.05	2.53
10th percentile	0.68	1.05	0.11	0.51	0.09	0.90	0.34	0.56	0.08	3.32
25th percentile	1.33	1.89	0.28	1.04	0.24	1.64	0.71	1.08	0.23	5.28
50th percentile	2.79	3.61	0.80	2.30	0.70	3.20	1.61	2.20	0.70	8.83
75th percentile	5.91	6.85	2.28	5.06	2.04	6.24	3.63	4.51	2.13	14.88
90th percentile	11.58	12.26	5.84	10.39	5.38	11.41	7.61	8.62	5.84	24.18
95th percentile	17.23	17.34	10.24	16.02	9.54	16.35	11.81	12.74	10.75	32.75
99th percentile	37.09	33.47	29.29	35.40	27.85	31.94	26.54	26.11	33.60	60.39

Table 3-2. Body weight and drinking water input distributions used in the probabilistic risk analyses, including the source of information and the type of statistical distribution used. Additional information on the data sources and fit parameters are described in Sections 3.1 and 3.2 for body weight and drinking water, respectively. Percentiles are based on the results of 100,000 Monte Carlo iterations. Note: all probabilistic risk calculations were based on the full range of these distributions. Distributions were not truncated below or above the 5th and 95th percentiles, respectively, although drinking water was constrained to a minimum of 0 mL/day.

Statistics	**Body Weight (kg)**	**Drinking Water (mL/day)**
Source	**Table 8-25, 2011 Exposure Factors Handbook**	**Table 3-23, 2011 Exposure Factors Handbook**
Distribution	**Lognormal**	**Beta**
Mean	79.92	1,025.65
Std. Dev.	20.67	950.44
5%	50.84	0.00
10%	55.80	0.00
25%	65.15	238.41
50%	77.37	770.06
75%	91.88	1,583.31
90%	107.25	2,444.20
95%	117.67	2,948.56
99%	139.90	3,765.73

3.1 *Body Weight*

The body weight used in U.S. EPA's deterministic calculation is 80 kg (USEPA, 2015), which is based on National Health and Nutrition Examination Survey (NHANES) data from 1999 to 2006 (USEPA, 2011). This represents the mean body weight for adults ages 21 and older. EPA's previously recommended default body weight was 70 kilograms, which was based on the mean body weight of adults from the NHANES III database (1988-1994). Florida's current human health criteria in Rule 62-302.530, F.A.C., were derived based on the earlier 70 kg input value.

Both the 70 and 80 values represent an assumed average weight for the adult population, assuming an average weight will be protective of the population. Individuals who weigh less than average may be under-protected by the default criteria if they consume fish and drinking water at rates near the 90th percentile values. Conversely, default criteria will be over-protective for individuals weighing more than the average, even if they consume fish and drink water at the 90th percentile rates. FDEP's probabilistic approach uses the range of body weights and other factors to more accurately estimate the risk to the population based on the combination of factors that influence individual risk.

The 2011 Exposures Factors Handbook (USEPA, 2011) recommends using Portier *et al*. (2007) when body weight distributions are used in risk calculations. Portier *et al*. (2007) computed the means and standard deviations of body weight as back transformations of the weighted means and standard deviations of natural log-transformed body weights from NHANES (National Health and Nutrition Examination Survey) II, III, and IV data. The NHANES data are nationally representative and remain the principal source of body-weight data collected nationwide from a large number of subjects. The 2011 Exposure Factors Handbook provided a summary of Portier *et al*. (2007) in Table 8-25, *Estimated Body Weights of Typical Age Groups of Interest in U.S. EPA Risk Assessments*. FDEP used this source as the basis of body weights for purposes of criteria derivation and risk analysis calculations. The body weight distribution was fit assuming a lognormal distribution and the mean (79.96) and standard deviation (20.73) reported for the NHANES IV survey (**Figure 4-1**).

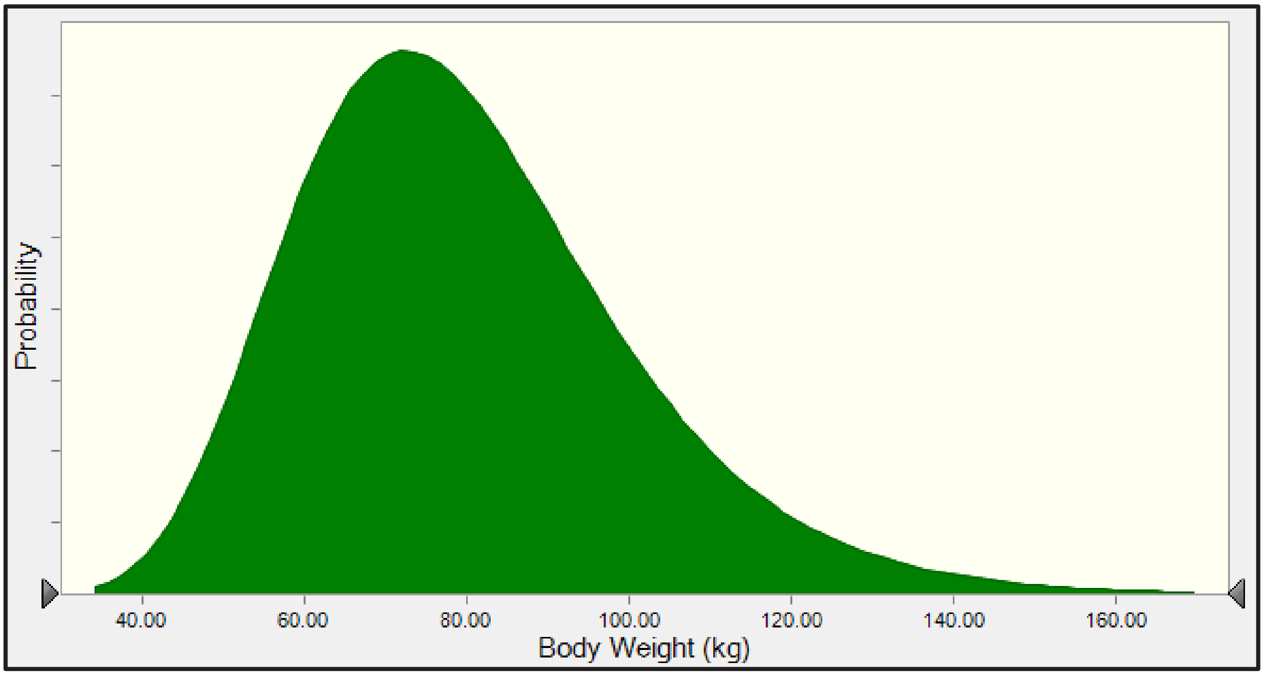


Figure 3-1. Adult body weight distributions used in all probabilistic analyses. Distribution was developed based on Table 8-25 of the 2011 Exposure Factors Handbook.

3.2 *Drinking Water Consumption*

Ingestion of surface water as drinking water is one of the two major human exposures to environmental contaminants. Most of the surface waters in Florida are designated as Class III (Fish Consumption, Waters for Recreation, and for the Propagation and Maintenance of Fish and Wildlife) and are not potable water sources. The fish consumption portion of the Class III designated use applies equally to Class I, I-Treated, II, and III-Limited waters. Additionally, Class I and Class I-Treated waters are designated for potable water supply, which requires consideration of the drinking water exposure route.

The adult drinking water consumption rate used by EPA in the deterministic approach is 2.4 L/day (USEPA, 2015), and was based on NHANES data from 2003 to 2006 (USEPA 2011, Table 3-23). This represents the per capita estimate of community water ingestion at the 90th percentile for adults ages 21 and older. EPA previously recommended a default drinking water consumption rate of 2.0 liters per day, which represented the per capita community water ingestion rate at the 86th percentile for adults surveyed in the US Department of Agriculture's 1994-1996 Continuing Survey of Food Intake by Individuals (CSFII) analysis and the 88th percentile of adults in the National Cancer Institute study of the 1977-1978 Nationwide Food Consumption Survey.

FDEP also used Exposure Factors Handbook Table 3-23 (USEPA, 2011) as the basis of drinking water consumption rates for purpose of criteria development and risk assessment. However, rather than selecting a point measure from the table, FDEP fit a continuous distribution to the data presented in Table 3-23 (USEPA, 2011). It was determined that a beta distribution best reproduced the percentiles and mean values provide in the source information (**Figure 4-2**). The fit statistics for the drinking water beta distribution were a minimum, maximum, alpha, and beta of -124, 4902, 0.87488, and 2.9761, respectively. Although the fitted distribution depicted in **Figure 3-2** extends below 0 mL/day at the extreme left-hand side of the distribution, drinking water consumption rates were constrained to a minimum of 0 mL/day for all Monte Carlo simulations. Constraining the distribution to a minimum of 0 mL/day resulted in an input distribution with a 10th percentile of 0 mL/day, consistent with the source distribution provided in the Exposure Factors Handbook.

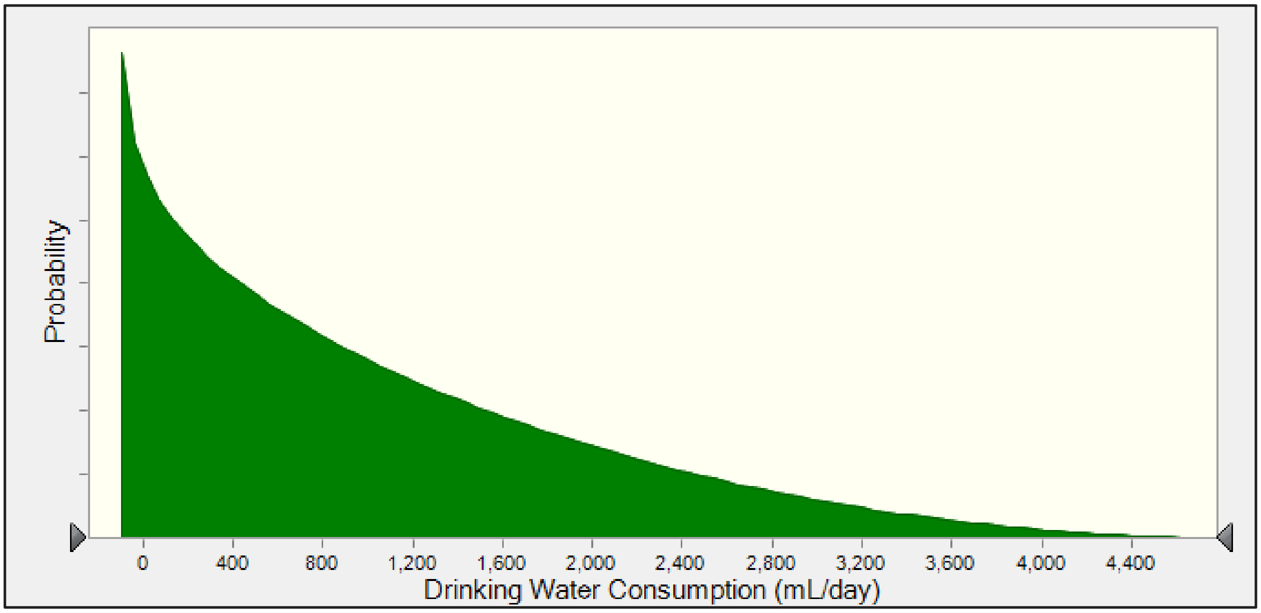


Figure 3-2. Drinking water distribution used in FDEP's probabilistic analyses. Distribution was fit from combined direct and indirect water ingestion for consumers-only in the 2011 Exposure Factors Handbook (Table 3-23 in USEPA, 2011). The distribution represents the general population consumption of "community water," which includes tap water from a community or municipal water supply, but excluded bottled water and indirect sources (water added to foods and beverages during final preparation at home or by local food service establishments such as school cafeterias and restaurants).

3.3 *Fish Ingestion Rates*

All human health-based criteria parameters are known to bioaccumulate or bioconcentrate to varying degrees in the tissues of fish and shellfish (hereafter referred to as fish) consumed by humans for food. Thus, consumption of contaminated fish can be a significant exposure route. Individual exposure to these contaminants is highly influenced by the amount of fish one consumes. An individual who consumes more fish will have a much greater exposure than an individual who consumes very little or no fish. The derivation of HHC involves the calculation of the maximum water concentration for a pollutant that will ensure that individuals or groups who ingest locally caught fish will not be exposed to levels of that pollutant in excess of levels shown to cause adverse health effects over a lifetime. Criteria derived to protect populations that consume large quantities of fish must be set at more stringent levels (lower criterion values) than those developed to protect populations that consume less fish.

In their 2015 HHC recommendations, EPA updated the total fish consumption rate to 21.3 grams per day (USEPA, 2015). This rate represents the 90th percentile consumption rate of fish and shellfish from inland and nearshore waters for the U.S. adult population 21 years of age and older, based on NHANES data from 2003 to 2010 (USEPA, 2014). EPA further broke the fish consumption rates into trophic level-specific rates to be used in conjunction with the trophic level-specific BAFs. EPA used the following trophic level-specific fish consumption rates to derive their 2015 updated HHC: TL2 = 7.6 g/d; TL3 = 8.6 g/d; and TL4 = 5.1 g/d. The trophic level-specific consumption rates were used for parameters that had trophic level-specific BAFs, while the 21.3 g/day was used for parameters that only had a single BCF value.

To increase the accuracy of consumption estimates from short-term studies, the National Cancer Institute (NCI) and others have developed a statistical methodology for estimating “usual intake” of episodically consumed foods (Tooze et al., 2006). Usual intake is defined as the long-term daily average consumption rate of a food or nutrient. The premise of the NCI method is that usual intake is equal to the probability of consumption on a given day multiplied by the average amount consumed on a "consumption day”; that is, the usual intake is a function of average amount consumed and probability of consuming. The NCI Method is preferred over earlier approaches to estimate long-term consumption because it accounts for days without consumption, distinguishes within-person from between-person variation, allows for the correlation between the probability of consumption and the consumption-day amount, and can use covariate data to better predict usual intake.

The NCI Method provides estimates of the usual fish consumption rate (UFCR) representing the long-term average grams of fish consumed per day. Due to the episodic nature of fish consumption, the NCI Method models both the probability of consumption on a given day and the amount consumed on days when some fish is consumed. These two predicted values are then multiplied together to get a usual intake value.

The calculations using the NCI Method are very time consuming. To get estimates in a reasonable time, EPA created a program that approximates the results from the NCI Method. USEPA (2014) used this estimated NCI method to develop a large number of UFCR distributions for the nation as a whole, geographic regions, and different fish types (*e.g.*, fresh and estuarine, marine, trophic level-specific). Most relevant to the task of deriving HHC for Florida, EPA included UFCR for the Gulf Coast, Atlantic Coast, and Inland South fresh and estuarine trophic level 2, 3, and 4 fish. USEPA (2014) defined these three regions as follows:

- Atlantic Coast = coastal counties in CT, DE, DC, FL (bordering Atlantic Ocean), GA, ME, MD, MA, NH, NJ, NY, NC, PA, RI, SC, and VA.
- Gulf of Mexico Coast = coastal counties in AL, FL (bordering Gulf of Mexico), LA, MS, and TX.
- Inland South = remaining non-coastal counties in DE, MD, DC, VA, NC, SC, GA, AL, MS, FL, LA, and TX and all of WV, KY, TN, AR, and OK.

The EPA analysis did not include smaller scale (*e.g.*, Florida-specific, Southeast) regions that may be more relevant to Florida; therefore, FDEP determined that the combination of these three regions provided the most locally specific and best representation of the fish consumption patterns for Floridians. FDEP used a total of nine UFCRs from USEPA (2014) as the basis of the fish consumptions rates to derive HHC. Distributions for all three trophic levels were necessary because the HHC are calculated by summing the exposures across all trophic levels. These distributions were fit based on statistics provided in Tables E-13, E-14, and E-15 for adults for each of the Atlantic, Gulf, and Inland South regions (USEPA, 2014).

The three sets of fish consumption rates in **Figures 3-3** through **3-5** were used in FDEP's probabilistic risk analyses to derive a single set of statewide human health criteria. Lognormal distributions were used to define all nine fish consumption rates. Fit statistics are provided in **Table 3-3**. The fish consumption rates were applied proportionally based on the proportion of the Florida population, as estimated by the 2010 Census, residing within each geographic region. Geographic region assignments were made based on Tiger Census Blocks 2010 in a manner consistent with the method used by USEPA (2014). All Census Blocks within counties that bordered the coastal waters[7] (Atlantic Ocean or Gulf of Mexico) were defined as being within the given geographic region. Additionally, Census Blocks whose centroids were within 25 miles of the coastal waters were assigned to the nearest geographic unit (*i.e.*, Atlantic Ocean or Gulf of Mexico). Census Blocks whose centroids were greater than 25 miles from coastal waters were assigned to the Inland South geographic unit. The total populations within the Census Blocks were then totaled by geographic region and used to calculate the proportion of the Florida population that resides within each region.

Using this approach, 44.8, 31.6, and 23.6 percent of the Florida population resides within the Atlantic Coast, Gulf Coast, and Inland South geographic regions, respectively. These proportions were used to define a custom distribution used in the probabilistic risk analysis to select the applicable set of fish consumption distributions. The probability of selecting a region was set equal to the percentage of the population residing within that region. Thus, each iteration of the Monte Carlo simulation first selected a geographic region and then selected from the trophic level 2, 3, and 4 fish consumption rates for that geographic region.

Table 3-3. Fit statistics used to describe lognormal distributions for Florida's human health based criteria derivation and risk assessment.

Statistic	Trophic Level	Atlantic	Gulf	Inland South
Log mean	TL2	1.0296	0.8329	0.4700
Log mean	TL3	1.2809	1.1632	0.7885
Log mean	TL4	-0.2231	-0.3567	-0.3567
Log standard deviation	TL2	1.1089	1.1770	1.2157
Log standard deviation	TL3	0.9586	0.9937	1.0634
Log standard deviation	TL4	1.5464	1.5856	1.6593

---

[7] Coastal waters includes embayments such as Tampa Bay, Perdido Bay, and Apalachicola Bay.

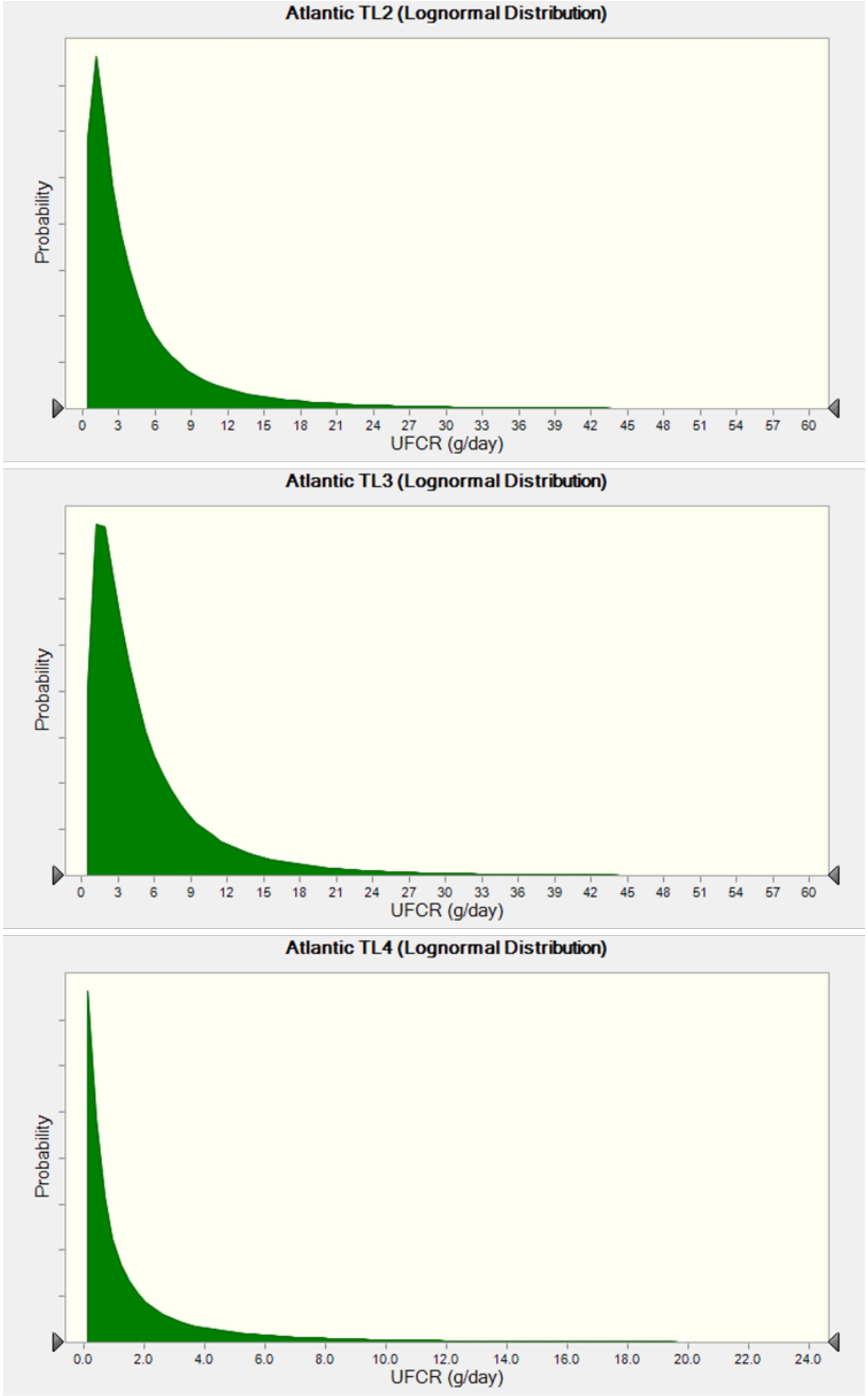


Figure 3-3. Fitted lognormal fresh and estuarine fish consumption rates for trophic levels 2 (TL2), 3 (TL3), and 4 (TL4) for the Atlantic coast geographic region.

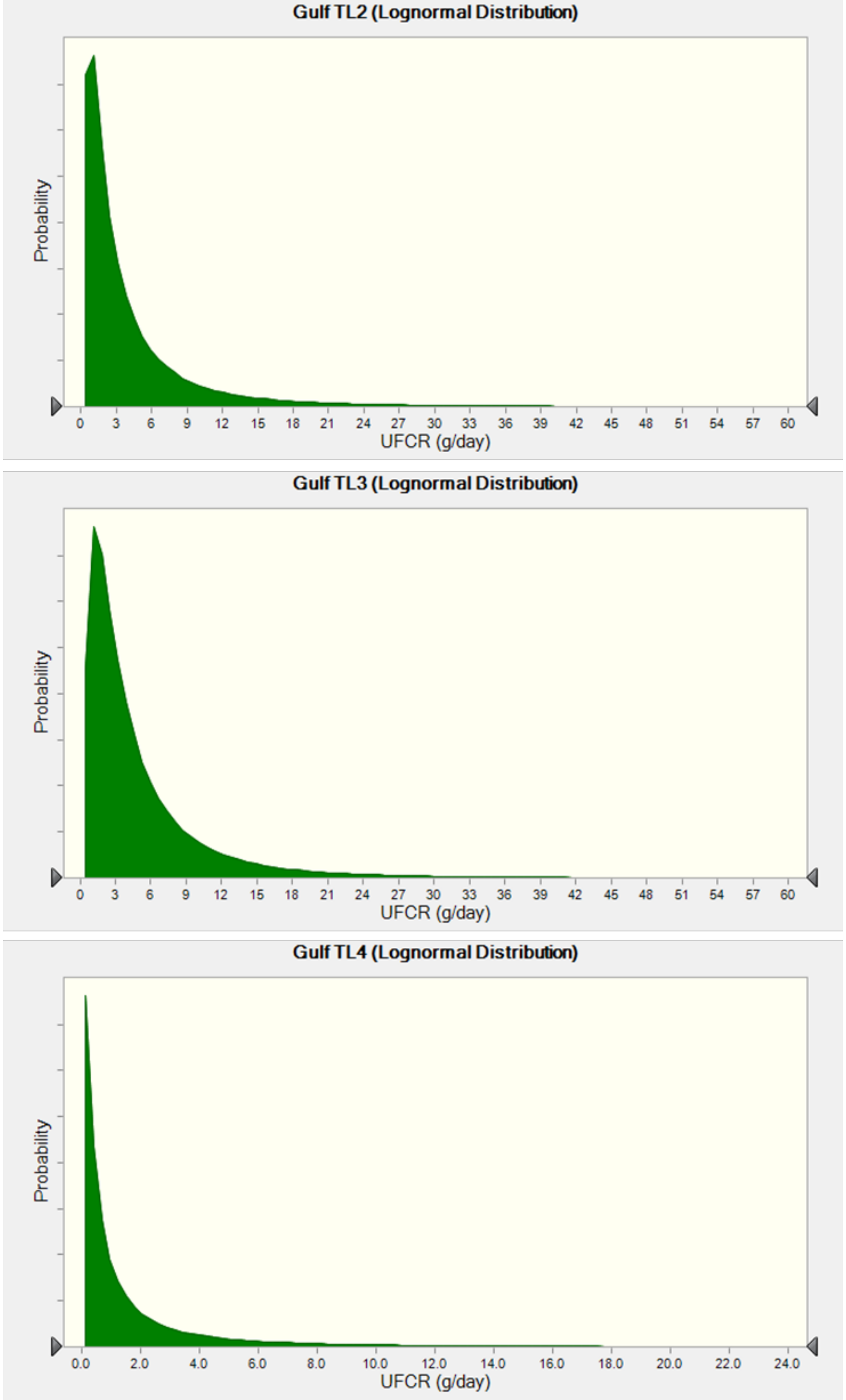


Figure 3-4. Fitted lognormal fresh and estuarine fish consumption rates for trophic levels 2 (TL2), 3 (TL3), and 4 (TL4) for the Gulf coast geographic region.

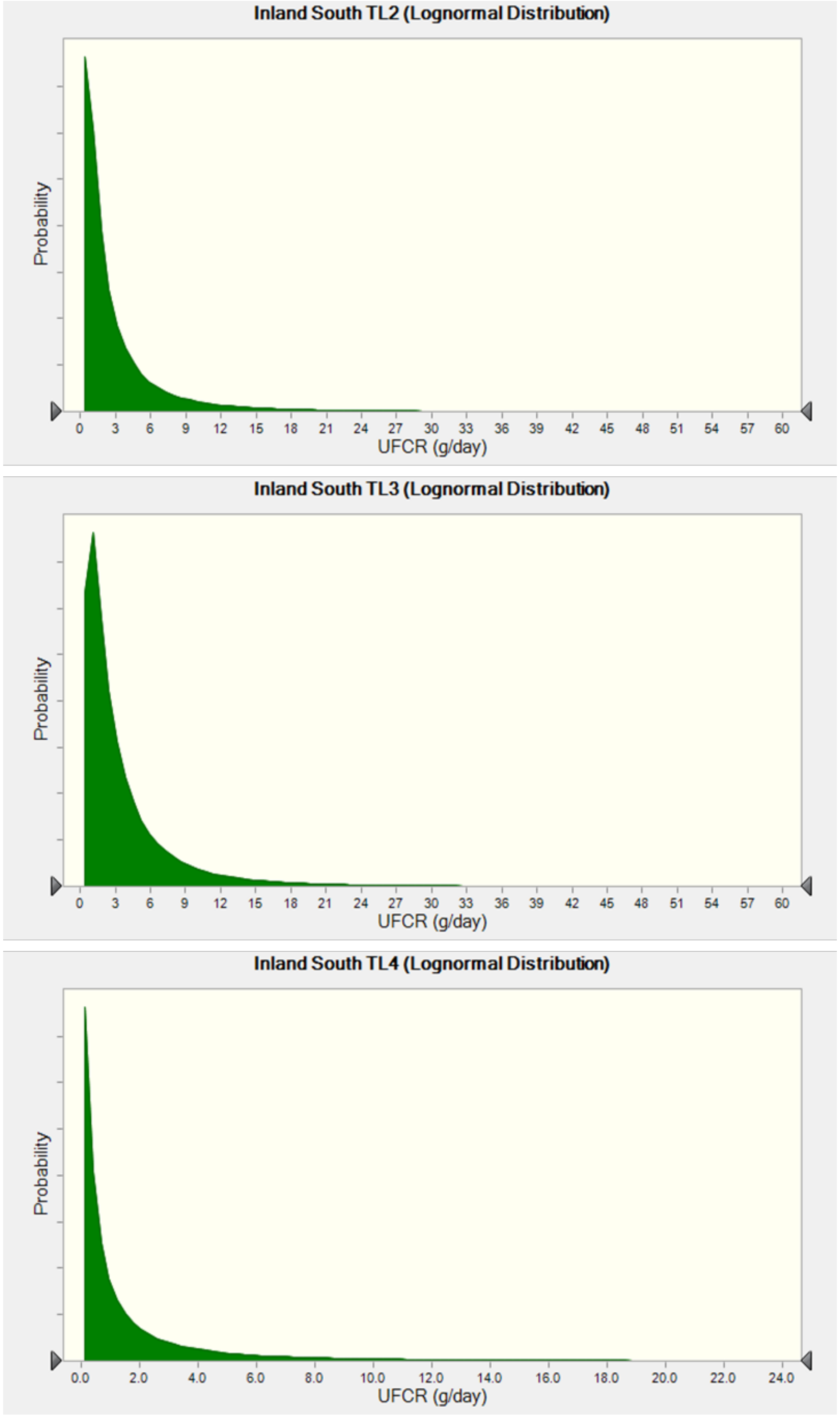


Figure 3-5. Fitted lognormal fresh and estuarine fish consumption rates for trophic levels 2 (TL2), 3 (TL3), and 4 (TL4) for the Inland South geographic region.

3.4 *Bioaccumulation and Bioconcentration Factors*

Bioconcentration (BCF) and bioaccumulation (BAF) factors relate the concentration of a pollutant dissolved in surface water to tissue concentrations within the tissues of aquatic fauna (fish and shellfish), and are used in the derivation of HHC to estimate the potential human exposure to these pollutants through consumption of fish and shellfish. The distinction between the two measures of accumulation is that a BCF is a measure of uptake via diffusion across the gill membranes, while BAFs include all uptake routes (*e.g.*, diffusion and diet). BAFs are the superior measure of potential accumulation because they include all uptakes. In both cases, the values represent a steady-state equilibrium between uptake, elimination, biodilution (growth), and biotransformation. EPA has historically used only BCFs in the derivation of the national recommend HHC. However, in 2015 (USEPA, 2015), the agency switched to trophic level-specific BAFs for the majority of chemicals. This switch is consistent with EPA’s HHC methodology (USEPA, 2000B), which recommends that BAFs be determined and applied to three trophic levels of fish.

EPA selected BAFs using a decision framework (**Figure 3-6**) for deriving national trophic level-specific BAFs (USEPA, 2000B; USEPA, 2003A). If the needed information was available, EPA used field-measured BAFs and laboratory-measured BCFs from peer-reviewed, publicly available databases to develop national BAFs. If this information was not available, EPA used laboratory BCFs or octanol-water partition coefficients (K_{ow} values), consistent with the Framework for Selecting Methods for Deriving National BAFs, from peer-reviewed sources to estimate BAFs. Following this decision framework, EPA selected the method from among six procedures that provided BAF estimates for all three trophic levels (TL2–TL4) in the following priority:

A. BAF estimated directly based on field-measured BAFs for all three trophic levels, if possible.
B. BAF estimated using the bioconcentration factor (BCF) data for all three trophic levels, if possible
C. BAF estimated using the Kow approach [Kow multiplied by a Food chain multiplier (FCM) for nonionic organic compounds with low or unknown metabolism] (see **Figure 3-6**).

EPA reviewed the available data and information for 94 parameters and developed recommended national trophic level specific BAFs for 74 of the parameters. The agency had sufficient laboratory and field data across the three trophic levels to develop BAFs based on field measured BAFs for 11 parameters (priority A., above) and estimate BAFs from field measured BCFs for 4 parameters (priority B., above). The agency also developed trophic level-specific BAFs for an additional 59 parameters using the K_{ow} approach (priority C.). There were a remaining 21 parameters for which there were insufficient laboratory or field BCF/BAF data across all three trophic levels and the K_{ow} methods was not applicable per the decision framework, and for these parameters, BCF values were used. The decision framework and approaches for deriving national BAFs are discussed in more detail in USEPA (2003A).

FDEP reviewed EPA’s 2015 BAFs, including the supplemental information provided by EPA in January 2016 (USEPA, 2016), and the peer-reviewed and publicly available databases that EPA used to develop laboratory and field baseline BAFs (Arnot and Gobas, 2006; Environment Canada, 2006). The department concluded that EPA did a thorough job of reviewing the available data, and that there were no additional laboratory or field test data that were more locally relevant to Florida. Therefore, the department determined that EPA's 2015 BAFs and BCFs (USEPA, 2016), with the exception of PAHs, provided the best currently available basis for deriving realistic bioaccummulation estimates for fish and shellfish. For the PAHs, the department determined that EPA did not properly account for the documented high metabolic transformation rates for PAHs when the agency developed its BAFs and BCFs.

EPA used Procedure 2 or 4, from the BAF Decision Framework **(Figure 3-6)**, (USEPA, 2003A) to calculate BAFs for the 12 PAHs (Acenaphthene, Anthracene, Benzo (a) Anthracene, Benzo (a) Pyrene, Benzo (b) Fluoranthene, Benzo (k) Fluoranthene, Chrysene, Dibenzo (a,h) Anthracene, Fluoranthene, Fluorene, Indeno (1,2,3-cd) Pyrene, and Pyrene); that is, the BAFs were calculated using laboratory BCF data. Procedures 2 and 4 are used for nonionic organic chemicals with high metabolic transformation within fish and shellfish. EPA calculated the BAFs for these 12 PAHs by multiplying the laboratory BCFs by food chain multipliers (FCMs). The FCMs are intended to relate the BCF for a trophic level to the BAF for that same trophic level. FCMs are calculated as the ratio of a baseline BAF for an organism of a particular trophic level to the baseline BCF (*i.e.*, BAF_{TLn}/BCF_{TLn}). FDEP does not believe that the use of FCMs for chemicals that are highly metabolized is either scientifically justifiable or consistent with EPA guidance (USEPA 2003A). The FCMs do not account for metabolism in the food web when it is present, and use of the FCMs in these cases will overestimate bioaccumulation.

The FCMs were derived using the Gobas food web model (Gobas, 1993). Because the FCMs were intended to apply to chemicals for which the rates of metabolism are low, EPA set the metabolism rates equal to zero in the model; that is, the model predicted FCMs are not representative of the sub-set of chemicals that are known to highly metabolize in fish and shellfish. USEPA (2003A) states that FCMs are used in Procedure 1 to estimate the dietary transfer of a chemical up the food web for chemicals where metabolism is believed or assumed to be negligible. The document does not state that FCMs are used for Procedures 2 and 4, and in fact, the Decision Framework (**Figure 3-6**) clearly indicates that when BCFs are used they should not be multiplied by a FCM.

Given this information, FDEP determinated that scientifically defensible BAFs could not be calculated for the 12 PAHs at this time; however, BCFs were available. Therefore, the department recalculated the BCFs for these 12 chemicals based on the laboratory BCF results provided in USEPA (2016), but did not apply FCMs. FDEP is proposing to use BCFs for the 12 PAHs.

EPA recognizes that there are large differences among waterbodies across the nation and strongly encouraged States and Tribes to make site-specific or state-specific modifications to EPA's national BAFs (USEPA, 2003A). FDEP determined that the final national BAF/BCFs were not fully representative of Florida conditions, and should be adjusted to account for Florida specific-conditions. The following sections describe the information and data the department relied upon to derive Florida-specific BAFs and BCFs.

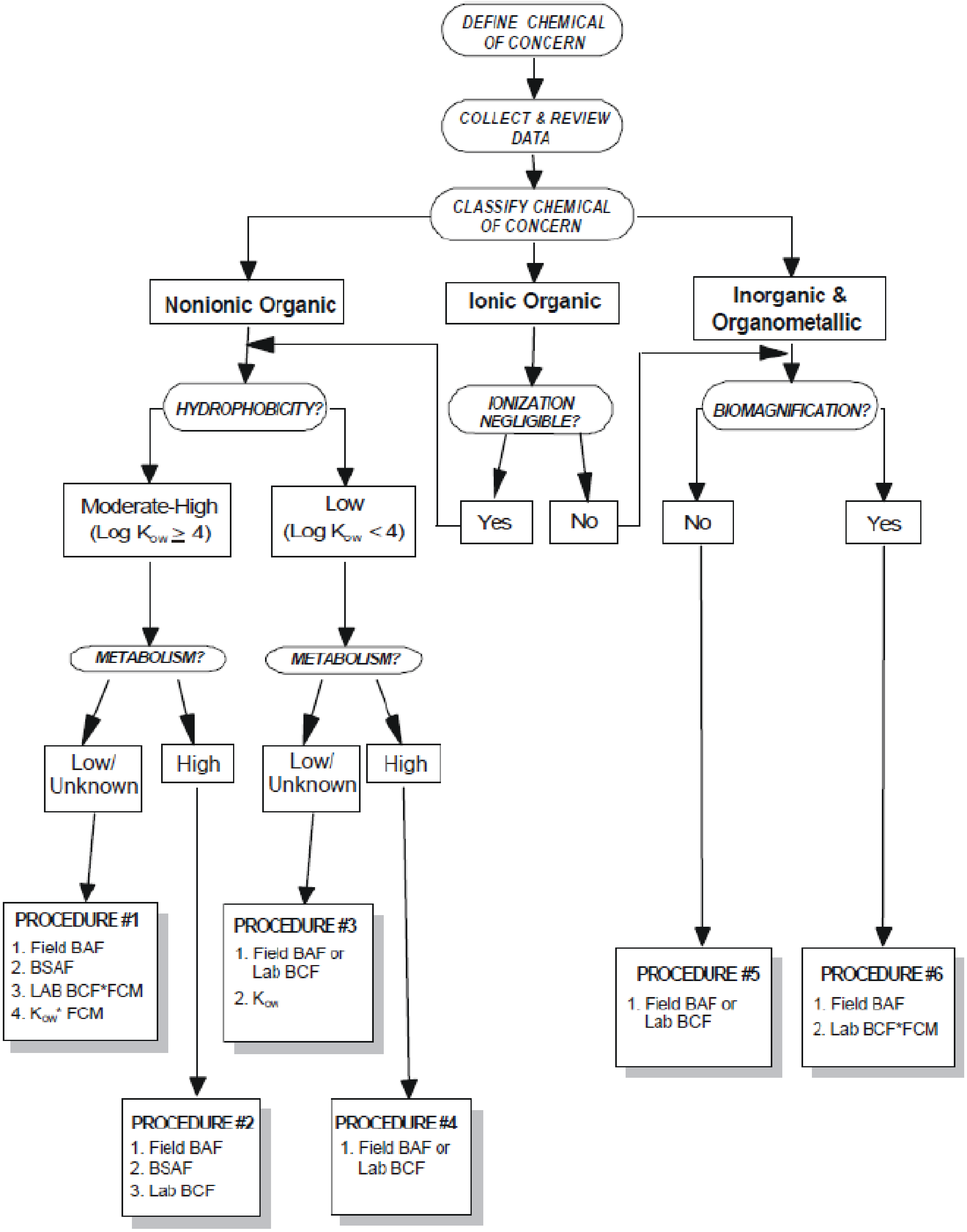


Figure 3-6. Framework for Selecting Methods for Deriving National BAFs (Source: USEPA 2003A, Figure 3-1, p. 3-2).

EPA recognized that there were large differences among waterbodies across the nation and strongly encouraged States and Tribes to make site-specific modifications to EPA's national BAFs (USEPA, 2003). The guidance recognizes that BAFs vary not only between chemicals and trophic levels, but also among different ecosystems and waterbodies/sites. A national average BAF value for a given chemical and trophic level may not provide the most accurate estimate of bioaccumulation for all waterbodies in the United States. At a given location, the BAF for a chemical may be higher or lower than the national BAF, depending on the nature and extent of site-specific influences.

It was not feasible or realistic for FDEP to develop waterbody, waterbody type, or regional specific BAF/BCFs; however, it was determined that the typical conditions within Florida waterbodies and the types of fish commonly consumed by Floridians differed sufficiently enough from the national average to warrant recalculation of the BAFs from the baseline values provided in USEPA (2016). Specifically, FDEP calculated Florida BAF/BCFs using Florida-specific dissolved organic content (DOC), particulate organic content (POC), and Florida fish and shellfish trophic level-specific lipid content.

EPA encourages States and authorized Tribes to use local or regional data on the organic carbon content of applicable waters when adopting criteria into their water quality standards (USEPA, 2003A). The agency encourages the use of appropriate locally or regionally derived values of DOC or POC over nationally derived values because local or regional conditions that affect DOC and POC concentrations can differ substantially from those represented by nationally derived values. Additionally, EPA encouraged States and authorized Tribes to use local or regional data on the lipid content and consumption rates of consumed aquatic species when adopting criteria into their water quality standards. The use of such locally or regionally derived data is encouraged over national-scale data because local or regional consumption patterns of fish and shellfish (and thus the amount of lipid consumed from aquatic organisms) can differ from national consumption patterns. Thus, modification of the national BAFs based on more locally relevant data and information was envisioned and even encouraged by EPA.

3.4.1 Organic Content (DOC and POC)

The DOC and POC content of surface water is used in the derivation of final BAFs to estimate the fraction of a chemical that is freely dissolved in the water column. It is assumed by EPA that this value represents the fraction that is available for uptake by aquatic organisms. Florida has one of the most extensive surface water quality databases in the nation, and FDEP utilized this database to calculate typical (median) DOC and POC concentrations for Florida waters. The median was used to be consistent with the national values, which were also based on median values.

FDEP queried DOC, POC, and total organic content (TOC) data from the IWR Run 50 database for all samples collected from Florida waters between 1980 and 2015. There were no reported POC values in the database; therefore, POC was calculated by subtraction from TOC and DOC (POC=TOC-DOC). The beginning (1980) of the period of record was selected to coincide with the beginning of the period of record used by EPA to develop the national DOC and POC values (USEPA, 2003A).

The data were screened or handled in a manner consistent with USEPA (2003A), but with some specific modifications. As done by USEPA, values coded with “J”, “K”, “Q”, “Y”, “V”, “>”, or “L” codes” were excluded from the analysis, and values reported as less than detection were replaced with one half the reported detection limit. However, FDEP evaluated the results with high detection limits (> 1.0 mg/L), while EPA excluded them due to the greater uncertainty involved in estimating definitive values of DOC and POC in these situations. The department did not exclude samples associated with high detection limits because these detection limits were used in waterbodies that typically exhibited high DOC and TOC levels above the detection limit. As such, the high detection limits did not bias the results or create greater uncertainty. In fact, exclusion of these data would have resulted in biased low DOC and POC for Florida.

FDEP also conducted one additional screening step not previously included by EPA. Because the POC values were calculated by subtraction from TOC and DOC, FDEP checked to see if DOC values were greater than TOC for a given sample. DOC is a component of TOC and thus in theory cannot exceed the total (TOC). The department calculated the fraction of TOC that was DOC (fraction = DOC/TOC) and excluded all pairs where the fraction of DOC was equal to or greater than 120 percent. Fractions between 100 and 119 percent were considered to be within the analytical noise and uncertainty.

There were 23,533 DOC measurements and 16,134 POC values available for analysis after screening the data as described above. FDEP calculated station daily averages and used these to calculate median values based on waterbody types (coastal, estuarine, stream, and lake) statewide using all the data and using medians for the state’s primary waterbody assessment units (**W**ater**b**ody **Id**entification Units or WBIDs) (**Table 3-4**). Data were available for WBIDs identified as springs, but these were not included in the analysis because springs only represent a small fraction of the surface water area in the state; it is unlikely that Floridians are catching and eating fish within springs; and, the source of water to springs is groundwater, and thus is not reflective of potential surface water contamination scenarios.

WBID medians in **Table 3-4** are medians of the WBID medians for all WBIDs within the given waterbody type. DOC and POC concentrations by waterbody types are provided for informational purposes and because EPA (2003A) also provided a summary of national organic carbon concentrations by waterbody type. Although EPA provided waterbody type specific values, the agency used national median DOC and POC (across all waterbody types) to calculate the national BAFs. Consistent with EPA’s calculations, FDEP used the median of all of the WBID medians (see All in **Table 3-4**) as the statewide values for DOC (12 mg/L) and POC (0.6 mg/L) in the calculation of the Florida BAF/BCFs. The value across all waterbody types was selected because it was most representative of the full range of waters from which Floridians catch and ultimately, consume, fish and shellfish. The WBID median value was used, rather than the data median, to minimize biasing the results towards waterbodies with larger numbers of samples. The Florida median DOC and POC values were converted to kg/L for purposes of BAF calculations, and were $1.2 \cdot 10^{-5}$ and $6.0 \cdot 10^{-7}$ kg/L, respectively.

Table 3-4. Summary of median Florida DOC and POC content in coastal, estuarine, streams, and lake waters. Coastal data were limited to WBIDs within 3 miles of the Florida shoreline.

Waterbody Type	DOC (mg/L) WBID Median	DOC (mg/L) Data Median	POC (mg/L) WBID Median	POC (mg/L) Data Median
Coastal	2.15	3.1	0.5225	0.3
Estuary	8.675	9.69	0.5	0.5
Stream	15.5	20	0.61	0.78
Lake	7.7	15.5	1.0	1
All	12	17.7	0.6	0.78

3.4.2 Lipid Content

National trophic-level specific BAFs are intended to represent the long-term, average bioaccumulation potential of a pollutant in aquatic organisms of a particular trophic level that are commonly consumed by humans throughout the U.S. For certain chemicals (*e.g.*, nonionic organics), chemical bioavailability, biota lipid content, and trophic transfer can affect bioaccumulation potential and ultimately the magnitude of BAFs. EPAs trophic level 2, 3, and 4 national recommended BAFs were standardized to lipid contents of 1.9, 2.6, and 3.0 percent, respectively. However, previous work in Florida (CEHT, 2008) demonstrated that the lipid content of Florida species commonly consumed by Floridians differed from the national values; and, therefore, the expected bioaccumulative potential for Florida species will differ from the national assumption. This earlier report documented that regional data for both consumption patterns and fish lipid content are readily available for Florida. FDEP used these regional and Florida specific data to calculate consumption weighted average lipid contents for the three trophic levels. The data sources included the Degner survey for Florida-specific fish consumption, which remains the best available estimate of consumption patterns of Florida species, and the Nutrient Database for Southeastern Seafoods (Sullivan and Otwell, 1992) for lipid contents.

Although it may be argued that the Degner survey is out of date because of the introduction of new species (*e.g.*, tilapia, pangasius) into the marketplace or increased consumption of aquaculture fish, it still represents the best estimates of the proportions of different fish species consumed from local Florida waters. Individuals or groups who choose to eat fish caught entirely from local waters can only choose to eat fish that inhabit Florida waters. The lipid content of non-native species, such as salmon, trout, pike, or perch, have no influence on exposures for individuals or groups who choose to eat fish caught from local waters. Additionally, the Degner survey can readily be used to calculate species weighting factors, unlike other potential data sources.

FDEP calculated consumption trophic level-specific lipid content by multiplying the species percent lipid tissue by the trophic level weighting factors and the total species consumption from the Degner survey, and then dividing the value by the total weighted trophic level consumption (**Table 3-4**). Calculating lipid content in this manner provides a consumption weighted average for each trophic level. Species-specific lipid contents were obtained from the Nutrient Database for Southeastern Seafoods (Sullivan and Otwell, 1992) and reported in the Baseline Risk Analysis (CEHT, 2008). Species trophic level weights were assigned following assignments in EPA (2014) Table 3, or by referencing FishBase.org for species not listed in EPA (2014). A trophic level weight of 1 indicates that the species occupies a single trophic level. Trophic level weights of 0.5 were assigned to species that occupy two trophic levels. The department calculated consumption-weighted averages for each trophic level. The Florida specific trophic level 2, 3, and 4 lipid contents are 1.8, 1.5, and 2.0 percent, respectively.

Table 3-5. Percent lipid content for Florida freshwater and inshore marine species by trophic level. Species-specific lipid contents were obtained from the Nutrient Database for Southeastern Seafoods (Sullivan and Otwell, 1992). Lipid contents that were not found in this document were available in the Nutrition Analysis Tool Version 2, an on-line nutrition analysis database maintained by the University of Illinois, Urbana Champaign, Department of Food Science and Human Nutrition. Lipid contents were assembled and reported in the 2008 Baseline Risk Analysis (CEHT, 2008). Average values were applied to "Other" or "Unknown" species.

Species	TL2 (Weighting Factor)	TL3 (Weighting Factor)	TL4 (Weighting Factor)	Total Consumption (kg)	TL2 Consumption (kg)	TL3 Consumption (kg)	TL4 Consumption (kg)	Lipid Content (percent)	TL2 Consumption Weighted Lipid	TL3 Consumption Weighted Lipid	TL4 Consumption Weighted Lipid
Amberjack			1	1305.56	0	0	1305.56	1.8	0	0	2350.008
Blue crab		1		7288.386	0	7288.386	0	1.4	0	10203.74	0
Bluefish			1	505.27	0	0	505.27	2.8	0	0	1414.756
Clams	1			19949.84	19949.84	0	0	1.1	21944.82	0	0
Crab		1		17100.04	0	17100.04	0	1.2	0	20520.05	0
Dolphin			1	22616.99	0	0	22616.99	0.8	0	0	18093.59
Flounder		0.5	0.5	54557.33	0	27278.665	27278.665	0.8	0	21822.93	21822.93
Freshwater catfish		0.5	0.5	37602.18	0	18801.09	18801.09	3.2	0	60163.49	60163.49
Freshwater crayfish		1		557.96	0	557.96	0	0.4	0	223.184	0
Grouper			1	52440.07	0	0	52440.07	2.6	0	0	136344.2
King mackerel			1	1906.25	0	0	1906.25	1.7	0	0	3240.625
Largemouth bass			1	7664.9	0	0	7664.9	1.3	0	0	9964.37
Lobster tails		1		8084.77	0	8084.77	0	1	0	8084.77	0
Mackerel			1	6988.443	0	0	6988.443	10.5	0	0	73378.65
Marine catfish		0.5	0.5	454.74	0	227.37	227.37	1.2	0	272.844	272.844
Mullet	1			28033.35	28033.35	0	0	3.7	103723.4	0	0
Mullet roe	1			4392.834	4392.834	0	0	1.81	7951.03	0	0
Other fresh frozen shellfish	0.5	0.5		4710.28	2355.14	2355.14	0	1.3	3061.682	3061.682	0
Other freshwater finfish		0.5	0.5	1011.54	0	505.77	505.77	1.7	0	859.809	859.809
Other marine finfish		0.5	0.5	8379.95	0	4189.975	4189.975	3.4	0	14245.92	14245.92

Species	TL2 (Weighting Factor)	TL3 (Weighting Factor)	TL4 (Weighting Factor)	Total Consumption (kg)	TL2 Consumption (kg)	TL3 Consumption (kg)	TL4 Consumption (kg)	Lipid Content (percent)	TL2 Consumption Weighted Lipid	TL3 Consumption Weighted Lipid	TL4 Consumption Weighted Lipid
Oysters	1			16600.23	16600.23	0	0	2.1	34860.48	0	0
Panfish		1		11998.47	0	11998.47	0	1.1	0	13198.32	0
Panfish roe		1		252.6333	0	252.6333	0	1.8	0	454.7399	0
Pompano			1	772.4135	0	0	772.4135	5.4	0	0	4171.033
Processed shellfish	0.5	0.5		909.48	454.74	454.74	0	1.3	591.162	591.162	0
Red drum			1	4510.87	0	0	4510.87	0.8	0	0	3608.696
Salad shrimp	0.5	0.5		2918.128	1459.064	1459.064	0	1.2	1750.877	1750.877	0
Scallops	1			9595	9595	0	0	0.9	8635.5	0	0
Sea Bass			1	480.67	0	0	480.67	1.5	0	0	721.005
Seatrout			1	12909.08	0	0	12909.08	2.5	0	0	32272.7
Shark			1	8389.444	0	0	8389.444	0.7	0	0	5872.611
Sheepshead	0.5	0.5		909.48	454.74	454.74	0	2.4	1091.376	1091.376	0
Shrimp	0.5	0.5		89298.29	44649.145	44649.145	0	1.5	66973.72	66973.72	0
Snapper			1	53062.71	0	0	53062.71	1.1	0	0	58368.98
Snook			1	893.94	0	0	893.94	0.95	0	0	849.243
Stone crab claws	0.5	0.5		21987.8	10993.9	10993.9	0	0.4	4397.56	4397.56	0
Sunshine bass			1	505.2667	0	0	505.2667	1.3	0	0	656.8467
Unknown finfish		0.5	0.5	5327.73	0	2663.865	2663.865	3.3	0	8790.755	8790.755
Unknown shellfish	0.5	0.5		197.79	98.895	98.895	0	1.3	128.5635	128.5635	0
Whitefish		1		2303.77	0	2303.77	0	1.5	0	3455.655	0
Sum					139036.878	161718.3883	228618.6122		255110.2	240291.1	457463
Lipid Range (%)								0.4-10.5	0.4-3.7	0.4-3.4	0.7-10.5
Weighted Average Lipid (%)									**1.8**	**1.5**	**2.0**

3.4.3 Florida BAFs and BCFs

FDEP used the final baseline BAFs reported in USEPA (2016) together with the Florida DOC, POC, and trophic level lipid content to calculate Florida BAF values following the procedures described in USEPA (2003A and 2016). Florida BAFs were calculated using the following equation:

$$\text{Florida BAF}_{(\text{TL n})} = [(\text{Baseline BAF})_{\text{TL n}} \cdot (f\,\ell)_{\text{TL n}} + 1] \cdot (f_{fd})$$

where:

Florida BAF = Florida BAF (L/kg-tissue)
$(\text{Baseline BAF})_{\text{TL n}}$ = mean baseline BAF for TL “n” (L/kg-lipid)
$f\ell_{(\text{TL n})}$ = fraction of tissue that is lipid in aquatic organisms at TL “n”
f_{fd} = fraction of the total concentration of chemical in water that is freely dissolved

Trophic level lipid content for Florida aquatic organisms is reported in **Table 3-5**. The fraction of the total concentration of chemical in water that is freely dissolved (f_{fd}) was calculated using the DOC and POC WBID median concentrations for all waterbody types reported in **Table 3-5** converted to kg/L, using the following equation:

$$f_{fd} = \frac{1}{1 + \text{POC} \cdot K_{OW} + \text{DOC} \cdot 0.08 \cdot K_{OW}}$$

where:

POC = concentration of particulate organic carbon (POC) in water (kilograms of particulate organic carbon per liter of water) (kg/L)
DOC = concentration of dissolved organic carbon (DOC) in water (kilograms of dissolved organic carbon per liter of water) (kg/L)
K_{ow} = n-octanol-water partition coefficient

Table 3-6 lists the Florida BAFs and BCFs, along with the baseline BAF or BCF, and the method for calculating the baseline BAF or BCF. There were insufficient data for bis(2-Ethylhexyl) phthalate, butylbenzyl phthalate, diethyl phthalate, dimethyl phthalate, and di-n-butyl phthalate to calculate BAFs across all three trophic levels. FDEP followed the approach in USEPA (2016), and calculated alternative BAFs for these five phthalates. The alternative BAFs were calculated as the geometric mean across the trophic levels for which there were sufficient data, and were applied as single value similar to BCFs. BCFs for indeno (1,2,3-cd) pyrene, benzo (b) fluoranthene, benzo (k) fluoranthene, chrysene, dibenzo (a,h) anthracene, and benzo (a) anthracene were based the laboratory-measured BCF for benzo(a)pyrene. This approach is consistent with conclusions of Neff (2002) that benzo(a)pyrene is a good indicator of the presence of pyrogenic PAHs in the environment and that these types of PAHs are expected to concentrate in organisms such as fish and shellfish as does benzo(a)pyrene.

It should be noted that FDEP calculated potential updated criteria for four parameters that EPA did not address in their 2015 recommendations [polychlorinated biphenyls (PCBs) and three metals (antimony, beryllium, and selenium)]. FDEP is proposing to update these four parameters to bring Florida's criteria in line with the most recent assumptions (*e.g.*, fish consumption, toxicity factors), and the BCFs listed in **Table 3-6** for these four chemicals are based on the most recent EPA values as indicated in the table.

Table 3-6. Florida BAFs and BCFs for parameters considered by FDEP for human health-based criteria revision. The fraction freely dissolved (f_{fd}), baseline BAFs and BCFs, and the BAF or BCF derivation method are also listed. Chemicals denoted an asterick (*) use a BCF rather than a BAF, and are listed at the end of the table. Values of "ND" and "N/A" mean that there were no data or the approach is not applicable, respectively. Alternative BAFs were calculated as geometric means across the trophic levels for which there were sufficient data.

CAS Number	Chemical Name	f_{fd}	Baseline BAF/BCF TL 2 (L/kg-lipid)	Baseline BAF/BCF TL 3 (L/kg-lipid)	Baseline BAF/BCF TL 4 (L/kg-lipid)	Derivation Method	FL BAF/BCF TL 2 (L/kg)	FL BAF/BCF TL 3 (L/kg)	FL BAF/BCF TL 4 (L/kg)	FL Alternative BAF/BCF (L/kg)
71-55-6	1,1,1-Trichloroethane	0.99952	309	309	309	Log Kow*FCM	6.6	5.6	7.2	ND
79-34-5	1,1,2,2-Tetrachloroethane	0.99962	245	245	245	Log Kow*FCM	5.4	4.7	5.9	ND
79-00-5	1,1,2-Trichloroethane	0.99959	263	263	263	Log Kow*FCM	5.7	4.9	6.3	ND
75-35-4	1,1-Dichloroethylene	0.99992	53	53	53	Log Kow*FCM	2.0	1.8	2.1	ND
120-82-1	1,2,4-Trichlorobenzene	0.98393	148,242	58,880	14,416	Field BAFs	2600	870	280	ND
95-50-1	1,2-Dichlorobenzene	0.99582	2,692	2,692	2,692	Log Kow*FCM	49	41	55	ND
107-06-2	1,2-Dichloroethane	0.99995	30	30	30	Log Kow*FCM	1.5	1.5	1.6	ND
78-87-5	1,2-Dichloropropane	0.99985	98	98	98	Log Kow*FCM	2.8	2.5	3.0	ND
122-66-7	1,2-Diphenylhydrazine	0.99864	871	871	871	Log Kow*FCM	17	14	18	ND
156-60-5	1,2-Trans-Dichloroethylene	0.99981	123	123	123	Log Kow*FCM	3.2	2.8	3.5	ND
541-73-1	1,3-Dichlorobenzene	0.99474	1,601	4,736	6,422	BCF*FCM	30	72	130	ND
542-75-6	1,3-Dichloropropene	0.99990	66	66	66	Log Kow*FCM	2.2	2.0	2.3	ND
106-46-7	1,4-Dichlorobenzene	0.99572	1,402	2,491	2,771	BCF*FCM	26	38	56	ND
88-06-2	2,4,6-Trichlorophenol	0.99242	4,898	4,898	4,898	Log Kow*FCM	88	74	98	ND
120-83-2	2,4-Dichlorophenol	0.99753	1,585	1,585	1,585	Log Kow*FCM	29	25	33	ND
105-67-9	2,4-Dimethylphenol	0.99969	200	200	200	Log Kow*FCM	4.6	4.0	5.0	ND
51-28-5	2,4-Dinitrophenol	0.99995	338	63	ND	Alternative BAF (BCF*FCM)	ND	ND	ND	3.7

CAS Number	Chemical Name	f_{fd}	Baseline BAF/BCF TL 2 (L/kg-lipid)	Baseline BAF/BCF TL 3 (L/kg-lipid)	Baseline BAF/BCF TL 4 (L/kg-lipid)	Derivation Method	FL BAF/BCF TL 2 (L/kg)	FL BAF/BCF TL 3 (L/kg)	FL BAF/BCF TL 4 (L/kg)	FL Alternative BAF/BCF (L/kg)
121-14-2	2,4-Dinitrotoluene	0.99985	95	95	95	Log Kow*FCM	2.7	2.4	2.9	ND
91-58-7	2-Chloronaphthalene	0.98776	7,943	7,943	7,943	Log Kow*FCM	140	120	160	ND
95-57-8	2-Chlorophenol	0.99977	148	148	148	Log Kow*FCM	3.7	3.2	4.0	ND
534-52-1	2-Methyl-4,6-Dinitrophenol	0.99952	305	305	305	Log Kow*FCM	6.5	5.6	7.1	ND
91-94-1	3,3'-Dichlorobenzidine	0.99648	2,265	2,265	2,265	Log Kow*FCM	42	35	46	ND
59-50-7	3-Methyl-4-Chlorophenol	0.99804	1,259	1,259	1,259	Log Kow*FCM	24	20	26	ND
50-29-3	4,4'-DDT	0.07310	12,983,835	64,106,489	266,025,613	Field BAFs	17000	70000	390000	ND
107-02-8	Acrolein	1.00000	1.0	1.0	1.0	Log Kow*FCM	1.0	1.0	1.0	ND
107-13-1	Acrylonitrile	1.00000	0.1	0.1	0.1	Log Kow*FCM	1.0	1.0	1.0	ND
309-00-2	Aldrin	0.16854	3,162,278	39,844,699	72,099,931	Log Kow*FCM	9600	100000	240000	ND
959-98-8	alpha-Endosulfan	0.98956	6,761	6,761	6,761	Log Kow*FCM	120	100	130	ND
71-43-2	Benzene	0.99979	135	135	135	Log Kow*FCM	3.4	3.0	3.7	ND
92-87-5	Benzidine	0.99997	22	22	22	Log Kow*FCM	1.4	1.3	1.4	ND
319-85-7	beta-BHC	0.99069	6,026	6,026	6,026	Log Kow*FCM	110	91	120	ND
33213-65-9	beta-Endosulfan	0.99354	4,169	4,169	4,169	Log Kow*FCM	76	63	84	ND
108-60-1	Bis(2-Chloro-1-Methylethyl) Ether	0.99953	302	302	302	Log Kow*FCM	6.4	5.5	7.0	ND
111-44-4	Bis(2-Chloroethyl) Ether	0.99997	22	22	22	Log Kow*FCM	1.4	1.3	1.4	ND
117-81-7	Bis(2-Ethylhexyl) Phthalate	0.01987	ND	635,542	603,776	Alternative BAF	ND	ND	ND	210
75-25-2	Bromoform	0.99961	251	251	251	Log Kow*FCM	5.5	4.8	6.0	ND
85-68-7	Butylbenzyl Phthalate	0.92270	ND	584,800	817,090	Alternative BAF	ND	ND	ND	11000
56-23-5	Carbon Tetrachloride	0.99932	437	437	437	Log Kow*FCM	8.9	7.5	9.7	ND
57-74-9	Chlordane	0.64897	346,737	2,132,432	2,494,425	Log Kow*FCM	4100	21000	32000	ND
108-90-7	Chlorobenzene	0.99892	692	692	692	Log Kow*FCM	13	11	15	ND

CAS Number	Chemical Name	f_{fd}	Baseline BAF/BCF TL 2 (L/kg-lipid)	Baseline BAF/BCF TL 3 (L/kg-lipid)	Baseline BAF/BCF TL 4 (L/kg-lipid)	Derivation Method	FL BAF/BCF TL 2 (L/kg)	FL BAF/BCF TL 3 (L/kg)	FL BAF/BCF TL 4 (L/kg)	FL Alternative BAF/BCF (L/kg)
124-48-1	Chlorodibromomethane	0.99977	145	145	145	Log Kow*FCM	3.6	3.2	3.9	ND
67-66-3	Chloroform	0.99985	93	93	93	Log Kow*FCM	2.7	2.4	2.9	ND
93-72-1	Chlorophenoxy Herbicide (2, 4, 5-TP)	0.99025	ND	2,203	ND	Alternative BAF (BCF*FCM)	ND	ND	ND	34
94-75-7	Chlorophenoxy Herbicide (2,4-D)	0.99899	861	360	ND	Alternative BAF (BCF*FCM)	ND	ND	ND	10
75-27-4	Dichlorobromomethane	0.99980	126	126	126	Log Kow*FCM	3.3	2.9	3.5	ND
60-57-1	Dieldrin	0.28798	1,584,893	17,750,804	29,320,524	Log Kow*FCM	8200	77000	170000	ND
84-66-2	Diethyl Phthalate	0.99965	ND	44,023	25,721	Alternative BAF	ND	ND	ND	580
131-11-3	Dimethyl Phthalate	0.99994	ND	142,845	142,966	Alternative BAF	ND	ND	ND	2500
84-74-2	Di-n-Butyl Phthalate	0.97532	ND	142,876	74,484	Alternative BAF	ND	ND	ND	1700
1031-07-8	Endosulfan Sulfate	0.99292	4,571	4,571	4,571	Log Kow*FCM	83	69	92	ND
72-20-8	Endrin	0.68475	295,121	1,663,597	1,858,967	Log Kow*FCM	3600	17000	25000	ND
100-41-4	Ethylbenzene	0.99160	5,433	5,433	5,433	Log Kow*FCM	98	82	110	ND
58-89-9	gamma-BHC (Lindane)	0.99188	64,469	91,186	85,165	Field BAFs	1200	1400	1700	ND
76-44-8	Heptachlor	0.33739	1,258,925	13,218,717	21,024,054	Log Kow*FCM	7600	67000	140000	ND
1024-57-3	Heptachlor Epoxide	0.71847	251,189	1,291,110	1,376,514	Log Kow*FCM	3200	14000	20000	ND
87-68-3	Hexachlorobutadiene	0.91408	1,255,208	112,028	38,762	Field BAFs	21000	1500	710	ND
77-47-4	Hexachlorocyclopentadiene	0.95088	33,113	57,418	44,504	Log Kow*FCM	570	820	850	ND
67-72-1	Hexachloroethane	0.99410	63,809	10,804	19,889	Field BAFs	1100	160	400	ND
78-59-1	Isophorone	0.99993	47	47	47	Log Kow*FCM	1.8	1.7	1.9	ND
72-43-5	Methoxychlor	0.89418	75,858	195,561	156,267	Log Kow*FCM	1200	2600	2800	ND
74-83-9	Methyl Bromide	0.99998	13	13	13	Log Kow*FCM	1.2	1.2	1.3	ND
75-09-2	Methylene Chloride	0.99997	20	20	20	Log Kow*FCM	1.4	1.3	1.4	ND
98-95-3	Nitrobenzene	0.99989	69	69	69	Log Kow*FCM	2.2	2.0	2.4	ND

CAS Number	Chemical Name	f_{fd}	Baseline BAF/BCF TL 2 (L/kg-lipid)	Baseline BAF/BCF TL 3 (L/kg-lipid)	Baseline BAF/BCF TL 4 (L/kg-lipid)	Derivation Method	FL BAF/BCF TL 2 (L/kg)	FL BAF/BCF TL 3 (L/kg)	FL BAF/BCF TL 4 (L/kg)	FL Alternative BAF/BCF (L/kg)
608-93-5	Pentachlorobenzene	0.80899	205,125	191,629	374,624	Field BAFs	3000	2300	6100	ND
87-86-5	Pentachlorophenol	0.86234	2,415	11,914	18,709	BCF*FCM	38	150	320	ND
108-95-2	Phenol	0.99996	29	29	29	Log Kow*FCM	1.5	1.4	1.6	ND
127-18-4	Tetrachloroethylene	0.99610	2,512	2,512	2,512	Log Kow*FCM	46	39	51	ND
108-88-3	Toluene	0.99918	525	525	525	Log Kow*FCM	10	8.9	11	ND
8001-35-2	Toxaphene	0.87291	93,325	269,897	223,328	Log Kow*FCM	1500	3500	3900	ND
79-01-6	Trichloroethylene	0.99936	407	407	407	Log Kow*FCM	8.3	7.1	9.1	ND
75-01-4	Vinyl Chloride	0.99996	23	23	23	Log Kow*FCM	1.4	1.3	1.5	ND
83-32-9	Acenaphthene*	0.98532	ND	19,847	ND	BCF	ND	ND	ND	290
120-12-7	Anthracene*	0.95788	24,493	19,339	ND	BCF	ND	ND	ND	340
56-55-3	Benzo (a) Anthracene*	0.61143	ND	ND	ND	BCF	ND	ND	ND	600
50-32-8	Benzo (a) Pyrene*	0.35828	862,368	11,824	ND	BCF	ND	ND	ND	600
205-99-2	Benzo (b) Fluoranthene*	0.36893	ND	ND	ND	BCF	ND	ND	ND	600
207-08-9	Benzo (k) Fluoranthene*	0.35828	ND	ND	ND	BCF	ND	ND	ND	600
218-01-9	Chrysene*	0.81600	ND	ND	ND	BCF	ND	ND	ND	600
53-70-3	Dibenzo (a,h) Anthracene*	0.08480	ND	ND	ND	BCF	ND	ND	ND	600
206-44-0	Fluoranthene*	0.88975	80,714	ND	ND	BCF	ND	ND	ND	1300
86-73-7	Fluorene*	0.97693	11,950	13,115	21,199	BCF	210	190	420	260
193-39-5	Indeno (1,2,3-cd) Pyrene8	0.14428	ND	ND	ND	BCF	ND	ND	ND	600
129-00-0	Pyrene*	0.89418	65,613	9,591	ND	BCF	ND	ND	ND	370
7440-41-7	Beryllium*	N/A	ND	ND	ND	1980 BCF	ND	ND	ND	18.9
7440-36-0	Antimony*	N/A	ND	ND	ND	2002 BCF	ND	ND	ND	1
57-12-5	Cyanide*	N/A	ND	ND	ND	2002 BCF	ND	ND	ND	1
	Polychlorinated Biphenyls (PCBs)*	N/A	ND	ND	ND	2002 BCF	ND	ND	ND	31200

CAS Number	Chemical Name	f_{fd}	Baseline BAF/BCF TL 2 (L/kg-lipid)	Baseline BAF/BCF TL 3 (L/kg-lipid)	Baseline BAF/BCF TL 4 (L/kg-lipid)	Derivation Method	FL BAF/BCF TL 2 (L/kg)	FL BAF/BCF TL 3 (L/kg)	FL BAF/BCF TL 4 (L/kg)	FL Alternative BAF/BCF (L/kg)
7782-49-2	Selenium*	N/A	ND	ND	ND	2002 BCF	ND	ND	ND	4.8

Human health-based criteria currently listed in Rule 62-302, F.A.C., were adopted and last updated in 1992, and used BCFs rather than BAFs. The Florida BAFs and alternative BCFs used to develop the proposed criteria presented herein represent a major improvement in the underlying science used to derive the criteria. **Table 3-7** lists the BCF used in 1992 to establish the existing criteria, and is provided for informational purposes to help the public and reviewers interpret the proposed criteria, particularly in comparison to the existing criteria. For example, the accumulation/concentration factor for 2-chlorophenol has been reduced significantly from a BCF of 134 L/kg to BAFs of 3.7, 3.2, and 4 kg/L for trophic levels 2, 3, and 4, respectively. The criterion for 2-chlorophenol would be expected to increase by a factor of approximately 37 based on the newer scientific information regarding the bioaccumulation of the parameter.

Table 3-7. Comparisons between the trophic level-specific Florida BAFs or Alternative BAFs used to develop the proposed revised HHC and BCF values used to develop HHC for chemicals currently listed in Rule 62-302.530, F.A.C., which were adopted in 1992.

Chemical Name	CAS Number	BCF (Existing Criteria) (L/kg)	FL BAF TL 2 (L/kg)	FL BAF TL 3 (L/kg)	FL BAF TL 4 (L/kg)	FL Alternative BCF (L/kg
1,1,2,2-Tetrachloroethane	79345	5.0	5.4	4.7	5.9	ND
1,1-Dichloroethylene	75354	5.6	2	1.8	2.1	ND
2,4,6-Trichlorophenol	88062	150	88	74	98	ND
2,4-Dichlorophenol	120832	40.7	29	25	33	ND
2,4-Dinitrophenol	51285	1.5	ND	ND	ND	3.7
2,4-Dinitrotoluene	121142	3.8	2.7	2.4	2.9	ND
2-Chlorophenol	95578	134	3.7	3.2	4.0	ND
Acenaphthene	83329	242	ND	ND	ND	290
Aldrin	309002	4670	9600	100000	240000	ND
Anthracene	120127	30	ND	ND	ND	340
Antimony	7440360	1	ND	ND	ND	1
Benzene	71432	5.2	3.4	3	3.7	ND
Benzo(a)pyrene[1]	50328	30	ND	ND	ND	600
Beryllium	7440417	19	N D	ND	ND	18.9
beta-Hexachlorocyclohexane (HCH)	319857	130	110	91	120	ND
Bromoform	75252	3.75	5.5	4.8	6.0	ND
Carbon Tetrachloride	56235	18.75	8.9	7.5	9.7	ND
Chlordane	57749	14100	4100	21000	32000	ND
Chlorodibromomethane	124481	3.75	3.6	3.2	3.9	ND
Chloroform	67663	3.75	2.7	2.4	2.9	ND
Dichlorobromomethane	75274	3.75	3.3	2.9	3.5	ND
Dieldrin	60571	4670	8200	77000	170000	ND
Fluoranthene	206440	1150	ND	ND	ND	1300
Fluorene	86737	30	210	190	420	ND
Heptachlor	76448	11200	7600	67000	140000	ND

Chemical Name	CAS Number	BCF (Existing Criteria) (L/kg)	FL BAF TL 2 (L/kg)	FL BAF TL 3 (L/kg)	FL BAF TL 4 (L/kg)	FL Alternative BCF (L/kg
Hexachlorobutadiene	87683	2.78	21000	1500	710	ND
Methylene Chloride	75092	0.9	1.4	1.3	1.4	ND
p,p'- Dichlorodiphenyltrichloroethane (DDT)	50293	53600	17000	70000	390000	ND
Pentachlorophenol	87865	11	38	150	320	ND
Polychlorinated Biphenyls (PCBs)		31200	ND	ND	ND	31200
Pyrene	129000	30	ND	ND	ND	370
Tetrachloroethylene (Perchloroethylene)	127184	30.6	46	39	51	ND
Trichloroethylene (TCE)	79016	10.6	8.3	7.1	9.1	ND

1. Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and Indeno(1,2,3-cd)pyrene were formerly included in total PAHs in Rule 62-302.530. The same BCF of 30 kg/L was applied to the derivation of all parameters included in total PAHs. The same alternative BCF, derived based on benzo(a)pyrene, is applied to the seven carcinogenic PAHs in the current proposal.

3.5 *Toxicity Data*

Toxicity data used in the calculation of the HHC included reference doses (RfD), minimal risk levels (MRLs), relative source contribution (RSC) factors, and cancer potency (slope) factors (CSF). These variables are parameter-specific and were entered into the analysis as point values based on the most recent June 2015 U.S. EPA recommendations. Although EPA’s primary source of toxicity values for developing their June 2015 recommended HHC was IRIS, EPA also systematically searched for toxicological assessments from seven additional peer-reviewed sources (EPA Office of Pesticide Programs, EPA Office of Pollution Prevention and Toxics, EPA Office of Water, EPA Office of Solid Waste and Emergency Response, U.S. Department of Health and Human Services- Agency for Toxic Substances and Disease Registry, Health Canada, and California Environmental Protection Agency- Office of Environmental Health Hazard Assessment).

To ensure the appropriateness of using the toxicity values derived from alternative sources, FDEP sought assistance from the Florida Department of Health to review the toxicity values derived from sources alternative to IRIS. After review, it was concluded the alternatively sourced toxicity values were appropriate and consistent with an EPA memo outlining the hierarchy of human health toxicity values (USEPA, 2003B). The EPA used a systematic approach for choosing which toxicity value was used in deriving its June 2015 human health criteria recommendations, which is detailed in each parameter-specific human health criteria derivation document, currently available at https://www.epa.gov/wqc/national-recommended-water-quality-criteria-human-health-criteria-table. This effort was undertaken to ensure that the most up-to-date, scientifically rigorous toxicity values were used to derive the EPA’s 2015 human health criteria recommendations.

3.5.1 Reference Dose and Uncertainty Factors

The reference dose is defined as "an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to humans (including sensitive subgroups) that is likely to be without an appreciable risk of adverse effects during a lifetime." An RfD for a given chemical is usually derived by first identifying the no effect level or Point of Departure [No Observed Adverse Effect Level (NOAEL), Lowest Observed Adverse Effect Level (LOAEL), or Benchmark Dose (BMD)] for the most sensitive known toxicity endpoint; that is, the toxic effect that occurs at the lowest dose or at pre-specified effect level (*e.g.*, 5th percentile). The Point of Departure (POD) is then divided by one or more uncertainty factors (UF) and potentially an additional modification factor (MF). Uncertainty factors are assigned individually on a log and half log scale (*i.e.*, 1, 3, or 10). EPA calculates a total uncertainty factor by multiplying the individual factors together (*i.e.*, UF_H x UF_A x UF_S x UF_D x UF_L x MF). The uncertainty factors, which are described in **Table 3-8**, are applied to account for scientific uncertainty in the toxicity data and to ensure that the final RfD is set at a level protective of the full population and sensitive subgroups such as children. Combined uncertainty factors for a given parameter typically range from 300 to 3,000, meaning that the applicable RfD is set at a level two to three orders of magnitude below the observed lowest effect (or no effect) level. Thus, there is considerable conservatism built into the criteria, which ensures that the population will not be exposed to contaminant levels that are likely to cause adverse health effects.

Table 3-8. Description of EPA uncertainty factors and modification factor for non-carcinogens (USEPA, 2000). With each UF or MF assignment, it is recognized that professional scientific judgment must be used. EPA states that the total product of the uncertainty factors and modifying factor should not exceed 3,000.

Factor	Description
UF_H	Use a 1, 3, or 10-fold factor when extrapolating from valid data in studies using long-term exposure to average healthy humans. This factor is intended to account for the variation in sensitivity (intraspecies variation) among the members of the human population.
UF_A	Use an additional factor of 1, 3, or 10 when extrapolating from valid results of long-term studies on experimental animals when results of studies of human exposure are not available or are inadequate. This factor is intended to account for the uncertainty involved in extrapolating from animal data to humans (interspecies variation).
UF_S	Use an additional factor of 1, 3, or 10 when extrapolating from less-than chronic results on experimental animals when there are no useful long-term human data. This factor is intended to account for the uncertainty involved in extrapolating from less-than-chronic NOAELs to chronic NOAELs.
UF_L	Use an additional factor of 1, 3, or 10 when deriving an RfD from a LOAEL, instead of a NOAEL. This factor is intended to account for the uncertainty involved in extrapolating from LOAELs to NOAELs.
UF_D	Use an additional 3- or 10-fold factor when deriving an RfD from an "incomplete" database. This factor is meant to account for the inability of any single type of study to consider all toxic endpoints. The intermediate factor of 3

Factor	Description
	(approximately ½ log10 unit, *i.e.*, the square root of 10) is often used when there is a single data gap exclusive of chronic data.
Modifying Factor	Use professional judgment to determine the MF, which is an additional uncertainty factor that is greater than zero and less than or equal to 10. The magnitude of the MF depends upon the professional assessment of scientific uncertainties of the study and database not explicitly treated above (*e.g.*, the number of species tested). The default value for the MF is 1.

3.5.2 *Minimal Risk Levels (MRLs)*

For three parameters (1,2-dichlorobenzene, 1,3-dichlorobenzene, and 1,4-dichlorobenzene), EPA chose minimal risk levels (MRLs) to represent the toxicity values used to derive the 2015 recommended human health criteria. A MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects over a specified duration of exposure. These substance-specific estimates, which are intended to serve as screening levels, are used by ATSDR health assessors and other responders to identify contaminants and potential health effects that may be a concern at hazardous waste sites.

3.5.3 *Relative Source Contribution*

The U.S. EPA methodology for assessing exposure to non-carcinogens incorporates the concept of relative source contribution (RSC). The RSC accounts for exposures from sources other than water and freshwater/estuarine fish and shellfish ingestion (*i.e.*, non-ambient sources). The RSC is typically expressed as a percentage of the reference dose remaining after considering all other exposure routes, including recreational contact, dietary intake other than fresh and estuarine fish, dermal exposure, and inhalation. When reliable data are available, the U.S. EPA determines and establishes parameter-specific RSC values for non-carcinogens using an analysis of overall exposure based on available data and the contributions from each known source. The U.S. EPA uses default assumptions following a decision tree when data are not sufficient (USEPA, 2000). The USEPA's *Exposure Decision Tree for Defining Proposed RfD Apportionment* (Fig. 4-1, USEPA, 2000) was used as the basis for the development of protective RSCs for non-carcinogenic compounds by EPA and the department.

The RSC can be derived through two primary methodologies: the subtraction and the percentage approaches. It is EPA's policy that the subtraction method cannot be used in cases where a pollutant is regulated for environmental releases under multiple programs (*e.g.*, drinking water, air); that is, the percentage method should be used. The percentage approach is usually considered to be the more conservative approach. The computational distinction between the two methodologies are often misunderstood. The misunderstanding is partially due to the fact that both approaches result in an RSC that is expressed as a percentage.

To derive an RSC using the subtraction approach, pollutant exposure sources other than drinking water and fish exposures are subtracted from the reference dose (RfD) to determine the RfD remainder that can be safely apportioned to the water and fish exposures. The RSC percentage is then calculated by dividing the RfD remainder by the RfD. To derive an RSC using the percentage approach, the sum of the exposure from drinking water and the fish/shellfish from the ambient waterbody of concern is divided by the total of all known exposures.

An example will help illustrate the difference between the two methodologies. The RfD for a hypothetical pollutant X is 0.2 mg/kg/day (200 µg/kg/day), and the daily exposures for the general adult population are listed in **Table 3-9**. An RSC using the subtraction method would be calculated by 1) summing the exposures other than drinking water and fish consumption (*i.e.*, all other foods, air, and other sources), 2) subtracting this value ($RfD_{remainder}$) from the RfD, and, 3) dividing the $RfD_{remainder}$ by the RfD. The computational steps are as follows:

1. RfD remainder = RfD – (Other food + Air + Other) = 200 – (20+2+1) =177
2. RSC = $RfD_{remainder}$/ RfD = 177/200=0.89.

A percentage method based RSC for pollutant X would be calculated by summing the exposures from fish consumption (FC) and drinking water (DW) and dividing this value by the sum of exposures from all exposures. The computation of the percentage based RSC is as follows:

RSC = (FC + DW)/(FC + DW + Other Food + Air + Other) = (5+10)/(5+10+20+2+1) = 0.39

Table 3-9. General adult population exposures to pollutant X.

Exposure Route	Daily Exposure (µg/day)	Percent of Total Exposure
Drinking water	5	13.2%
Fish consumption	10	26.3%
All other foods	20	52.6%
Air	2	5.3%
Other sources	1	2.6%

It is EPA's policy that RSCs calculated using either method should be subject to a floor of 20% (0.20) and a ceiling of 80% (0.80). Thus, for the hypothetical examples above, the subtraction method calculated RSC for pollutant X would need to be reduced to value of 0.8, while the percentage method calculated RSC is within the range and would not require further adjustment. Utilizing the 80% "ceiling" ensures that the criterion will be low enough to provide adequate protection for individuals whose total exposure to a contaminant is, due to dietary or other exposure, higher than currently indicated by available data. This approach, in effect, introduces an additional uncertainty factor and results in a lower criterion. It ensures that the criterion will result in no adverse effects with an adequate margin of safety (See Federal Register Vol, 50, N0. 97, 22068-22070, May 22, 1989).

The department completed an assessment for the potential development of parameter-specific RSCs alternative to the default floor (0.20) and ceiling (0.80) values recommended by EPA (**Appendix D**). For the assessment, the department completed an extensive literature review analysis to locate exposure information for ten parameters (chloroform, toluene, nitrobenzene, selenium, acenaphthene, anthracene, fluoranthene, fluorene, pyrene, and dimethyl phthalate) in an effort to develop RSCs. The department attempted to locate Florida data to the maximum extent practicable, but did not limit the review to Florida data if these were insufficient, and so the analysis also relied on regional and national level data. FDEP selected these ten parameters to serve as a "proof of concept" analysis intended to determine whether 1) sufficient data and information were available to set quantitative RSCs; and, 2) determine whether quantitatively established RSCs would differ significantly from those used by U.S. EPA in their national recommendations.

These ten particular parameters were selected for the analysis based on information from an earlier RSC analysis (Weaver and Summerfield, 2014), which had shown that these a) were the most information rich parameters, b) represented different types of chemicals (metal, solvent, industrial chemical, plasticizer, disinfection byproduct, petrogenic and pyrogenic PAHs) that Floridians may be exposed to in the environment, and c) represented a range in K_{ow} values.

The department first calculated RSC values for these parameters as part of rulemaking conducted in 2012/2013, but EPA provided comments on September 21, 2015 that the department needed to use the percentage method rather than the subtraction method because "when more than one criteria is relevant (*e.g*., chemical is regulated in drinking water (MCL), air or soil, has pesticides residue requirements), the subtraction method cannot be used." As FDEP's earlier analysis used the subtraction method for all non-carcinogenic parameters, the department has, as part of this rulemaking, revised the calculations for these ten parameters using the percentage method to be consistent with the 2000 methodology.

The primary exposure pathways evaluated for the updated analysis were ambient sources (surface waters and ingestion of freshwater and estuarine fish) and non-ambient sources [treated drinking water, inhalation, soil, oceanic/marine levels, and diet (other than fresh or estuarine fish)]. From the available data and information gathered through the literature analysis, the department then calculated applicable RSCs using the percentage method for both Class I/Class I-Treated and Class III (includes Classes II and III-Limited) waters.

Under the exposure decision tree approach, the EPA has very rigorous data adequacy requirements for data used to calculate state-specific RSC values, including considerations of "(1) sample size (*i.e*., the number of data points); (2) whether the data set is a random sample representative of the target population (if not, estimates drawn from it may be biased no matter how large the sample); (3) the magnitude of the error that can be tolerated in the estimate (estimator precision); (4) the sample size needed to achieve a given precision for a given parameter (*e.g*., a larger sample is needed to precisely estimate an upper percentile than a mean or median value); (5) an acceptable analytical method detection limit; and (6) the functional form and variability of the underlying distribution, which determines the estimator precision (*e.g*., whether the distribution is normal or lognormal and whether the standard deviation is 1 or 10)" as enumerated in EPA's 2000 *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health*.

The department developed a separate technical document that outlines the methodology and analysis used to develop the RSCs for the ten parameters listed above (**Appendix D**). As documented in the RSC technical document, the department determined that quantitative RSCs for the ten parameters did not differ from U.S. EPA's national recommendations. In fact, given the inherent uncertainty and variability in available data, the RSCs derived for all ten parameters defaulted to the floor of 0.20.

The information and data that the department was able to assemble provided only estimates of exposures that do not meet the rigorous data adequacy recommendations, and there is considerable remaining uncertainty in exposure rates. Most notably lacking is robust data on ambient exposures (*i.e.*, drinking water, surface water, and fish tissue concentrations). Therefore, the department concluded, through this "proof of concept" analysis, that it is highly unlikely that additional analysis of the remaining non-carcinogen RSCs would lead to different conclusions than were reached by EPA through application of the *Exposure Decision Tree*.

3.5.4 Cancer Slope Factors

The default methodology for developing cancer slope factors (CSF) is based on a linear model and the assumption that any exposure to a carcinogen poses some probability of adverse response. The probability of adverse response increases incrementally with increased exposures. EPA's approach to carcinogens is prudent given the fact that carcinogenesis may begin with mutation of a single exposed cell. The CSF is calculated as the slope of a line with an intercept of zero (*i.e.*, zero dose and effect/risk). The slope of the line is calculated as $0.1/LED_{10}$, where LED_{10} is the lower 95 percent confidence limit on a dose associated with a 10 percent extra risk of tumor incidence or tumor precursor development.

If the point of departure (LED_{10}) was based on animal studies, it is adjusted to equivalent human doses using toxicokinetic information on the particular chemical. However, in most cases, there are insufficient data available to compare dose effects between species. In these cases, the estimate of a human equivalent dose is based on default assumptions. To derive an equivalent human oral dose from animal data, the default procedure is to scale daily applied oral doses experienced for a lifetime in proportion to body weight of the test animal raised to the 3/4 power ($BW^{3/4}$). The adjustment factor is used because metabolic rates, as well as most rates of physiological processes that determine the disposition of dose, scale in this manner (USEPA, 2000).

FDEP developed proposed criteria for carcinogens using the same CSF factors as EPA used in their 2015 national recommended criteria (**Table 3-10**)

3.5.5 Toxicity Value Inputs

The parameter-specific toxicity values (RfD, CSF, MRL, and RSC) used to calculate the HHC are listed in **Table 3-10**. These toxicity inputs were entered into the Monte Carlo analyses as fixed values. As noted previously, RfD, CSF, and MRL values are based on the toxicity values used by EPA to derive their latest June 2015 HHC derivation and represent the most recent scientific information available. When developing their 2015 recommended HHC, the EPA evaluated all available toxicity values for both non-carcinogenic and carcinogenic toxicological effects for each parameter and presented both an RfD and CSF, or MRL and CSF when available. The more protective toxicological endpoint was then used to derive the HHC. This methodology was also used by the department when deriving HHC for Florida.

There have been changes to numerous RfD and CSF values, reflecting the latest science, since the previously adopted HHC were developed. These changes include the following:

- Updated cancer slope factors in IRIS for carbon tetrachloride, chlordane, methylene chloride, hexachloroethane, PCBs, pentachlorophenol, tetrachloroethylene (perchloroethylene), and trichloroethylene (TCE).
- The IRIS CSF assessment for benzene was updated in 2000 (USEPA 2000B) based on the Rinsky et al. (1981, 1987) analyses of a Pliofilm rubber worker cohort studied by Infante et al. (1977). USEPA (2000B) recommended a range of CSF for benzene based on differing risk estimates for the Pliofilm rubber worker cohort. Differences among the risk estimates were largely due to differences in exposure estimates used in the dose-response modeling of the cohort. When a linear dose-response model was used, the choice of cancer unit risk estimates narrowed to a range between $7.1 \cdot 10^{-3}$ and $2.5 \cdot 10^{-2}$ at 1 ppm ($2.2 \cdot 10^{-6}$ to $7.8 \cdot 10^{-6}$ at 1 $\mu g/m^3$ of benzene in air[8]), depending on whether the exposure estimates from Crump and Allen (1984) or Paustenbach et al. (1993) were used. USEPA (2000B) recommended the use of the range of risk estimates and stated that each estimate within the range had equal scientific plausibility. Given that EPA recommends a range of CSFs for benzene, and that all values within this range are equally valid, DEP entered the benzene CSF into its probabilistic risk analysis as uniform[9] distribution (minium: $1.5 \cdot 10^{-2}$; median: $3.5 \cdot 10^{-2}$; mean: $3.5 \cdot 10^{-2}$; maximum: $5.5 \cdot 10^{-2}$ per mg/kg-day). Use of a uniform distribution is consistent with EPA's finding that all values between the minium and maxium of the range have equal scientific plausibility.
- Updated CSFs for 1,2-dichloropropane, 4,4'-DDE, bromoform, chlorodibromomethane, dichlorobromomethane, and hexachlorobutadiene are available from peer reviewed sources. Revision of the CSFs for these parameters was recommended by the HHPRC. The CSFs all came from EPA published documents generated by either the EPA Superfund or Drinking Water programs. The CSF for 1,2-Dichloropropane was taken from the Public Health Goal for 1,2-Dichloropropane in Drinking Water (Fan and Alexeff, 1999). The CSFs for 4,4'-DDE (note that FDEP did not add a criterion for 4,4'-DDE because it is a banned pesticide) and hexachlorobutadiene were taken from EPA Health Effects Support Documents for 1,1-Dichloro-2,2-bis(p- chlorophenyl)ethylene (DDE) (EPA 822-R-08-003) and hexachlorobutadiene (EPA 822-R-03-002), respectively. The CSFs for bromoform, chlorodibromomethane, and dichlorobromomethane were taken from the Drinking Water Criteria Document for Brominated Trihalomethanes (EPA 822-R-05-011).
- Cancer is no longer considered the most stringent endpoint for chloroform. EPA states that the RfD for non-cancer effects is derived from the most sensitive endpoint in the most sensitive species. The RfD is based on fatty cysts formation (fat accumulation) in the liver and elevation of serum glutamic pyruvic transaminase (SGPT) in dogs (Heywood *et al*., 1979). Hepatic fat accumulation and elevated SGPT are considered early signs of impaired liver function resulting from chloroform-induced cytotoxicity. This effect occurs at doses at or below those that cause increased labeling index,

---

[8] The air exposure risk estimate range is equivalent to oral slope factor to $1.54 \cdot 10^{-2}$ to $5.54 \cdot 10^{-2}$ per mg/kg-day (USEPA 2003).

[9] All values between the minium and maximum are equally likely to occur.

morphological changes, or cellular necrosis, so protection against this effect is believed to protect against cytolethality and regenerative hyperplasia. Accordingly, the RfD of 0.01 mg/kg/day can be considered protective against increased risk of cancer (http://www.epa.gov/iris/subst/0025.htm). Use of the new RfD rather than the previous CSF results in a considerably higher chloroform criterion.

- Florida's existing beryllium and 1,1-Dichloroethene criteria were based on an assumption of carcinogenicity. Recently, however, the EPA has withdrawn its cancer slope factors for these parameters and now considers ingested beryllium and 1,1-Dichloroethene to be non-carcinogenic. The proposed criteria are based on EPA's newer RfDs taken from IRIS.
- Updated RfDs for acrolein, hexachlorocyclopentadiene, nitrobenzene, and toluene
- The most recent U.S. EPA developed RfD for Lindane is provided in the Revised Health Effects Division Risk Assessment for Lindane.
- The updated RfD for methyl bromide was based on information contained within USEPA (2006).

Given that there have been a number of changes in toxicity values due to new scientific analyses and research since the last human health criteria adoption, the calculated criteria are subject to change even if all other inputs and the methodology remain unchanged. These changes must be considered when making comparisons between the criteria developed under the current efforts and the existing criteria listed in Rule 62-302.530, F.A.C.

For example, some of the criteria have become less stringent because there has been a decrease in the cancer slope factor, which indicates that new research or scientific analysis supports a conclusion that the compound is less toxic or less likely to trigger tumor formation at low dosage than was previously assumed. As noted previously, cancer slope factors for 1,2-dichloropropane, benzene, bromoform, carbon tetrachloride, chlordane, chlorodibromomethane, dichlorobromomethane, methylene chloride, hexachlorobutadiene, PCBs, and tetrachloroethylene (perchloroethylene) have decreased since Florida's HHC were originally adopted and/or since EPA's 2002 national recommendations. Criteria for these parameters are expected to increase based on the latest toxicological information, yet the revised criteria are still considered fully protective. Conversely, criteria for hexachloroethane, pentachlorophenol, trichloroethylene (TCE), and vinyl chloride are expected to decrease due to increases in their respective cancer slope factors.

As previously noted, criteria for 1,1-dichloroethene, beryllium, and chloroform are now calculated using reference doses rather than CSFs as was the case when Florida's current criteria were adopted. The change in toxicity assumptions, which is based on the latest scientific information, is expected to result in higher criteria values for these parameters even if all other factors (*i.e.*, fish consumption, body weight, drinking water intake) were held constant. It must be stressed that these changes are based on the most recent scientific understanding of the toxicological response to these compounds and that the CSF and RfDs have undergone a full peer review process.

Table 3-10. List of parameter specific toxicity values for carcinogens (C) and non-carcinogens (NC). Toxicity values were entered into the Monte Carlo analyses as point values and were not varied, with the exception of the CSF for benzene. Reference doses (RfD), minimal risk levels (MRLs), and relative source contribution (RSC) apply only to non-carcinogens, while cancer slope factors (CSF) apply only to carcinogens. The column labeled "62-302.530," contains the cancer slope factors (q1*) and oral reference doses (RfD) used to calculate the HHC currently listed in Rule 62-302.530, F.A.C.

Effect	Parameter	CAS Number	62-302.530	RfD (mg/kg-d)	CSF (per mg/kg-d)	MRLs (mg/kg-d)	RSC
C	1,1,2,2-Tetrachloroethane	79345	q1*= 0.2	$2\cdot10^{-2}$	$2\cdot10^{-1}$		0.2
C	1,1,2-Trichloroethane	79005		$4\cdot10^{-3}$	$5.7\cdot10^{-2}$		0.2
C	1,2,4-Trichlorobenzene	120821		$1\cdot10^{-2}$	$2.9\cdot10^{-2}$		0.2
C	1,2-Dichloroethane	107062		$7.8\cdot10^{-2}$	$3.3\cdot10^{-3}$		0.2
C	1,2-Dichloropropane	78875		$8.93\cdot10^{-2}$	$3.6\cdot10^{-2}$		0.2
C	1,2-Diphenylhydrazine	122667			$8\cdot10^{-1}$		NA
C	1,3-Dichloropropene	542756		$2.5\cdot10^{-2}$	$1.22\cdot10^{-1}$		0.2
C	2,4,6-Trichlorophenol	88062	q1*=0.011	$1\cdot10^{-3}$	$1.1\cdot10^{-2}$		0.2
C	2,4-Dinitrotoluene	121142	q1*= 0.311	$2\cdot10^{-3}$	$6.67\cdot10^{-1}$		0.2
C	Acrylonitrile	107131	q1* = 0.54		$5.4\cdot10^{-1}$		NA
C	Aldrin	309002	q1* = 0.00003	$3\cdot10^{-5}$	17		0.2
C	Benzidine	92875		$3\cdot10^{-3}$	$2.3\cdot10^{2}$		0.2
C	Benzo(a)anthracene[4]	56553			0.73		NA
C	Benzo(a)pyrene[4]	50328			7.3		NA
C	Benzo(b)fluoranthene[4]	205992			0.73		NA
C	Benzo(k)fluoranthene[4]	207089			0.073		NA
C	beta-Hexachlorocyclohexane (HCH)	319857	q1* = 1.8		1.8		NA
C	Bis(2-Chloroethyl) Ether	111444			1.1		NA
C	Bis(2-Ethylhexyl) Phthalate	117817			$1.4\cdot10^{-2}$	$6\cdot10^{-2}$	0.2

Effect	Parameter	CAS Number	62-302.530	RfD (mg/kg-d)	CSF (per mg/kg-d)	MRLs (mg/kg-d)	RSC
C	Bromoform	75252	q1*= 0.0079	$3\cdot10^{-2}$	$4.5\cdot10^{-3}$		0.2
C	Butylbenzyl Phthalate	85687		1.3	$1.9\cdot10^{-3}$		0.2
C	Carbon Tetrachloride	56235	q1* = 0.13	$4\cdot10^{-3}$	$7\cdot10^{-2}$		0.2
C	Chlordane	57749	q1* = 1.3	$5\cdot10^{-4}$	$3.5\cdot10^{-1}$		0.2
C	Chlorodibromomethane	124481	q1*= 0.084	$2\cdot10^{-2}$	$4\cdot10^{-2}$		0.2
C	Chrysene[4]	218019			0.0073		NA
C	Dibenzo(a,h)anthracene	53703			7.3		NA
C	Dichlorobromomethane	75274	q1* = 0.062	$3\cdot10^{-3}$	$3.4\cdot10^{-2}$		0.2
C	Dieldrin	60571	q1*= 16	$5\cdot10^{-5}$	16		0.2
C	Heptachlor	76448	q1*=4.5		4.1	$1\cdot10^{-4}$	0.2
C	Heptachlor Epoxide	1024573		$1.3\cdot10^{-5}$	5.5		0.2
C	Hexachlorobutadiene	87683	q1*= 0.078	$3\cdot10^{-4}$	$4\cdot10^{-2}$		0.2
C	Hexachloroethane	67721		$7\cdot10^{-4}$	$4\cdot10^{-2}$		0.2
C	Indeno(1,2,3-cd)pyrene[4]	193395			0.73		NA
C	Isophorone	78591		$2\cdot10^{-1}$	$9.5\cdot10^{-4}$		0.2
C	Methylene Chloride	75092	q1* = 0.0075	$6\cdot10^{-3}$	$2\cdot10^{-3}$		0.2
C	p,p'-Dichlorodiphenyltrichloroethane (DDT)	50293	q1* = 0.34	$5\cdot10^{-4}$	$3.4\cdot10^{-1}$		0.2
C	Pentachlorophenol	87865	q1* =0.12	$5\cdot10^{-3}$	$4\cdot10^{-1}$		0.2
C	PCB[1]	1336363	q1* = 7.7		2.0		NA
C	Tetrachloroethylene (Perchloroethylene)	127184	q1*= 0.0398	$6\cdot10^{-3}$	$2.1\cdot10^{-3}$		0.2
C	Toxaphene[2]	8001352	q1*=1.1	$3.5\cdot10^{-4}$	1.1		0.2
C	Trichloroethylene (TCE)	79016	q1*=0.0126	$5\cdot10^{-4}$	$5\cdot10^{-2}$		0.2
C	Vinyl Chloride	75014		$3\cdot10^{-3}$	1.5		0.2
C	3,3'-Dichlorobenzidine	91941	q1*= 0.45		$4.5\cdot10^{-1}$		NA
C	Benzene[5]	71432	q1* = 0.029		$1.5\cdot10^{-2}$ to $5.5\cdot10^{-2}$	$5\cdot10^{-4}$	0.2

Effect	Parameter	CAS Number	62-302.530	RfD (mg/kg-d)	CSF (per mg/kg-d)	MRLs (mg/kg-d)	RSC
NC	1,1,1-Trichloroethane	71556		2			0.2
NC	1,1-Dichloroethylene	75354	q1*= 0.6	$5\cdot10^{-2}$			0.2
NC	1,2-Dichlorobenzene	95501				$3\cdot10^{-1}$	0.2
NC	1,3-Dichlorobenzene	541731				$2\cdot10^{-3}$	0.2
NC	1,4-Dichlorobenzene	106467				$7\cdot10^{-2}$	0.2
NC	2,4-Dichlorophenol	120832	RfD= 0.003	$3\cdot10^{-3}$			0.2
NC	2,4-Dimethylphenol	105679		$2\cdot10^{-2}$			0.2
NC	2,4-Dinitrophenol	51285	RfD = 0.002	$2\cdot10^{-3}$			0.2
NC	2-Chloronaphthalene	91587		$8\cdot10^{-2}$			0.8
NC	2-Chlorophenol	95578	RfD = 0.005	$5\cdot10^{-3}$			0.2
NC	2-Methyl-4,6-Dinitrophenol	534521		$3\cdot10^{-4}$			0.2
NC	3-Methyl-4-Chlorophenol	59507		$1\cdot10^{-1}$			0.2
NC	Acenaphthene	83329	RfD = 0.06	$6\cdot10^{-2}$			0.2
NC	Acrolein	107028		$5\cdot10^{-4}$			0.2
NC	Anthracene	120127	RfD = 0.3	$3\cdot10^{-1}$			0.2
NC	Antimony[3]	7440360	RfD = 0.0004				0.2
NC	Bis(2-Chloro-1-Methylethyl) Ether	108601		$4\cdot10^{-2}$			0.2
NC	Chlorobenzene	108907		$2\cdot10^{-2}$			0.2
NC	Chloroform	67663	q1*= 0.0061	$1\cdot10^{-2}$			0.2
NC	Cyanide	577125		$6\cdot10^{-4}$			0.2
NC	Diethyl Phthalate	84662		$8\cdot10^{-1}$			0.2
NC	Dimethyl Phthalate	131113		$1\cdot10^{1}$			0.2
NC	Di-n-Butyl Phthalate	84742		$1\cdot10^{-1}$			0.2
NC	Ethylbenzene	100414		$2.2\cdot10^{-2}$			0.2
NC	Fluoranthene	206440	RfD =0.04	$4\cdot10^{-2}$			0.2
NC	Fluorene	86737	RfD =0.04	$4\cdot10^{-2}$			0.2
NC	Hexachlorocyclopentadiene	77474		$6\cdot10^{-3}$			0.2

Effect	Parameter	CAS Number	62-302.530	RfD (mg/kg-d)	CSF (per mg/kg-d)	MRLs (mg/kg-d)	RSC
NC	Methyl Bromide	74839		$2\cdot10^{-2}$			0.2
NC	Nitrobenzene	98953		$2\cdot10^{-3}$			0.2
NC	Pentachlorobenzene	608935		$8\cdot10^{-4}$			0.2
NC	Pyrene	129000	RfD = 0.03	$3\cdot10^{-2}$			0.2
NC	Toluene	108883		$9.7\cdot10^{-3}$			0.2
NC	trans-1,2-Dichloroethylene (DCE)	156605		$2\cdot10^{-2}$			0.2
NC	Chlorophenoxy Herbicide (2,4,5-TP)[6] [Silvex]	93721	1986 Gold Book	$8\cdot10^{-3}$			0.8
NC	Chlorophenoxy Herbicide (2,4-D)[6]	94757	1986 Gold Book	$2.1\cdot10^{-1}$			0.2
NC	Methoxychlor	72435		$2\cdot10^{-5}$			0.8
NC	Beryllium[7]	7440417	q1* = 4.3	0.002			0.2
NC	Phenol[8]	108952		$6\cdot10^{-1}$			0.2
NC	Alpha-Endosulfan[2]	959988	RfD = 0.006	$6\cdot10^{-3}$			0.2
NC	Beta-Endosulfan[2]	33213659	RfD = 0.006	$6\cdot10^{-3}$			0.2
NC	Endosulfan Sulfate[2]	1031078		$6\cdot10^{-3}$			0.2
NC	Selenium[2]	7782492	RfD = 0.005				0.2
NC	Endrin[2]	72208		$3\cdot10^{-4}$			0.8
NC	Gamma-Hexachlorocyclohexane (HCH)[2]	58899	q1* = 1.3	$4.7\cdot10^{-3}$			0.5

1. The EPA did not propose new human health criteria for PCBs as part of their 2015 recommendations. However, the department is proposing to update criteria for this parameter so it is consistent with EPA's 2002 HHC recommendations (USEPA, 2002).
2. Parameters that have more stringent aquatic life criteria include: selenium, endrin, gamma-HCH, alpha-endosulfan, beta-endosulfan, endosulfan sulfate, and toxaphene. The department is proposing to retain the current criteria in Rule 62-302.530, F.A.C., for these parameters because the aquatic life endpoint is more sensitive than human health and is therefore fully protective of all uses.
3. The EPA did not propose new HHC for antimony as part of their 2015 recommendations. However, the department is proposing to update criteria for this parameter so it is consistent with EPA's 2002 human health criteria recommendations (USEPA, 2002).

4. Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and Indeno(1,2,3-cd)pyrene were formerly included in total PAHs (carcingogenic) in Rule 62-302.530, but were broken out into individual parameters by EPA in 2015. FDEP is proposing to follow the EPA recommendation and list individual carcinogenic PAHs.
5. EPA selected a CSF range of $1.5 \cdot 10^{-2}$ per mg/kg-d (0.015 per mg/kg-d) to $5.5 \cdot 10^{-2}$ per mg/kg-day (0.055 per mg/kg-day) for benzene based on a 2000 EPA IRIS assessment. EPA's IRIS program derived the CSF range using principal studies by Rinsky et al. (1981; 1987), Paustenbach et al. (1993), Crump (1994), and USEPA (1998A; 1999) based on the development of leukemia in humans with occupational inhalation exposure to benzene.
6. The existing Class I criteria for 2,4-D and 2,4,5-TP were based on the 1986 Gold Book (EPA 440/5-86-001) recommendations for domestic water supplies and did not include an RfD, CSF, or BCF.
7. The EPA did not propose new HHC for beryllium as part of their 2015 recommendations. However, the department is proposing to update criteria for this parameter so it is consistent with EPA's most recent toxicity recommendations. Florida's existing beryllium criteria were based on an assumption of carcinogenicity. U.S. EPA has withdrawn its cancer slope factors for this parameter and now considers ingested beryllium to be non-carcinogenic. The proposed criterion is based on EPA's newer RfD (0.002) taken from IRIS and listed in the table above.
8. Phenol currently has organoleptic effect-based criteria (300 µg/L) contained in Chapter 62-302.530, F.A.C., that are more protective than the proposed HHC. Thus, this parameter is not proposed for revision.

4 Criteria Derivation

FDEP used a probabilistic risk approach utilizing Monte Carlo analysis to derive protective HHC. The Microsoft Add-in Crystal Ball (Oracle Corporation, Release 11.1) was used to run all Monte Carlo analyses using the exposure inputs described in **Section 3**. Specifically, the toxicity values listed in **Table 3-10**, the BAFs and BCFs in **Table 3-6**, and distributions summarized in **Table 3-1** and **3-2** served as inputs into the calculations (*i.e*., Equations 3-1, 3-2, and 3-6), via repeated random sampling (Monte Carlo simulation) from the applicable distributions, to simulate population characteristics and estimate risks. Reference doses (RfD), cancer slope factors (CSF), relative source contributions, BAFs, and BCFs were entered in the calculations as point values, with the exception of the CSF for benzene. Fish consumption rates (FCR), body weight (BW), and drinking water consumption (DI) were entered as distributions, such that the input values were randomly varied, based on the respective distributions, during each Monte Carlo iteration. **Figures 4-1** and **4-2** provide conceptual flowcharts for non-carcinogens and carcinogens, respectively, of the FCR, BW, and DI selection process and subsequent calculation process for each model iteration. Although **Figures 4-1** and **4-2** depict separate processes, criteria and risks for all non-carcinogens and carcinogens were run simultaneously in a single spreadsheet with the same FCR, BW, and DI inputs for each parameter during a given iteration.

A total of 100,000 iterations were conducted per Monte Carlo analysis run. An initial seed value was not specified. For convenience[10], FDEP set the initial HHC at EPA's current national recommended value. As previously explained, the proposed non-carcinogen criteria were derived by running the probabilistic analysis to calculate surface water criteria (Equations 2-1 and 2-2), and then setting the criterion at the 10th percentile of the Monte Carlo calculated results. Criteria for carcinogens were derived with the objective of not exceeding an incremental cancer risk of 1 in 1,000,000 (10^{-6}) at the arithmetic mean of the risk distribution and no more than a 1 in 100,000 (10^{-5}) incremental increase in risk at the 90th percentile.

The results of the probabilistic risk analysis were used to solve for the HHC necessary to achieve the target risk level for each parameter. The risk distributions generated by each Monte Carlo run of 100,000 iterations were inspected after each run for an indication of whether the HHC needed to be decreased or increased to attain the target risk level. The values of the HHC for carcinogens were adjusted between trials until the target risk was achieved at the mean for carcinogens of the simulated risk distribution. Carcinogen criteria were adjusted up or down based on excess or remaining risk (relative to 10^{-6}) at the mean of the risk distribution produced through the probabilistic risk analysis (Monte Carlo). If the risk at the mean risk exceeded 10^{-6} then there was still excess risk and the criterion was adjusted downward. If the mean risk was less than 10^{-6} than there was remaining risk and the criterion was adjusted upward. The adjustment (either up or down) was done by multiplying the criterion by the quotient of the mean risk divided by the target risk of 10^{-6}; that is, by adjusting the criterion proportional to the level of excess or remaining risk. For example, if the risk at the mean for a carcinogen was $2.1 \cdot 10^{-5}$, then the SWQC was reduced by a factor of 21 ($2.1 \cdot 10^{-5}/1 \cdot 10^{-6} = 21$) prior to the next simulation. This process was iteratively continued until the target risk level was achieved for all parameters. For

---

[10] The final result is insensitive to the initial criteria inputs.

non-carcinogens, the criterion was set to the 10th percentile criterion calculated using the equations 2-1 and 2-2.

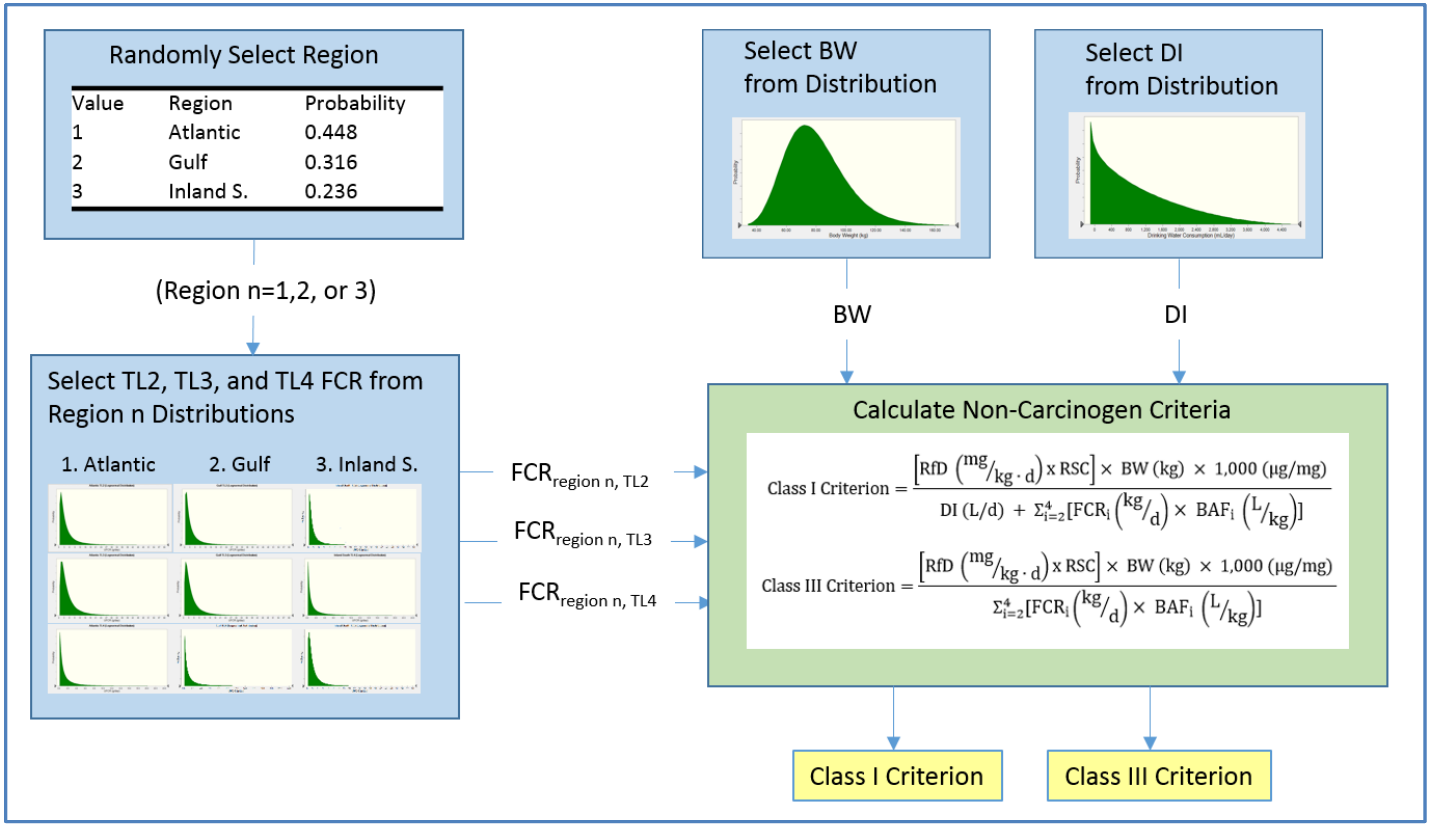
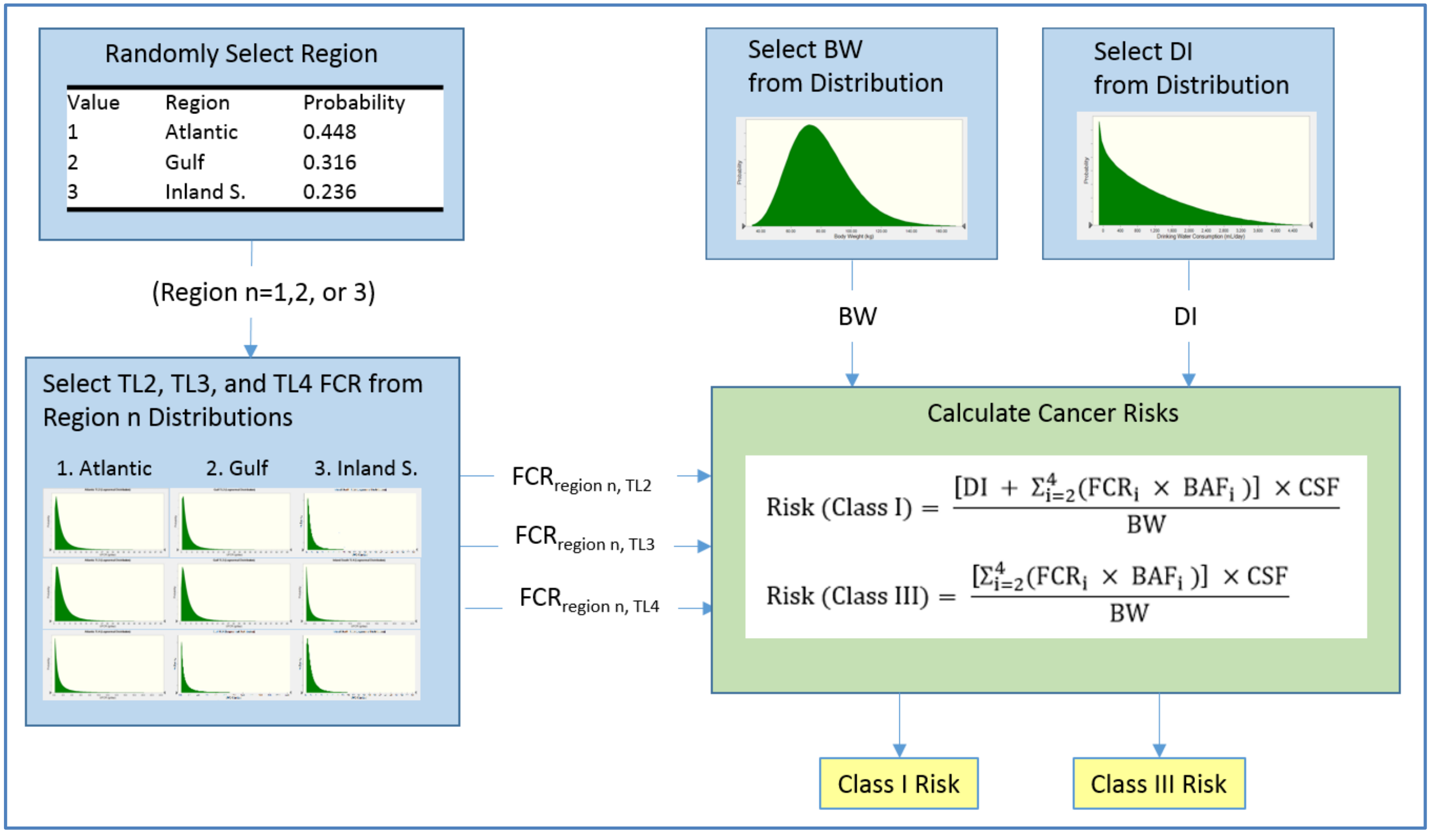

Randomly Select Region
Value Region Probability
1 Atlantic 0.448
2 Gulf 0.316
3 Inland S. 0.236
(Region n=1,2, or 3)
Select TL2, TL3, and TL4 FCR from Region n Distributions
1. Atlantic
2. Gulf
3. Inland S.
$FCR_{region\ n,\ TL2}$
$FCR_{region\ n,\ TL3}$
$FCR_{region\ n,\ TL4}$
Select BW from Distribution
Select DI from Distribution
BW
DI
Calculate Non-Carcinogen Criteria
$\text{Class I Criterion} = \frac{\left[\text{RfD}\left(\frac{mg}{kg \cdot d}\right) \times \text{RSC}\right] \times \text{BW (kg)} \times 1{,}000\ (\mu g/mg)}{\text{DI (L/d)} + \Sigma_{i=2}^{4}\left[\text{FCR}_i\left(\frac{kg}{d}\right) \times \text{BAF}_i\left(\frac{L}{kg}\right)\right]}$
$\text{Class III Criterion} = \frac{\left[\text{RfD}\left(\frac{mg}{kg \cdot d}\right) \times \text{RSC}\right] \times \text{BW (kg)} \times 1{,}000\ (\mu g/mg)}{\Sigma_{i=2}^{4}\left[\text{FCR}_i\left(\frac{kg}{d}\right) \times \text{BAF}_i\left(\frac{L}{kg}\right)\right]}$
Class I Criterion
Class III Criterion

Figure 5-1. Conceptual flowchart of the Monte Carlo calculations conducted during each model iteration for non-carcinogens. The model was run for a total of 100,000 iterations with the Class I and III criteria results being saved for all iterations for subsequent evaluation. Class III criteria also apply to Class II and III-Limited waters. Class I criteria also apply to Class I-Treated waters.



Value	Region	Probability
1	Atlantic	0.448
2	Gulf	0.316
3	Inland S.	0.236

$$\text{Risk (Class I)} = \frac{[\text{DI} + \Sigma_{i=2}^{4}(\text{FCR}_i \times \text{BAF}_i)] \times \text{CSF}}{\text{BW}}$$

$$\text{Risk (Class III)} = \frac{[\Sigma_{i=2}^{4}(\text{FCR}_i \times \text{BAF}_i)] \times \text{CSF}}{\text{BW}}$$

Figure 5-2. Conceptual flowchart of the Monte Carlo calculations conducted during each model iteration for carcinogens. The model was run for a total of 100,000 iterations with the Class I and III risk results being saved for all iterations for subsequent evaluation. Risks for Class III waters also apply to Class II and III-Limited waters. Class I criteria also apply to Class I-Treated waters.

Sensitivity reports were generated for each parameter after the criteria setting procedure. These reports quantified the sensitivity of the risk distribution to each assumption (input distribution). The sensitivity results are presented in **Appendix E**. Values in the appendix are rank correlation coefficients calculated by the Crystal Ball software. The correlation coefficients in the appendix indicate that degree to which each variable influenced the final criterion or risk. The magnitude (absolute value) indicates the degree of influence exerted by each variable on the criterion or risk level. Negative correlation coefficients indicate an inverse relationship between risk or criterion, while a positive correlations indicate a direct relationship (same direction). For example, as body weight (BW) increases cancer risk and HQ decreases. Conversely, as BW increases the values of the non-carcinogenic criteria also increase.

5 Results

5.1 *Proposed Criteria*

FDEP evaluated 88 parameters through the use of probabilistic risk-based analyses for potential revision of existing criteria listed in Rule 62-302.530, F.A.C., or addition of new criteria to the rule. Criteria calculated for these parameters are listed in **Table 5-1** (the table does not include chemicals that FDEP is not considering for revision or addition). The table lists both cancer and non-cancer effects criteria for 31 chemical for which EPA has both cancer slope factors and reference doses. The most stringent endpoint for these 31 chemicals were used as the basis of the final HHC.

After calculating the HHC, the criteria were compared to existing aquatic life or organoleptic effects-based criteria listed in Rule 62-302.530, F.A.C, and if one of these other end-points was more sensitive, then the more stringent existing criterion was retained. The aquatic life criteria for eight (seven for Class I) parameters were clearly more stringent than the human health values, and in these cases the existing criterion was retained because it provides full protection of aquatic life, fish consumption, and drinking water consumption. Additionally, the organoleptic effects-based criterion for phenol is more stringent than the human health-based criterion; therefore, the existing criterion will be retained. FDEP is proposing to add or revise water quality criteria for 80 (79 in Class III) parameters based on the protection of human health (**Table 5-2**).

Table 5-1. Potential human health-based criteria for Florida waters. Class III criteria will also apply to Class II and III-Limited waters. Class I criteria also apply to Class I-Treated waters. Criteria were rounded to four significant figures. Criteria for some parameters include both cancer and non-cancer endpoints. Both end-points were calculated for chemicals with both a cancer slope factor and reference dose. The department used the most sensitive (lowest) endpoint as the basis for the proposed surface water quality criteria (**Table 5-2**).

Parameter	CAS Number	Effect End-point	Class I (µg/L)	Class III (µg/L)
1,1,1-Trichloroethane	71556	Non-Cancer	11850	193700
1,1,2,2-Tetrachloroethane	79345	Cancer	0.3461	5.866
1,1,2,2-Tetrachloroethane	79345	Non-Cancer	119.3	2343

Parameter	CAS Number	Effect End-point	Class I (µg/L)	Class III (µg/L)
1,1,2-Trichloroethane	79005	Cancer	1.21	19.53
1,1,2-Trichloroethane	79005	Non-Cancer	23.82	444.8
1,1-Dichloroethylene	75354	Non-Cancer	303.3	15730
1,2,4-Trichlorobenzene	120821	Cancer	0.1429	0.1514
1,2,4-Trichlorobenzene	120821	Non-Cancer	4.121	4.262
1,2-Dichlorobenzene	95501	Non-Cancer	1396	3903
1,2-Dichloroethane	107062	Cancer	21.89	1219
1,2-Dichloroethane	107062	Non-Cancer	474.4	31290
1,2-Dichloropropane	78875	Cancer	1.978	62.53
1,2-Dichloropropane	78875	Non-Cancer	539.6	20060
1,2-Diphenylhydrazine	122667	Cancer	0.07713	0.479
1,3-Dichlorobenzene	541731	Non-Cancer	8.274	17.92
1,3-Dichloropropene	542756	Cancer	0.5878	23.45
1,3-Dichloropropene	542756	Non-Cancer	151.5	7126
1,4-Dichlorobenzene	106467	Non-Cancer	344.6	1150
2,4,6-Trichlorophenol	88062	Cancer	3.321	6.598
2,4,6-Trichlorophenol	88062	Non-Cancer	3.812	7.245
2,4-Dichlorophenol	120832	Non-Cancer	15.58	65.03
2,4-Dimethylphenol	105679	Non-Cancer	119.8	2753
2,4-Dinitrophenol	51285	Non-Cancer	11.97	327.5
2,4-Dinitrotoluene	121142	Cancer	0.1069	3.504
2,4-Dinitrotoluene	121142	Non-Cancer	12.09	466.3
2-Chloronaphthalene	91587	Non-Cancer	961.3	1438
2-Chlorophenol	95578	Non-Cancer	30.08	858.6
2-Methyl-4,6-Dinitrophenol	534521	Non-Cancer	1.779	29.31
3,3'-Dichlorobenzidine	91941	Cancer	0.1104	0.3404
3-Methyl-4-Chlorophenol	59507	Non-Cancer	536.9	2683
Acenaphthene	83329	Non-Cancer	106	125.4
Acrolein	107028	Non-Cancer	3.049	304.8
Acrylonitrile	107131	Cancer	0.1346	11.33
Aldrin	309002	Cancer	3.76E-06	3.76E-06
Aldrin	309002	Non-Cancer	0.00019	0.00019
alpha-Endosulfan	959988	Non-Cancer	19.85	32.2
Anthracene	120127	Non-Cancer	460.5	537
Antimony	7440360	Non-Cancer	2.439	243.8
Benzene	71432	Cancer	2.008	52.99
Benzene	71432	Non-Cancer	3.012	92.58
Benzidine	92875	Cancer	0.000315	0.01958
Benzidine	92875	Non-Cancer	18.26	1345
Benzo(a)anthracene	56553	Cancer	0.01231	0.01403

Parameter	CAS Number	Effect End-point	Class I (µg/L)	Class III (µg/L)
Benzo(a)pyrene	50328	Cancer	0.001231	0.001403
Benzo(b)fluoranthene	205992	Cancer	0.01231	0.01403
Benzo(k)fluoranthene	207089	Cancer	0.1231	0.1403
Beryllium	7440417	Non-Cancer	11	64.5
beta-Endosulfan	33213659	Non-Cancer	24.31	50.68
beta-Hexachlorocyclohexane (HCH)	319857	Cancer	0.01814	0.03261
Bis(2-Chloro-1-Methylethyl) Ether	108601	Non-Cancer	237.3	3972
Bis(2-Chloroethyl) Ether	111444	Cancer	0.06579	4.094
Bis(2-Ethylhexyl) Phthalate	117817	Cancer	1.494	2.09
Bromoform	75252	Cancer	15.36	255.8
Bromoform	75252	Non-Cancer	178.8	3446
Butylbenzyl Phthalate	85687	Cancer	0.2918	0.2941
Butylbenzyl Phthalate	85687	Non-Cancer	72.15	72.47
Carbon Tetrachloride	56235	Cancer	0.9534	10.3
Carbon Tetrachloride	56235	Non-Cancer	23.4	288
Chlordane	57749	Cancer	0.001023	0.001028
Chlordane	57749	Non-Cancer	0.01783	0.01787
Chlorobenzene	108907	Non-Cancer	114.2	969.6
Chlorodibromomethane	124481	Cancer	1.765	43.73
Chlorodibromomethane	124481	Non-Cancer	120.4	3491
Chloroform	67663	Non-Cancer	60.46	2331
Chlorophenoxy Herbicide (2,4,5-TP) [Silvex]	93721	Non-Cancer	160.4	570.3
Chlorophenoxy Herbicide (2,4-D)	94757	Non-Cancer	1212	12720
Chrysene	218019	Cancer	1.231	1.403
Cyanide	57125	Non-Cancer	3.7	363.5
Dibenzo(a,h)anthracene	53703	Cancer	0.001231	0.001403
Dichlorobromomethane	75274	Cancer	2.084	56.65
Dichlorobromomethane	75274	Non-Cancer	18.08	576.7
Dieldrin	60571	Cancer	5.39E-06	5.4E-06
Dieldrin	60571	Non-Cancer	0.000426	0.000426
Diethyl Phthalate	84662	Non-Cancer	774.5	835.7
Dimethyl Phthalate	131113	Non-Cancer	2378	2424
Di-n-Butyl Phthalate	84742	Non-Cancer	34.65	35.64
Endosulfan Sulfate	1031078	Non-Cancer	23.49	46.33
Endrin	72208	Non-Cancer	0.05314	0.05337
Ethylbenzene	100414	Non-Cancer	80.02	143.1
Fluoranthene	206440	Non-Cancer	17.97	18.64
Fluorene	86737	Non-Cancer	76.59	93.58

Parameter	CAS Number	Effect End-point	Class I (µg/L)	Class III (µg/L)
gamma- Hexachlorocyclohexane (HCH)	58899	Non-Cancer	5.001	5.175
Heptachlor	76448	Cancer	2.48E-05	2.48E-05
Heptachlor	76448	Non-Cancer	0.001003	0.001004
Heptachlor Epoxide	1024573	Cancer	9.84E-05	9.91E-05
Heptachlor Epoxide	1024573	Non-Cancer	0.000702	0.000705
Hexachlorobutadiene	87683	Cancer	0.01756	0.01772
Hexachlorobutadiene	87683	Non-Cancer	0.01955	0.01964
Hexachlorocyclopentadiene	77474	Non-Cancer	4.678	5.005
Hexachloroethane	67721	Cancer	0.237	0.272
Hexachloroethane	67721	Non-Cancer	0.6736	0.7303
Indeno(1,2,3-cd)pyrene	193395	Cancer	0.01231	0.01403
Isophorone	78591	Cancer	75.8	3619
Isophorone	78591	Non-Cancer	1214	68530
Methoxychlor	72435	Non-Cancer	0.02253	0.02302
Methyl Bromide	74839	Non-Cancer	121.8	9997
Methylene Chloride	75092	Cancer	36.18	2252
Methylene Chloride	75092	Non-Cancer	36.52	2691
Nitrobenzene	98953	Non-Cancer	12.12	565.5
p,p'- Dichlorodiphenyltrichloroethane (DDT)	50293	Cancer	0.000153	0.000153
p,p'- Dichlorodiphenyltrichloroethane (DDT)	50293	Non-Cancer	0.002621	0.002622
PCBs	x	Cancer	9.75E-05	9.75E-05
Pentachlorobenzene	608935	Non-Cancer	0.1443	0.1463
Pentachlorophenol	87865	Cancer	0.06735	0.1066
Pentachlorophenol	87865	Non-Cancer	14.49	21.27
Phenol	108952	Non-Cancer	3649	247300
Pyrene	129000	Non-Cancer	42.87	49.13
Selenium	7782492	Non-Cancer	29.89	634.9
Tetrachloroethylene (Perchloroethylene)	127184	Cancer	22.88	65.99
Tetrachloroethylene (Perchloroethylene)	127184	Non-Cancer	28.37	83.02
Toluene	108883	Non-Cancer	56.3	607.3
Toxaphene	8001352	Cancer	0.001905	0.001961
Toxaphene	8001352	Non-Cancer	0.07399	0.07523
trans-1,2-Dichloroethylene (DCE)	156605	Non-Cancer	120.6	3942
Trichloroethylene (TCE)	79016	Cancer	1.342	15.35
Trichloroethylene (TCE)	79016	Non-Cancer	2.933	38.34
Vinyl Chloride	75014	Cancer	0.04823	2.956
Vinyl Chloride	75014	Non-Cancer	18.26	1327

Table 5-2. Final proposed criteria for 80 (79 in Class III) chemicals reviewed for revised HHC for Florida Waters. The table also lists criteria for 8 (9 in Class III) chemicals that were reviewed as part of the HHC evaluation, but are not proposed for revision because other uses are more sensitive than fish and drinking water consumption. Draft HHC were rounded to two significant figures. Class III criteria will also apply to Class II and III-Limited waters. Class I criteria also apply to Class I-Treated waters. Florida's existing Class I and III criteria (Section 62-302.530, F.A.C.) are listed for comparison purposes. The "Most Sensitive Endpoint" indicates the most sensitive criterion endpoint (cancer, non-cancer, aquatic life, or organoleptic effects) and is the basis of the final proposed criteria. Use of the most sensitive endpoint ensures that all uses are fully protected. The "Updated CSF or RfD" column indicates whether (yes) or not (no) there has been an update to the RfD or CSF for a given parameter since the adoption of Florida's existing criteria. A value of "N/A" in the column indicates that an earlier CSF or RfD is not applicable because Florida does not have existing numeric criterion for the chemical.

Chemical Name	CAS Number	Most Sensitive End-point	Class I (µg/L)	Existing Class I (µg/L)	Class III (µg/L)	Existing Class II/III (µg/L)	Updated CSF or RfD
1,1,1-Trichloroethane	71556	Non-cancer	12000		190000		N/A
1,1,2,2-Tetrachloroethane	79345	Cancer	0.35	0.17	5.9	10.8	No
1,1,2-Trichloroethane	79005	Cancer	1.2		20		N/A
1,1-Dichloroethylene	75354	Non-cancer	300	0.057	16000	3.2	Yes
1,2,4-Trichlorobenzene	120821	Cancer	0.14		0.15		N/A
1,2-Dichlorobenzene	95501	Non-cancer	1400		3900		N/A
1,2-Dichloroethane	107062	Cancer	22		1200		N/A
1,2-Dichloropropane	78875	Cancer	2		63		N/A
1,2-Diphenylhydrazine	122667	Cancer	0.077		0.48		N/A
1,3-Dichlorobenzene	541731	Non-cancer	8.3		18		N/A
1,3-Dichloropropene	542756	Cancer	0.59		23		N/A
1,4-Dichlorobenzene	106467	Non-cancer	340		1100		N/A
2,4,6-Trichlorophenol	88062	Cancer	3.3	2.1	6.6	6.5	No
2,4-Dichlorophenol	120832	Non-cancer	16	93	65	790	No
2,4-Dimethylphenol	105679	Non-cancer	120		2800		N/A
2,4-Dinitrophenol	51285	Non-cancer	12	69.7	330	14260	No
2,4-Dinitrotoluene	121142	Cancer	0.11	0.11	3.5	9.1	Yes

Chemical Name	CAS Number	Most Sensitive End-point	Class I (µg/L)	Existing Class I (µg/L)	Class III (µg/L)	Existing Class II/III (µg/L)	Updated CSF or RfD
2-Chloronaphthalene	91587	Non-cancer	960		1400		N/A
2-Chlorophenol	95578	Non-cancer	30	120	860	400	No
2-Methyl-4,6-Dinitrophenol	534521	Non-cancer	1.8		29		N/A
3,3'-Dichlorobenzidine	91941	Cancer	0.11		0.34		No
3-Methyl-4-Chlorophenol	59507	Non-cancer	540		2700		N/A
Acenaphthene	83329	Non-cancer	110	1200	130	2700	No
Acrolein	107028	Non-cancer	3		300		N/A
Acrylonitrile	107131	Cancer	0.13		11		No
Aldrin	309002	Cancer	3.80E-06	0.00013	3.80E-06	0.00014	Yes
Anthracene	120127	Non-cancer	460	9600	540	110000	No
Antimony	7440360	Non-cancer	2.4	14	240	4300	No
Benzene	71432	Cancer	2.0	1.18	53	71.28	N/A
Benzidine	92875	Cancer	0.00031		0.02		N/A
Benzo(a)anthracene	56553	Cancer	0.012	0.0028	0.014	0.031	Yes
Benzo(a)pyrene	50328	Cancer	0.0012	0.0028	0.0014	0.031	No
Benzo(b)fluoranthene	205992	Cancer	0.012	0.0028	0.014	0.031	Yes
Benzo(k)fluoranthene	207089	Cancer	0.12	0.0028	0.14	0.031	Yes
Beryllium	7440417	Non-cancer	11	0.0077	64	0.13	Yes
beta-Hexachlorocyclohexane (HCH)	319857	Cancer	0.018	0.014	0.033	0.046	No
Bis(2-Chloro-1-Methylethyl) Ether	108601	Non-cancer	240		4000		N/A
Bis(2-Chloroethyl) Ether	111444	Cancer	0.066		4.1		N/A
Bis(2-Ethylhexyl) Phthalate	117817	Cancer	1.5		2.1		N/A
Bromoform	75252	Cancer	15	4.3	260	360	Yes
Butylbenzyl Phthalate	85687	Cancer	0.29		0.29		N/A
Carbon Tetrachloride	56235	Cancer	0.95	0.25	10	4.42	Yes
Chlordane	57749	Cancer	0.001	0.00058	0.001	0.00059	Yes

Chemical Name	CAS Number	Most Sensitive End-point	Class I (µg/L)	Existing Class I (µg/L)	Class III (µg/L)	Existing Class II/III (µg/L)	Updated CSF or RfD
Chlorobenzene	108907	Non-cancer	110		970		N/A
Chlorodibromomethane	124481	Cancer	1.8	0.41	44	34	Yes
Chloroform	67663	Non-cancer	60	5.67	2300	470.8	Yes
Chlorophenoxy Herbicide (2,4,5-TP) [Silvex]	93721	Non-cancer	160	10	570		Yes
Chlorophenoxy Herbicide (2,4-D)	94757	Non-cancer	1200	100	13000		Yes
Chrysene	218019	Cancer	1.2	0.0028	1.4	0.031	Yes
Cyanide	577125	Non-cancer Aquatic Life (Class III)	3.7	5.2	5.2F/1.0M	5.2F/1.0M	N/A
Dibenzo(a,h)anthracene	53703	Cancer	0.0012	0.0028	0.0014	0.031	No
Dichlorobromomethane	75274	Cancer	2.1	0.27	57	22	Yes
Dieldrin	60571	Cancer	5.40E-06	0.00014	5.40E-06	0.00014	No
Diethyl Phthalate	84662	Non-cancer	770		840		N/A
Dimethyl Phthalate	131113	Non-cancer	2400		2400		N/A
Di-n-Butyl Phthalate	84742	Non-cancer	35		36		N/A
Ethylbenzene	100414	Non-cancer	80		140		N/A
Fluoranthene	206440	Non-cancer	18	300	19	370	No
Fluorene	86737	Non-cancer	77	1300	94	14000	No
Heptachlor	76448	Cancer	0.000025	0.00021	0.000025	0.00021	Yes
Heptachlor Epoxide	1024573	Cancer	0.000098		0.000099		N/A
Hexachlorobutadiene	87683	Cancer	0.018	0.45	0.018	49.7	Yes
Hexachlorocyclopentadiene	77474	Non-cancer	4.7		5		N/A
Hexachloroethane	67721	Cancer	0.24		0.27		N/A
Indeno(1,2,3-cd)pyrene	193395	Cancer	0.012	0.0028	0.014	0.031	Yes
Isophorone	78591	Cancer	76		3600		N/A
Methoxychlor	72435	Non-cancer	0.023	0.03	0.023	0.03	N/A

Chemical Name	CAS Number	Most Sensitive End-point	Class I (µg/L)	Existing Class I (µg/L)	Class III (µg/L)	Existing Class II/III (µg/L)	Updated CSF or RfD
Methyl Bromide	74839	Non-cancer	120		10000		N/A
Methylene Chloride	75092	Cancer	36	4.65	2300	1580	Yes
Nitrobenzene	98953	Non-cancer	12		570		N/A
p,p'- Dichlorodiphenyltrichloroethane (DDT)	50293	Cancer	0.00015	0.00059	0.00015	0.00059	No
PCBs	x	Cancer	0.000098	0.000044	0.000098	0.000045	Yes
Pentachlorobenzene	608935	Non-cancer	0.14		0.15		N/A
Pentachlorophenol	87865	Cancer	0.067	0.28	0.11	8.2	Yes
Pyrene	129000	Non-cancer	43	960	49	11000	No
Tetrachloroethylene (Perchloroethylene)	127184	Cancer	23	0.8	66	8.85	Yes
Toluene	108883	Non-cancer	56		610		N/A
trans-1,2-Dichloroethylene (DCE)	156605	Non-cancer	120		3900		N/A
Trichloroethylene (TCE)	79016	Cancer	1.3	2.7	15	80.7	Yes
Vinyl Chloride	75014	Cancer	0.048		3		N/A
alpha-Endosulfan	959988	Aquatic Life	0.056	0.056	0.056 F/0.0087 M	0.056 F/0.0087 M	No
beta-Endosulfan	33213659	Aquatic Life	0.056	0.056	0.056 F/0.0087 M	0.056 F/0.0087 M	No
Endosulfan Sulfate	1031078	Aquatic Life	0.056	0.056	0.056 F/0.0087 M	0.056 F/0.0087 M	N/A
Endrin	72208	Aquatic Life	0.0023	0.0023	0.0023	0.0023	N/A
gamma- Hexachlorocyclohexane (HCH)	58899	Aquatic Life	0.95	0.95	0.95 F/0.16 M	0.95 F/0.16 M	Yes
Selenium	7782492	Aquatic Life	5	5	5 F/71 M	5 F/71 M	No
Toxaphene	8001352	Aquatic Life	0.0002	0.0002	0.0002	0.0002	No
Phenol	108952	Organoleptic	300	300	300	300	N/A

5.2 *Risk Analysis and Risk Impact Statemtent*

After the criteria derivations, a series of probabilistic risk assessments were conducted for each parameter. The results of these analyses constitute the Risk Impact Statement (RIS), which is required under Section 120.81, Florida Statutes (F.S). These probabilistic risk assessments used the same distributional and toxicity inputs used during the criteria setting procedure (**Tables 3-1**, **3-4**, and **3-6**). The criteria inputs for this risk assessment were the criteria calculated in the derivation step; that is, the proposed criteria values. These probabilistic risk assessments were conducted to characterize the level of risk to the population and to confirm that a stable solution had been established for all parameters. The risk analyses were run at a high number of iterations (100,000) to fully characterize the range of risks for the population (*e.g.*, **Figure 5-1** and **5-2**). The probabilistic risk analysis used uniform (exact same inputs) exposure distributions for all contaminants and demonstrates that equal protection is provided for each parameter. These risk assessments were conducted in a single spreadsheet including both the carcinogens and non-carcinogens. Hazard Quotients (HQ) or Risks were calculated for all parameters simultaneously using the same population inputs; that is, the same body weights, fish consumption rate, and drinking water rate were used for all parameters for each iteration, with inputs randomly varied between iterations. 100,000 model iterations were run to generate risk distributions for all parameters of given effect type. Additionally, the risk analysis was run for carcinogens using the exposure distributions to verify that the 90th percentile of the population, high-end consumers (99th percentile), and subsistence fishers would be protected at the 10^{-5}, 10^{-4}, and 10^{-4} levels, respectively.

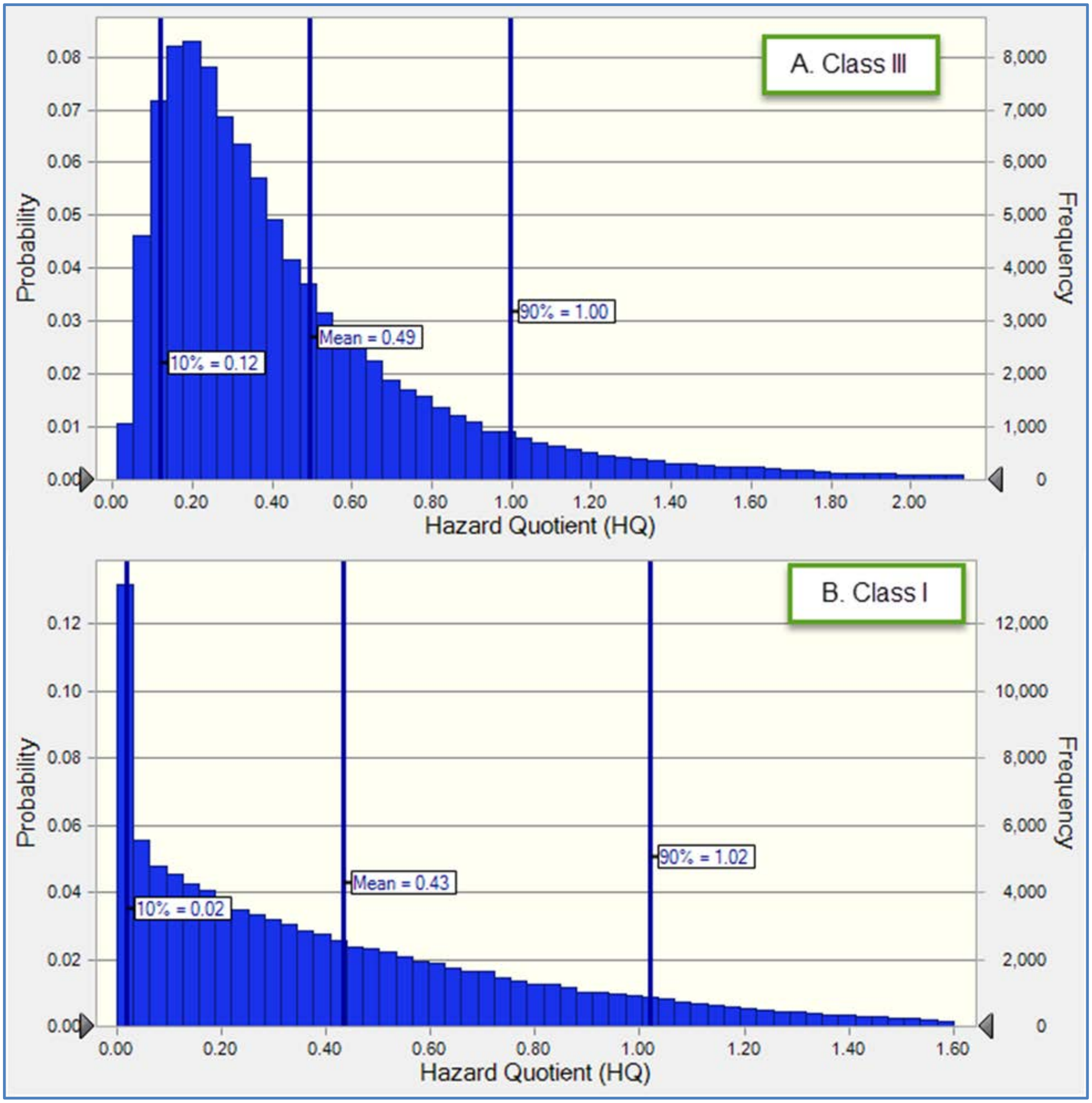


Figure 5-1. Example (chloroform) HQ risk distributions for a non-carcinogen at the proposed HHC. A) depicts the risk for Class II, III and III-Limited waters, and B) depicts risk for Class I and I-Treated. Monte Carlo analyses were run for a total of 100,000 iterations.

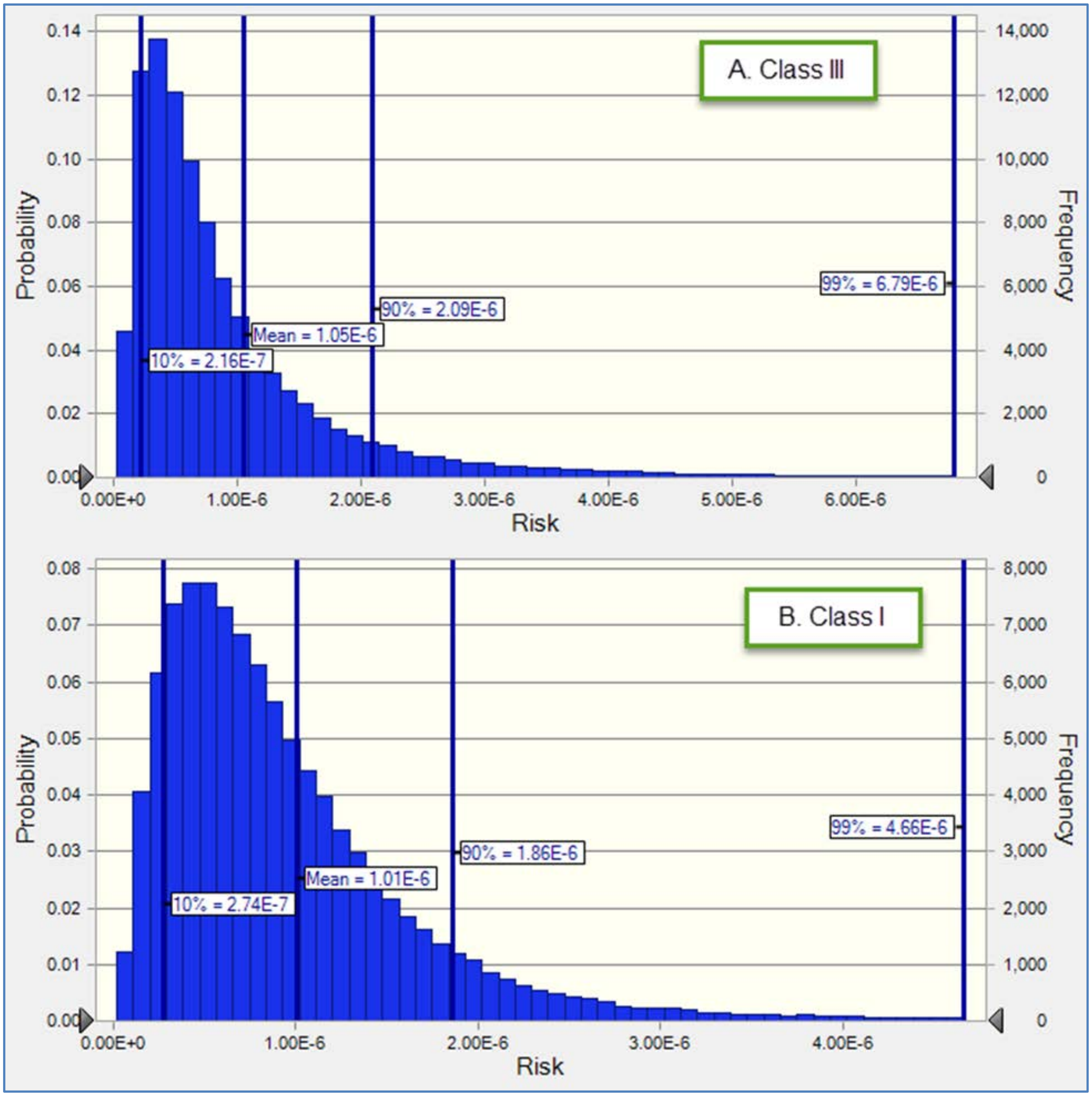


Figure 5-2. Example (pentachlorophenol) risk distributions for a carcinogen at the proposed HHC. A) depicts the risk for Class II, III and III-Limited waters, and B) depicts risk for Class I and I-Treated. Monte -Carlo analyses were run for a total of 100,000 iterations.

The results of the follow-up risk assessment are summarized in **Appendix F**, and show that the target risks were achieved for both carcinogens and non-carcinogens. The vast majority of the adult Florida population is expected to experience risk levels well below 1.0 for non-carcinogens and increased cancer risk of less than 10^{-6} for carcinogens. Furthermore, the risk analysis indicated that the 90th percentile Floridian will be protected at better than 10^{-5} increased cancer risk, and highly exposed individuals will be protected at better than 10^{-4} for carcinogens. In fact, the risk levels at the upper percentiles are well below the targets (**Table F-3**). Risks at the 90th percentile ranged from $1.85 \cdot 10^{-6}$ to $2.42 \cdot 10^{-6}$, with an average of $2.09 \cdot 10^{-6}$. Ninety-ninth percentile risks ranged from $3.50 \cdot 10^{-6}$ to $8.27 \cdot 10^{-6}$, with an average of $5.12 \cdot 10^{-6}$.

National EPA policy states that subsistence fishers must be protected at least at the 10^{-4} level for carcinogens. Additional risk analyses were conducted to assess risks for subsistence fishers. EPA's current national recommendations do not include a specific subsistence fisher consumption rate. However, the agency's earlier recommendations did include a consumption rate of 142.4 g/day. This consumption rate is equivalent to assuming that subsistence fishers eat one 5-ounce meal of Florida fish per day.

Analysis of risks for subsistence fishers was complicated by the fact that the earlier consumption rate was for all fresh and estuarine fish, and did not apportion the rate between the three trophic levels. In order to use this single consumption rate with the trophic level-specific BAFs, FDEP created a Monte Carlo simulation (100,000 iterations) that randomly apportioned the 142.4 g/day across the three trophic levels. For the analysis, any given trophic level accounted for between 0 and 100% of the total consumption, but the total consumption across the three trophic levels also equaled 142.4 g/day.

All other inputs (*i.e*., body weight, drinking water intake, BAFs, BCFs, CSF, and criteria) were identical to those used in the other risk assessments. Use of the same distributions and inputs assumes that general population statistics such as body weight and drinking water intake are also representative of the population of subsistence fishers.

Lifetime incremental increased cancer risk for the subsistence fisher population are listed in **Appendix G**. The risk analysis demonstrates that, while some subsistence fishers will exceed the 10^{-5} risk level, all were below a 10^{-4} increased cancer risk, even for the most sensitive and highly exposed individuals (*i.e.,* 99th percentile). The average of the mean risks, across all parameters, for the subsistence fisher population is $8.7 \cdot 10^{-6}$, while the average 99th percentile risk is $1.8 \cdot 10^{-5}$.

5.3 *Criteria Duration*

Criteria for carcinogenic compounds have historically been expressed as annual averages based on the fact that the toxicity thresholds (cancer slope factors) were developed using data from long-term studies. Sufficient human population studies are usually inadequate to function as the sole basis of the carcinogenic risk assessment, but are used as a component of EPA's weight-of-evidence review. Current standardized carcinogenicity studies in rodents test at least 50 animals per sex per dose group in each of three treatment groups and in a concurrent control group, usually for 18 to 24 months, depending on the rodent species tested (OECD, 1981; USEPA, 1998B; USEPA, 2005). Given that the underlying toxicity data for carcinogens are based on chronic long-term effects, it logically follows that the criteria should continue to be expressed on a long-term basis; that is, as annual averages not to be exceeded.

In contrast, the HHC for non-carcinogens have previously been expressed as single-sample maximums in Florida's adopted HHC. Because it was not clear why the criteria duration was shorter for the non-carcinogens, FDEP reviewed the principal and supporting studies used by U.S. EPA to develop the reference doses (RfD) for the individual non-carcinogenic human health criteria parameters. The purpose of the DEP review was to determine the most appropriate duration component, consistent with the duration of the underlying toxicological studies, to use for criteria expression for each parameter.

The department found that EPA reviewed studies involving subchronic exposure (occurring usually over 3 months) and chronic exposure (those involving an extended period of time or a significant fraction of the subjects' lifetime) to determine the no-observed-adverse-effect levels (NOAEL) or lowest-observed-adverse-effect level (LOAEL) toxic effects associated with continuous or repeated exposure to a chemical (U.S. EPA, 2000). U.S. EPA (2000) further explains that subchronic studies provide information on health hazards likely to arise from repeated exposure over a limited period of time, while chronic studies provide information on potential effects following prolonged and repeated exposure. Such chronic effects might require a long latency period or are cumulative in nature before manifesting disease.

EPA concluded that ideal dosing regimes include dosing for 5 to 7 days per week for a duration of at least 13 weeks (90 days) for subchronic, and at least 12 months or greater for chronic studies in rodents. For other species, EPA concluded that repeated dosing should ideally occur over 10 percent or more of the test animal's lifespan for subchronic studies and 50 percent or more of the test animal's lifespan for chronic studies. Reference doses were set at either the NOAEL, benchmark dose levels, or no effect level extrapolated from a LOAEL adjusted through the use of an uncertainty factor for critical effects observed over the entire dosing period. EPA applies a 1-, 3-, or 10-fold uncertainty factor (UF) when extrapolating from less-than-chronic results on experimental animals when there are no useful long-term human data. A 10-fold factor is the most commonly applied. As such, the reference dose represents chronic (long-term) effects.

FDEP compiled the principal and supporting study documentation for each of the non-carcinogens (**Table 5-3**). Principal study duration and any uncertainty factors applied by EPA, particularly the UFs related to study duration or extrapolation of subchronic to chronic effects, were also compiled. Out of the 43 non-carcinogenic toxicity values (3 of which are MRLs), 21 of the primary studies were a year or greater in duration, 20 are less than a year, one was a multigenerational study with effects observed after 95 days, and, one was an extended 1-generation study. For extrapolation of subchronic studies to chronic effects, EPA applied a UF of 3 to 10 (most typically 10) to the RfD calculation for all parameters with a study of less than 1 year, with the exception of 2,4-Dichlorophenol. In the case of 2-4-Dichlorophenol, EPA reasoned that an additional factor for use of a subchronic study was not necessary because the test animals were exposed both in utero and through milk before the 15-week administration in drinking water; that is, the exposure was chronic given the study design.

The RfDs as developed by EPA are therefore best interpreted as long-term (annual) averages. Shorter term effects were not demonstrated at these levels, and in fact the application of uncertainty factors provides further protection from adverse effects over a shorter periods of days or months. Therefore, given that the underlying toxicity data for non-carcinogens are based on chronic long-term effects, it logically follows that the criteria should be expressed on a long-term basis; that is, as annual averages not to be exceeded, as has been the case for carcinogens.

Table 5-3. Summary of non-carcinogen principle study duration and additional considerations (uncertainty factors) used by EPA when extrapolating short-term (sub-chronic) to long-term (chronic effects).

Parameter	Study Duration	Additional Consideration
1,1-Dichloroethene	> 1 year	
1,2 (trans) Dichloroethylene	<1 year (~90 days)	UF of 10 applied for the use of a subchronic study for chronic RfD derivation
1,2,4-Trichlorobenzene	Multi-generation; Effects observed after 95 days	UF of 10 applied for the use of a subchronic study for chronic RfD derivation
1,1,1-Trichloroethane	< 1 year (~ 90 days)	UF of 3 applied for the use of a subchronic study for chronic RfD derivation
1,2-Dichlorobenzene (MRL)	> 1 year	
1,3-Dichlorobenzene (MRL)	< 1 year (~ 90 days)	UF of 10 applied to account for intermediate-to-chronic duration to derive a chronic-duration oral MRL
1,4-Dichlorobenzene (MRL)	1 year	
2,4-Dichlorophenol	<1 year (~90 days)	Because the test animals were exposed both in utero and through milk before the 15-week administration in drinking water, an additional factor for use of a subchronic study was not considered necessary
2,4-Dimethylphenol	<1 year (~90 days)	UF of 10 applied for the use of a subchronic study for chronic RfD derivation
2,4-Dinitrophenol	<1 year (~90 days)	UF of 10 applied for the use of a subchronic study for chronic RfD derivation

Parameter	Study Duration	Additional Consideration
2-Chloronaphthalene	<1 year (~90 days)	UF of 10 applied for the use of a subchronic study for chronic RfD derivation
2-Chlorophenol	<1 year (~90 days)	UF of 10 applied for the use of a subchronic study for chronic RfD derivation
2-Methyl-4,6-Dinitrophenol	< 1 year (average of 5.5 weeks)	UF of 3 applied for the use of a subchronic study for chronic RfD derivation
3-methyl-4-chlorophenol	2 years	
Chlorophenoxy herbicide (2,4,5-TP)	2 years	
Chlorophenoxy herbicide (2,4-D)	Extended 1-generation study	
Acenaphthene	<1 year (~90 days)	UF of 10 applied for the use of a subchronic study for chronic RfD derivation
Acrolein	> 1 year	
Anthracene	<1 year (~90 days)	UF of 10 applied for the use of a subchronic study for chronic RfD derivation
Antimony	> 1 year	
Beryllium	> 1 year	
Bis(2-Chloro-1-Methylethyl) Ether	> 1 year	
Chlorobenzene	<1 year (~90 days)	UF of 10 applied for the use of a subchronic study for chronic RfD derivation
Chloroform	> 1 year	

Parameter	Study Duration	Additional Consideration
Cyanide	< 1 year	UF of 10 applied for the use of a subchronic study for chronic RfD derivation
Diethyl phthalate	<1 year (~16 weeks)	UF of 10 applied for the use of a subchronic study for chronic RfD derivation
Dimethyl phthalate	>1 year	
Di-n-Butyl phthalate	1 year	UF of 10 applied for the use of a subchronic study for chronic RfD derivation
Endosulfan	>1 year	
Endosulfan sulfate	>1 year	
Endrin	>1 year	
Ethylbenzene	2 year study in rats and 2 year study in mice	
Fluoranthene	<1 year (~90 days)	UF of 10 applied for the use of a subchronic study for chronic RfD derivation
Fluorene	<1 year (~90 days)	UF of 10 applied for the use of a subchronic study for chronic RfD derivation
gamma-Hexachlorocyclohexane (HCH)	>1 year	
Hexachlorocyclopentadiene	<1 year (~90 days)	To account for the uncertainty in using a subchronic study for RfD derivation, an UF of 3 is applied
Methoxychlor	>1 year	
Methyl bromide	>1 year	
Nitrobenzene	<1 year (~90 days)	A subchronic to chronic UF of 3 was applied to account for less-than-

Parameter	Study Duration	Additional Consideration
		lifetime exposure in the principal study
Pentachlorobenzene	< 1 year	UF of 10 applied for the use of a subchronic study for chronic RfD derivation
Pyrene	<1 year (~90 days)	UF of 10 applied for the use of a subchronic study for chronic RfD derivation
Selenium	> 1 year (lifetime)	
Toluene	>1 year	

5.4 *Uncertainty*

The 2008 Baseline Risk Analysis listed a number of uncertainties that potentially affected the risk analysis. Many of these same uncertainties still exist. The uncertainties listed in the Baseline Risk Analysis, with updates to reflect the current analysis and current understandings, are repeated below.

1. The toxicity values used for this analysis (RfDs and CSFs) were developed by the U.S. EPA for regulatory purposes and are conservative. For example, most of the RfDs include large uncertainty factors (see Section 3.5.1 and **Appendix C**). The actual thresholds of adverse health effects are probably well above the RfD value. While the use of uncertainty factors helps ensure a minimal possibility of an adverse health effect, it should be recognized that a dosage that exceeds the RfD does not necessarily indicate that toxicity is likely. Similarly, the CSFs developed by the U.S. EPA reflect a number of conservative choices in risk extrapolation. These include the assumption of a linear, non-threshold dose-response relationship for cancer, interpretation of animal carcinogenicity data, and dose-metrics for extrapolation of results from rodents to humans. As a result, cancer risk estimates using these values reflect high-end estimates of risk. Therefore, while the following uncertainties in the criteria calculations exist, they are balanced by the factors considered in setting the RfD and CSF values.
2. The risk calculations assume that for each population, all of the drinking water ingested and all the fish consumed were exposed to water contaminated at a concentration equal to the HHC. While this is theoretically possible, a more likely scenario is that only a portion of a surface waterbody reaches the HHC, while the remainder has contaminant concentrations that are much lower. It is further highly unlikely that fish consumed by the typical commercial consumer will all come from the same waterbody and thus have a constant contamination level. It is more likely that the fish consumed will have varying

levels of contamination potential, with many fish characterized as having little or no contamination.

3. It is expected that fish will move between areas of greater potential contamination (*e.g.*, near a discharge) to areas with lesser contamination. Due to depuration that occurs when fish are in uncontaminated waters, it is expected that fish tissue will likely have lower contamination levels than predicted under the scenario of continuous exposure. Even if some fish remain in the area of greatest contamination, it is unlikely that these fish comprise all of the fish in an average person's diet. However, it is possible that there are individuals (primarily subsistence fishers) within the population who routinely fish in waters directly affected by a discharge, perhaps due to convenience and proximity. These individuals are more likely than the general population to eat fish that meet the continuous exposure assumption.

   Additionally, there are large segments of the population who use waterbodies affected by large urban drainage areas and runoff (*e.g.*, Tampa Bay), which likely contains contaminants such as PAHs (Yates *et al*., 2011). This runoff has a high potential to affect segments of the waterbodies and thus increase exposure levels to fish and ultimately humans who consume the fish. It is these highly exposed individuals that the criteria are meant to protect. The HHC represent the maximum degradation of water quality that still provides health protection to highly exposed individuals who may routinely use a waterbody.
4. The concentration in fish predicted by uptake models is assumed to be the concentration in fish when ingested. Most fish are cooked prior to ingestion and cooking may lead to loss of some contaminants. The extent of loss depends upon the physical-chemical properties of the contaminant, food preparation techniques, and cooking method, and may be quite variable and difficult to quantify. Most studies in the literature regarding the loss of contaminants due to cooking have focused on PCBs and organic pesticides, and these studies have found losses ranging from 0 to 75 percent. A summary of the literature and discussion of cooking loss appears in Appendix C of the 2008 Baseline Risk Analysis.

   The HHPRC initially supported using a conservative 0.9 cooking loss factor (10th percentile loss) for organics, but the consensus was to rely on the results of the Trihalomethane (THM) cooking loss study conducted by FDEP. FDEP completed the cooking loss study data and determined that there was not a statistically significant reduction in THMs due to cooking, and as such, FDEP concluded that a cooking loss term should not be included (the report was subsequently distributed to the HHPRC for comment).
5. When calculating risks associated with Class I HHC, it was assumed that all drinking water and fish consumed were from Class I waters. In fact, an individual consuming drinking water from a Class I water body might obtain a significant fraction of their fish from Class III waters, which have higher HHC. As such, the approach used could result in an underestimate of contaminant intake from fish for those individuals.
6. This analysis calculated risks associated with individual chemicals at their HHC concentrations. It is conceivable that exposure could occur to more than one contaminant at the same time, and that these contaminants could produce a cumulative or even synergistic toxicity. Many of the contaminants under consideration affect the same organ (typically the liver) and thus cumulative effects are more likely (see **Appendix C**). A

chemical-by-chemical assessment of risk, as conducted in this analysis, could underestimate risks from more than one chemical in combination.

7. Risks to children were qualitatively addressed. The Degner *et al*. (1994) study showed that children consumed less fish at home than adults on an absolute weight basis, but on a per kilogram body weight basis, the risk estimates could be higher than those calculated for adults. Also, there is reason to suspect that drinking water ingestion rates for children, per unit body weight, are greater than adults. Considering both pathways (fish ingestion and, for Class I waters, drinking water ingestion), it is possible that the risk distributions derived for adults underestimate risks for children. However, the risk assessments are meant to represent lifetime exposures, and EPAs default RfDs and CSFs were developed based on assumptions of lifetime exposure, unless early life developmental effects were identified as the most sensitive end-point. EPA considers early life effects when developing RfD values. If insufficient data exist to characterize these risks, EPA applies an uncertainty factor of 3 or 10 and reduces the RfD to ensure full protection of children.
8. The November 2012 Draft of this report clearly demonstrated that available Florida fish stocks were insufficient to sustain the assumed fish consumption rate over the entire population. These rates can only be sustained through significant importation. However, there are likely to be groups of individuals, many living in coastal areas that have access to and make the choice to consume all their seafood obtained from local waters. These people may either catch almost all of their own fish or purchase Florida seafood from the numerous retailers that feature "Fresh from Florida" seafood (http://www.freshfromflorida.com/Divisions-Offices/Marketing-and-Development/Agriculture-Industry/Join-Fresh-From-Florida). The proposed criteria presented in this document were derived with an assumption that all consumed seafood were obtained from local waters with a lipid profile consistent with native fish. Therefore, the criteria are clearly protective of the population of Florida freshwater and estuarine fish consumers.

   The criteria are more than sufficiently stringent for the general population who may only occasionally consume Florida seafood. Therefore, the risks presented herein actually overstate the risk of adverse health risks to the general Florida population. Most individuals will have a substantially lower risk level. The actual risk experienced by individual consumers is dependent on their particular balance of Florida and imported seafood as well as the level of contamination in imported products. Note: risk associated with imported seafood is assumed to be controlled by regulations in place in the State of origin and through FDA inspections programs.
9. As recently clarified by EPA, the goal of human health-based water quality criteria is to allow individuals the opportunity to safely consume, from local waters, the amount of fish they would normally consume from all fresh and estuarine waters. To achieve this goal, an assumption is made that the distribution of all freshwater and estuarine fish is representative of this group regardless of the seafood source (*i.e*., state waters, interstate waters, international importation, or aquaculture). The assumption is based on the idea that most individuals will typically eat the same amount of similar (with regard to habitat and taste) fish species regardless of source and that there are groups within the overall population who choose to eat exclusively or primarily locally caught fish. Additionally,

individuals may, for various reasons, choose to replace imported fish with local fish; for example, and eat only "Fresh from Florida" seafood.

6 Conclusions

With expert input provided by the HHPRC (see **Appendix A**) and EPA, FDEP developed proposed human health criteria for 80 (79 in Class III) parameters using an approach that builds on the 2008 Baseline Risk Analysis and specifically addresses 43 (40 in Class III) parameters currently listed in Rule 62.302.530, F.A.C., and an additional 39 (37 in Class I) proposed as new criteria for chemicals listed by EPA as priority pollutants. As noted in Section 1.4, FDEP considered adding criteria for all of the priority pollutants, but decided not to add criteria for banned pesticides or parameters for which current toxicological data does not support criteria revision at this time.

FDEP evaluated the methods available to derive HHC and concluded that the probabilistic approach, which uses distributions of inputs that are representative of the target population(s), produces the most accurate and thorough assessment. The probabilistic approach provides an estimation of the risk to the entire population and can be used to develop criteria at a pre-specified risk level as opposed to an assumed high level of protection produced by the deterministic approach. For non-carcinogens, the protective criteria were derived by running the probabilistic analysis (Monte Carlo) to calculate surface water criteria (Equations 2-1 and 2-2), and then setting the criterion at the 10th percentile of the Monte Carlo calculated results. For carcinogens, protective criteria were derived by iteratively conducting the probabilistic risk analysis until the target risk was achieved at the arithmetic mean of the distribution.

All proposed criteria meet the target risk levels for the general adult population. Additionally, risk analyses indicate that Florida's high risk individuals (*i.e.*, high-end consumers of fish and drinking) will still be protected at better than the 10^{-4} level for carcinogens, and in fact, they will be protected at better than 10^{-5}. The mean 99th percentile cancer risk is $5.1 \cdot 10^{-6}$, with a maximum of $8.3 \cdot 10^{-6}$ (Table F-3).

Furthermore, there is still considerable conservatism built into the criteria. For example, EPA applies multiple uncertainty factors to lower the reference dose (RfD), which reduces the RfD by several orders of magnitude. A very small segment of the population may potentially exceed the target risks, due to high level exposure, but it is highly unlikely that they will actually exceed doses that will result in an adverse health effect given the remaining conservatism associated with the RfD. Therefore, FDEP has concluded that the proposed water quality criteria are highly protective of human health.

7 References

Arnot, J.A., and A.P.C. Gobas. 2006. A review of bioconcentration factor (BCF) and bioaccumulation factor (BAF) assessments for organic chemicals in aquatic organisms. Environmental Reviews 14(4):257–297.

CEHT (University of Florida Center for Environmental & Human Toxicology). 2008. Final Baseline Risk Analysis for Chapter 62-302, F.A.C. University of Florida, Gainesville, Fl.

Crump, K.S. 1994. Risk of benzene-induced leukemia: A sensitivity analysis of the pliofilm cohort with additional follow-up and new exposure estimates. Journal of Toxicology and Environmental Health 42(2):219–242.

Degner, D.L., C.M. Adams, S.D. Moss, and S.K. Mack. 1994. Per Capita Fish and Shellfish Consumption in Florida. Florida Agricultural Market Research Center, University of Florida, Gainesville, FL.

Environment Canada. 2006. Bioaccumulation Canada. In The OECD QSAR Toolbox, Version 3.3.2. An online database. Retrieved January 5, 2015. Organisation for Economic Co-operation and Development, Paris, France. http://www.oecd.org/chemicalsafety/risk-assessment/theoecdqsartoolbox.htm.

Fan, A.M. and G.V. Alexeff. 1999. Public Health Goal for 1,2-Dichloropropane in Drinking Water. Office of Environmental Health Hazard Assessment, California EPA, Available from: http://oehha.ca.gov/water/phg/pdf/12dcp_f.pdf.

Florida RBPC (Risk-Based Priority Council). 1996. Guidelines for Risk Analyses undertaken in conjunction with Rule-making. Final Report.

Gobas FAPC. 1993. A model for predicting the bioaccumulation of hydrophobic organic chemicals in aquatic food-webs: Application to Lake Ontario. Ecol Mod 69:1-17.

Halmes, N. C., K. M Portier, and R. C. James. 1999. Risk Impact Analysis Plan for Chapter 62-302, F.A.C: Florida Department of Environmental Protection, Tallahassee, FL.

Heywood, R., R.J. Sortwell, and P.R.B. Noel. 1979. Safety Evaluation of Toothpaste containing Chloroform: III. Long-term Study in Beagle Dogs. *J Environ Pathol Toxicol* 2:835-851.

Infante, P.F., R.A. Rinsky, J.K. Wagoner, and R.J. Youg. 1977. Leukemia in benzene workers. Lancet 2:76-78.

Neff, J.M. 2002. Bioaccumulation in Marine Organisms: Effect of Contaminants from Oil Well Produced Water. Battelle, Coastal Resources and Environmental Management, Duxbury, MA.

OECD (Organization for Economic Cooperation and Development). 1981. Guidelines for testing of chemicals. Carcinogenicity studies. No. 451. Paris, France.

Paustenbach, D.J., R.D. Bass, and P. Price. 1993. Benzene toxicity and risk assessment, 1972–1992: Implications for future regulation. Environmental Health Perspectives Supplements 101(6):177–200.

Portier K., J. Tolson, and S. Roberts. 2007. Body weight Distributions for Risk Assessment. *Risk Anal* 27(1):11−26.

Rinsky, R.A., R.J. Young, and A.B. Smith. 1981. Leukemia in benzene workers. American Journal of Industrial Medicine 2(3):217–245.

Rinsky, R.A., A.B. Smith, R. Horning, T.G. Filloon, R.J. Young, A.H. Okun, and P.J. Landrigan. 1987. Benzene and leukemia: An epidemiologic risk assessment. The New England Journal of Medicine 316:1044–1050.

Sullivan, A.L, and W.S. Otwell. 1992. A Nutrient Database for Southeastern Seafoods. A Comprehensive Nutrient and Nomenclature Handbook for Selected Southeastern Species, Florida Sea Grant Program, University of Florida, 1992.

Tooze, J.A., Midthune, D., Dodd, K.W., Freedman, L.S., Krebs-Smith, S.M., Subar, A.F., Guenther, P.M., Carroll, R. J., Kipnis, V. 2006. A New Statistical Method for Estimating the Usual Intake of Episodically Consumed Foods with Application to their Distribution. *J Am Diet Assoc*. 106(10):1575-87.

U.S. EPA. (United States Environmental Protection Agency). 1998. Carcinogenic effects of benzene: an update. Prepared by the National Center for Environmental Health, Office of Research and Development. Washington, DC. EPA/600/P-97/001F.

USEPA. (United States Environmental Protection Agency). 1998B. Health effects test guidelines: OPPTS 870.4300 combined chronic toxicity/carcinogenicity. Office of Prevention, Pesticides and Toxic Substances, Washington, DC. EPA/712/C-98/212.

USEPA. (United States Environmental Protection Agency). 1999. Extrapolation of the benzene inhalation unit risk estimate to the oral route of exposure. National Center for Environmental Health, Office of Research and Development. Washington, DC. NCEA-W-0517.

USEPA. (United States Environmental Protection Agency). 2000A. Benzene (CASRN 71-43-2). Integrated Risk Information System. Carcinogenicity assessment Agency consensus date January 3, 2000. U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC. Accessed May 2016. https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=276.

USEPA. (United States Environmental Protection Agency). 2000B. Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health. EPA-822-B-00-004. Office of Water, Washington, DC.

USEPA. (United States Environmental Protection Agency). 2002. National Recommended Water Quality Criteria: 2002, Human Health Criteria Calculation Matrix. EPA-822-R-02-012. Office of Water, Washington, DC.

USEPA. (United States Environmental Protection Agency). 2003A. Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health 2000, Technical Support Document. Vol. 2, Development of National Bioaccumulation Factors. EPA-822-R-03-030. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington, DC. https://www.epa.gov/wqc/human-health-water-quality-criteria

USEPA. (United States Environmental Protection Agency). 2003B. Memorandum: Human Health Toxicity Values in Superfund Risk Assessments. OSWER Directive 9285.7-53.

USEPA. (United States Environmental Protection Agency). 2005. Guidelines for Carcinogen Risk Assessment. Risk Assessment Forum, Washington, DC. EPA/630/P-03/001F. Available at http://www.epa.gov/cancerguidelines/

USEPA. (United States Environmental Protection Agency). 2006. Human Health Assessment, Methyl Bromide. Office of Pesticide Programs, Health Effects Division, Washington, DC.

USEPA. (United States Environmental Protection Agency). 2009. Toxicological Review of Thallium and Compounds. Integrated Risk Information System (IRIS), National Center for Environmental Assessment, Washington, DC. Available online at http://www.epa.gov/iris.

USEPA. (United States Environmental Protection Agency). 2011. Exposure Factors Handbook: 2011 Edition. EPA/600/R-090/052F. Office of Research and Development, Washington, DC.

USEPA. (United States Environmental Protection Agency). 2014. Estimated Fish Consumption Rates for the U.S. Population and Selected Subpopulations (NHANES 2003-2010), Final Report. EPA-820-R-14-002

USEPA. (United States Environmental Protection Agency). 2016. Development of National Bioaccumulation Factors: Supplemental Information for EPA's 2015 Human Health Criteria Update. Office of Water, Office of Science and Technology, Washington, DC. EPA 822-R-16-001.

Weaver, K. and K. Summerfield. 2014. (DRAFT) Appendix D. Relative Source Contribution (RSC) Derivation for Non-carcinogenic Parameters Evaluated for Chapter 62-302, FAC Human Health Criteria Revision. Florida Department of Environmental Protection, Tallahassee, FL.

Yates, K.K., H. Greening, and G. Morrison. 2011. Integrating Science and Resource Management in Tampa Bay, Florida. U.S. Geological Survey, Reston, VA.

Appendix A. Human Health-Based Peer Review Committee Consensus Report

Human Health Peer Review Committee:

Discussion of Charge Questions

October 8 and 9, 2012

Florida Dept. Environmental Protection

The Human Health Peer Review Committee (HHPRC) panelists included Dr. Elizabeth Doyle (US Environment Protection Agency Office of Water), Dr. Kendra Goff (Florida Dept. of Health), Dr. Raymond Harbison (University of South Florida), Dr. Dale Hattis (Clark University), Dr. Charles Jagoe (Florida Agricultural and Mechanical University), Dr. Susan Klasing (California Environment Protection Agency), and Dr. Chris Teaf (Florida State University).

In preparation for the meeting, the panelists reviewed FDEP's Human Health Criteria Technical Support Document and the public comments/questions submitted to FDEP on the issue. They received these charge questions in advance of the meeting and were prepared to express their expert opinion on each topic. The meeting moderator was Dr. Stephen Roberts (UF). After the meeting, the panelists reviewed this document and provided final input.

I) Application of a probabilistic approach, rather than a deterministic approach.

1) *The Florida Department of Environmental Protection (Department or FDEP) used a probabilistic approach to develop criteria at a specified risk level to provide protection to Florida residents. Do you agree that this approach represents an improvement over the standard deterministic approach?*

   The panel agreed that use of the probabilistic approach was generally superior to the deterministic approach, with the following additional discussion:

   - FDEP should clearly express the goals of the analysis. FDEP subsequently stated that the goal was to develop water quality criteria that ensured protection of Florida residents to a specified level of risk for carcinogens (10^{-6} for the general population

and 10 $^{-5}$ for high risk [90th percentile] Floridians), and for the 90th percentile of the population to not exceed the reference dose for non-carcinogens. The targeted protection is from risk posed by waters regulated under surface water standards, specifically freshwaters and near shore marine waters.
- The probabilistic approach could theoretically be applied to uncertainty factors associated with the reference dose or cancer slope factors and to estimates of human sensitivity. However, the panel agreed that, while this was a good idea, additional research would be needed before Florida could incorporate these concepts in standards.

Consensus: Use of the probabilistic approach was superior to the deterministic approach where appropriate data are available.

2) *Do you have any other input on how to strike an adequate balance between reducing excessive conservatism with the need to protect Floridians from adverse health effects over a lifetime?*

During the discussion, panelists offered the following opinions:

- The assessment should be consistent with other FDEP risk management decisions and policies.
- A member suggested an approach in which the likelihood of both cancer and non-cancer effects are considered in probability terms, and protection is defined as a specific probability of real harm within a specified confidence interval (*e.g.*, 1 in 100,000 chance of a significant adverse effect with 95th percentile confidence). This approach would require fundamental revision in the way that reference doses are used [it was pointed out that standard reference doses may be too high to meet such a definition]. After further discussion, the panel concluded that this approach was not widely accepted and its application to revision of Chapter 62-302 would be premature.
- There should be flexibility on what constitutes negligible risk, noting that the Department of Health uses an incremental increase of cancer risk of 10 $^{-5}$ when issuing fish consumption advisories, assuming one eight ounce meal per week (32 g/day).
- If the water quality criterion corresponding to an incremental increase of cancer risk of 10 $^{-6}$ for the general population (*i.e.*, at the 50th percentile) was similar to the criterion corresponding to an incremental risk of 10 $^{-5}$ for high risk Floridians (*i.e.*, at the 90th percentile), the risk management decision would be essentially the same. Determining this “adequate balance” is a policy/risk management choice.

Consensus: In conclusion, the group’s opinion included: 1) that excessive conservatism could be reduced by using data distributions, where possible, 2) that a management decision could be based on incremental increase of cancer risk of 10 $^{-6}$ at the 50th percentile as long as 90th percentile Floridians were protected at 10 $^{-5}$, and 3) that a probability of adverse effect approach for non-cancer effects was not widely accepted.

II) *Toxicological input variables for individual parameters*

1) *The Department relied on toxicological information in IRIS. Is this the most recent information available? If you are aware of more recent data that the Department should consider, has it been peer reviewed in a manner similar to the IRIS process, and can you articulate why it would be adequate for use in deriving water quality criteria?*

   Panelists stated:

   - The toxicity data source should be better specified in the TSD, as data from some compounds (*e.g.*, dichloropropane, benzene, thallium, chloromethane) did not appear to originate from IRIS.
   - California EPA, ATSDR, Health Canada, and the Netherlands government have more recent information than IRIS for some parameters, and use of this information potentially could be acceptable to EPA and FDEP with proper documentation. A hierarchy of toxicological references should be developed to guide FDEP's toxicological input variable selection.
   - California EPA, Office of Environmental Health Hazard Assessment (OEHHA), has developed a new (2010) cancer slope factor for benzo[a]pyrene that includes an age-dependent adjustment factor (ADAF). It is included in the Public Health Goal (PHG) for benzo[a]pyrene and can be found, with supporting information:
     - http://oehha.ca.gov/water/phg/091610phgs.html
     - http://oehha.ca.gov/media/downloads/water/chemicals/phg/091610benzopyrene.pdf
   - Information on other PHGs and reference exposure levels are found at:
     - http://oehha.ca.gov/water/phg/allphgs.html

   Consensus: The panel concluded that use of IRIS data is acceptable unless more recent, peer reviewed data (six compounds were mentioned, including thallium) are available, and that FDEP should establish a hierarchy of sources for use in criteria derivation and clearly note which source was used in the TSD.

2) *FDEP used a probabilistic approach to estimate exposure, but relied on IRIS input values for the toxicological information. Should FDEP use probabilistic methods for toxicity assumptions, and if so, how can FDEP address the uncertainty in the toxicological data, including the uncertainty factors used? Do you know of ways to quantify the degree of uncertainty in the methodology?*

   Consensus: Although technically feasible, HHPRC members did not think it was widely accepted or practical to address the uncertainty in toxicity assumptions using a probabilistic approach at this time. One member described an innovative approach, where pharmacokinetics and pharmacodynamics could be used to estimate the variability in toxicology targets for each group of non-carcinogens through a traditional probit type population dose-response relationship. The opinion of the group was that, although this idea had merit, it was beyond the scope of accepted current practices.

III*) Exposure input variables*

1) *General*

a) *The equations assume that the concentration of the parameter is present in Florida waters at the criterion concentration and that fish are constantly exposed to that concentration. How should FDEP account for the fact that there is significant spatial and temporal variability in concentrations and that some fish species move over significant distances?*

The group discussed the following points:

- Several members said they did not know how to account for spatial and temporal variability in concentrations.
- One member noted that, because fish integrate contaminants over time, a model could theoretically be established to estimate the concentration of a given contaminant in fish, as long as the fluctuations in ambient water column concentrations were known and the rate of absorption/depuration in fish were known. The model would allow a series of predictions that could be checked against empirical data. However, quantitatively addressing this question is currently too difficult given the available data.
- Another member noted that water quality criteria are designed to establish an upper bound, beyond which there is the potential for adverse effects, and the criteria should ensure that those effects are not realized. Therefore, assuming that all fish are residing in surface waters that approach/equal the maximum allowable level provides a conservative and protective method for developing water quality criteria. Excluding fish that are not freshwater or nearshore estuarine taxa is one way to address excess conservatism in this approach.
- One member noted that it would be possible to compare empirically observed concentrations of contaminants in fish with those that would be predicted using the favored steady state/constant exposure assumption. This would allow development of mean correction factors and distributions of observed/predicted fish concentrations for use in making more accurate distributional descriptions of this uncertainty. However, this was considered to be a longer term research project that would require appreciable time, funding and effort.

Consensus: Assuming fish are exposed at concentrations equal to the water quality criteria is a conservative element, but the data are not currently available to develop a quantifiable method to account for the variability in concentrations and exposure to fish. As such, the consensus was to continue to rely on this assumption as a conservative measure, but that FDEP could address this issue in permitting.

b) *When permitting dischargers, how might the Department issue an allowable mixing zone for the HH WQC that takes into account fish mobility, the potential for human exposure, and the likely frequency of human exposure?*

The discussion included the following:

- There were some questions from the HHPRC to FDEP about how limits were set in permits, and FDEP replied that mixing zones have been established for human health-based criteria on a site-specific basis, and that other States also issue such mixing zones.
- It is unlikely that fish are exclusively living near a discharge and that people exclusively fish at a discharge, so allowing mixing zones makes sense from the risk management perspective.
- The decision to grant mixing zones should be based on site-specific information.
- Subsistence fishers should be taken into account and be protected from carcinogens at the 90th percentile of the 10^{-4} additional cancer risk. The EPA uses the 99th percentile per capita fish ingestion rate for subsistence fishers as consumers for ambient water quality criteria.

Consensus: No consensus was reached regarding how to account for fish mobility, potential for human exposure and frequency of human exposure, but there was support for site-specific mixing zones from a risk management perspective.

2) *Fish Consumption Rate (Note that this question was addressed out of order.)*

a) FDEP used results from the 1994 Degner study to estimate fish consumption rates for Florida, after comparing the results to more recent studies (NHANES). Does the Degner Study represent the best available estimate of fish consumption by Floridians? If not, what consumption data would you recommend, and why? Or how could the Department adjust the Degner Study to incorporate more recent information?

Group discussion ranged as follows:

- The value of the types of data provided in the Degner study, including fish ingestion data by species, information on cooking methods, etc. was acknowledged by the panel, but there were significant concerns that the study is outdated and may not reflect current consumption rates.
- Two options for approaches FDEP could take emerged from discussions by the panel:
  - Option 1: Use the same fish consumption distribution employed by the EPA to derive their 17.5 g/day national fish consumption rate. Use current NHANES data on fish consumption to compare regional ingestion rates with national ingestion rates. If the regional ingestion rate is confirmed to be higher, use the comparison data to adjust the fish ingestion distribution used by EPA upward. Because offshore species are already excluded from the 17.5 g/day national fish consumption rate, no further adjustment for species included, landings, etc. is needed.
  - Option 2: Use a fish ingestion distribution derived from regional NHANES fish consumption data. Because these data reflect total fish consumption, adjustment in the distribution would be needed. Data from Degner *et al.* and other sources should be used to adjust consumption rates to exclude off-shore species, farm-raised fish, and imported fish (*e.g.*, through landings adjustment).

- Time permitting, the panel thought it would be useful for the FDEP to examine both approaches.
- Different opinions were expressed regarding the need to correct the fish consumption distributions to reflect annual average consumption rates given that all of the candidate fish consumption distributions are based upon consumption on only a few survey days. Opinions that a correction was important or not important were expressed.
- Some members were concerned with the assumption that all fish caught in Florida are eaten in Florida.
- The 90th percentile fish consumption rates from 2005 NHANES (for finfish, oysters, and shrimp/crabs) were used for the Deepwater Horizon evaluation, but NHANES data does not distinguish between marine and estuarine fish.
- The Degner Study does provide for species level data, but as more fish (marine fish) are excluded from the distribution, the resolution of the Degner Study is less valuable.
- A member asked about consumption rates for subsistence fishermen, and was informed that the EPA estimate is 142 g/day, with a different risk target.
- Because there are no data to indicate that Floridians are currently experiencing health problems due to inadequate water quality standards based on the 6.5 g/day consumption rate, an opinion was expressed that large adjustments are probably not necessary, making use of the national guidance (17.5 g/day) protective. Another member countered that absent a specific study designed to determine such health effects, in should not be assumed that current risks are acceptable.

Consensus: The HHPRC concluded that alternatives to the Degner Study were preferable, rather than further adjustments. The HHPRC recommended two approaches. The first would be to adjust the distribution from which the national fish consumption guidance rate (17.5 g/day) was derived using the ratio of NHANES consumption rates for the Southeast states over the National average NHANES consumption rates. The HHPRC preferred that the distribution for the adjusted national recommendation be used, rather than a point estimate, but it was not clear whether the data were available. The HHPRC acknowledged that NHANES data included offshore fish and concluded it would be difficult to make adjustments in the NHANES data directly to exclude offshore fish or to make other landings adjustments to the distribution. The second approach would be to use recent SE NHANES consumption data (distribution), and adjust the rates to exclude non-Florida fish and offshore fish using the Florida species-specific distributions in the Degner study.

b) *Do you have any comments regarding the assumptions (landings adjustment, percent non-consumers, weekly consumption probability, consumption distribution, and intra-individual variability as an auto-correlation) and approach used to translate 7-day recall survey into long-term consumption distributions? Are there any alternate statistical approaches you can suggest to better quantify fish consumption by Floridians?*

Consensus: Given that the HHPRC recommended alternatives to the Degner Study, it did not reach consensus on these issues. The alternative approaches are described in the consensus for the previous question.

c) *EPA recommends that States include fresh and estuarine fish (not marine fish) for estimates of fish consumption. FDEP selected Florida species, and excluded cod, conch, imitation crabmeat (pollock), freshwater crayfish, breaded fish fillets, fishsticks, haddock, halibut, herring, whole lobster (Homarus americanus), mussels, orange roughy, salmon, sardines, swordfish, canned tuna, and fresh tuna. However, FDEP included some species that tend to occupy high salinity areas, such as amberjack, dolphin, and grouper. Which types of fish should be included in the consumption rate? How should FDEP account for marine species that spend the majority of their lifecycle in ocean waters where concentrations of pollutants are low (or undetectable) and not directly linked to land-based sources? If so, how should the marine species be selected?*

Panelists offered the following points:

- The panel agreed that non-nearshore marine fish should be excluded.
- One member thought that offshore fish should be given some weighting since they might eat inshore prey and bioaccumulate contaminants, however, other panelists did not think this could be adequately quantified.
- Spending a small portion of the life-cycle inshore is unlikely to result in long-term retention of contaminants except for metals.
- Weighting and exclusion criteria should be transparent.

Consensus: The panelists agreed that fish that are not expected to be directly linked to Florida land based sources of contamination should be excluded (or significantly "down-weighted") from the criteria derivation process. This would include those species that spend the majority of their life cycle offshore, imported species, or those produced via aquaculture. This is important if option 2 in 2a above is pursued. Any weighting and exclusion factors should be transparent.

3) *Relative Source Contribution (RSC)*

FDEP used the EPA recommended RSC factors for non-carcinogens. Given that FDEP is currently excluding non-Florida species, which could include exclusion of marine fish, do you have any recommendations on RSCs beyond the EPA recommendations?

Are you aware of any more recent information to update the RSCs?

Panelists offered the following points:

- FDEP could attempt to take into account Florida-specific risks and exposures if data were available, but the data are not available.
- EPA designed the RSCs to be primarily address drinking water exposure, not surface waters in general, so FDEP should only apply RSCs to Class I waters.
- The maximum RSC used by the EPA is 0.8

Consensus: The panelists concluded that the EPA default RSCs are reasonable for all parameters.

4) *Exposure via Drinking Water*

Public drinking water systems that use surface waters as their source water are required to provide treatment (including filtration and chlorination), but the amount of treatment for each priority pollutant is not known and not taken into account in the derivation of the HH WQC. Do you know of any way to take this treatment into account when deriving the criteria?

Consensus: While panelists thought that data could be collected to compare input to output or pre- vs. post- treatment concentrations of contaminants in drinking water facilities, the consensus was that such data did not exist, and no statewide adjustment was currently possible. The panel did agree that contaminants that are bound to particulates (*e.g.*, PAHs) would not be expected in treated drinking water.

5) *Bioconcentration Factors (BCFs)*

FDEP used EPA-recommended BCFs. Do you know of any more recent studies that would provide updated BCFs?

Should FDEP use probabilistic methods for BCF or BAF assumptions and is there an accepted, scientifically defensible basis for doing so?

Some public comments suggested that compounds with relatively low BCF values (<100) have a limited potential for bioconcentration. Should FDEP treat compounds with low BCF values differently those with higher values and if so in what manner? Are you aware of empirical data that demonstrates that fish exposed to a compound with BCF < 100 do not accumulate the compound?

- The discussion included the lipid adjustment factor associated with the EPA BCFs, that there were no readily available alternate BCFs, and whether to adjust BCFs <100 to a value of 1. One panel member stated that the BCF values used by FDEP date back to the 1980s and that the values were standardized to a lipid content of 1th percentile and not the 3th percentile assumed by FDEP.

Consensus: FDEP should use EPA-recommended BCFs as point values (not probabilistic estimates), and use the actual BCF values, including those less than 100. After the meeting, FDEP re-reviewed the EPA-recommended BCFs, and confirmed that the original criteria were standardized to 3 percent lipid content.

6) *Dermal Absorption*

Is there sufficient scientific basis to include dermal absorption exposures for several parameters (acenaphthene, anthracene, fluoranthene, fluorene, pyrene, pentachlorophenol, total PAHs, and hexachlorobutadiene)? Do you agree with inclusion of dermal absorption factors in the empirical derivation of the criteria? Conversely, are the uncertainties associated with dermal absorption too great to justify their inclusion of *in the derivation of HH WQC? Are there other more scientifically defensible approaches that could be used to address additional exposure via dermal absorption?*

The following were discussion points:

- DOH does not use dermal absorption for fish consumption advisories due to uncertainty, and instead set the targets for beach sediments at the MDL.
- EPA applies dermal absorption for recreational (swimming) exposure, not exposure via showering.
- Several panelists thought that dermal absorption of PAHs via water is extremely unlikely and irrelevant to criteria development, and FDEP should not use dermal absorption for PAHs because they end up in sediments, not water.
- There was discussion about the fact that permeability coefficients (Kp) are outside the effective predictive model domain for the most the parameters adjusted for dermal absorption by FDEP. EPA's Risk Assessment Guidance for Superfund Sites clearly states that a risk analysis must acknowledge the uncertainty in Kp values, but also states that dermal absorption needs to be addressed. Several panelists expressed the opinion that perhaps a complete risk analysis should be conducted in the future and that the use uncertainty or adjustment factors (*e.g*., 5, 10) would be more defensible at this time for the parameters outside the effective domain.

Consensus: Because the baseline risk analysis determined that dermal exposure via swimming was significant for some chemicals, FDEP should use dermal absorption in the derivation of criteria using adjustment factors for those with Kp values outside of the effective predictive model domain (potentially, except for PAHs), but not include exposure from showering/bathing because drinking water is treated and must meet drinking water standards.

7) *Cooking Loss*

FDEP did not include a cooking loss term in the derivation of the criteria. Do you have any information that would support such a term? Should cooking loss be included in FDEP's methodology for deriving HH WQC?

- Other states use cooking loss terms from 30th percentile to 50th percentile in deriving their criteria.
- The FDEP lab shared recently collected data that indicated 20th percentile or less loss of trihalomethanes (THMs) when cooked under controlled laboratory conditions (pre- vs. post-cooking r^2 ~0.8). Because THMs are thought to be more volatile than most contaminants, these results suggest cooking loss may not be as significant as other States believed.
- The panel discussed the variability and inconsistency in the data regarding cooking loss, and therefore perhaps the data are insufficient to support a specific adjustment factor.

Consensus: While there was some initial support for using a conservative 0.9 cooking loss factor (10th percentile loss) for organics, the consensus was to rely on the results of the THM cooking loss study conducted by FDEP. FDEP has

completed its review of the cooking loss study data and determined that there was not a statistically significant reduction in THMs due to cooking, and as such, FDEP concluded that a cooking loss term should not be included. The final report will be provided to the HHPRC as soon as possible (within the next few weeks). One panelist stated a need to review the FDEP cooking loss study to ensure it was sufficient for deciding that a cooking loss factor was not needed.

IV) *Landings adjustment for fish consumption*

1) *FDEP adjusted the consumption estimates from the Degner Study to account for the fact that extrapolation of the survey results to the entire population would result in Floridians eating more fish than were actually caught in Florida during the study. Do you agree with the approach described in the TSD? Is there a way to recognize that landings data are reported as whole fish, while edible portions typically represent only 30-60th percentile of the fish by weight in the landings adjustment?*

    - Panelists agreed that Florida landings adjustments for the Degner Study were scientifically defensible, and that, if landing adjustments were needed, they should reflect only edible portions of fish (and to consider wasted food). However, as noted previously, the HHPRC recommended two alternative approaches to the Degner Study fish consumption distribution.

    Consensus: The HHPRC concluded that landings adjustments are not appropriate for the approach that adjusts the national fish consumption guidance (17.5 g/day) using a ratio derived from Southeast NHANES consumption rate to the National average NHANES consumption rate. For the second approach, which would use recent SE NHANES consumption data (distribution) and adjust it to exclude non-Florida fish and offshore fish using the Florida species specific distributions in the Degner study, the HHPRC supported application of the landings adjustment and applying reduction factors to account for the edible portions of the landings adjusted data, as well as excluding marine fish.

2) *Is there a way to account for the sustainable production of Florida waters, if it is found that consumption of Florida species is greater than the sustainable yield? If so, how should landings adjustment be modified to account for long-term sustainability?*

    - One panelist mentioned a public presentation that indicated that estimated consumption was 20 times the sustainable yield, and another panelist wondered if the calculations were correct and asked if sustainable yield data were available.

    Consensus: The panel agreed that FDEP should take into account available information about the sustainable yield when evaluating the estimated consumption rates to ensure they are realistic. This concept was implemented in Option 3 discussed above.

V) Appropriate risk levels for the general population and high risk groups

1) *In the draft TSD sent to the HHPRC, the draft criteria for carcinogens were set using a target of an increased risk of 1 x 10^{-6} for the 90^{th} percentile Floridian and the draft*

criteria for non-carcinogens were set using a hazard index (HI) of one for the 90th percentile. The Department of Health issues advisories when fish tissue concentrations exceed levels representative of a 1 X 10^{-5} risk levels. Florida Statues for remediation suggest reducing increased risk to a 1 x 10^{-6} level. Given the various levels of conservatism in the methodology, would it be appropriate to set the criteria at levels that would protect the average Floridian at 1 x 10^{-6} and ensure that at least the 90th percentile Floridian (representative of more highly exposed populations like recreational fishermen) are protected at 1 x 10^{-5}?

2) *How does the risk level compare to other States and the Florida Department of Health policies?*

   This question was skipped during the meeting, but written comments from the HHPRC were received.

   HHPRC member comments:

   - One member thought that the level should not be adjusted until a probabilistic analysis is performed to assess the expected changes in risk distributions in the population, allowing an informed policy/risk management decision.
   - Another panelist stated they were comfortable with 10 $^{-6}$ increased risk for the general population and 10 $^{-4}$ increased risk for subsistence fishers.

VI) Appropriate averaging time for the criteria.

1) *The current criteria for carcinogens are expressed as "annual means." Given that the method for derivation of the criteria for carcinogens is generally described as presuming a life-time exposure (70 years), what is the appropriate averaging period associated with the criteria for carcinogens?*

   Consensus: Annual averaging is appropriate for carcinogens.

2) *In cases where the detection limit is orders of magnitude above the criteria, a single value above the MDL will greatly influence the mean value. Would it be more appropriate to express the criteria as a median value or some other expression? Are there other expressions that would account for atypical detections?*

   - One panelist noted that some programs assume the compound is not present if less than 5th percentile of the values are above the MDL.
   - If a positive result above the MDL occurs, FDEP should follow up with confirmatory testing prior to taking regulatory action.

   Consensus: This is a FDEP regulatory decision.

3) *Are there any methods to take into account lifetime residency (or the lack thereof) of Floridians when deriving HH WQC?*

   - Although the average Florida residency is 33 years, lifelong residents (70 years) should also be protected

Consensus: Can use length of residency adjustments in the derivation as long as lifelong residents are adequately protected at the 90th percentile. However, the inclusion of residency time may not be appropriate for all non-carcinogens.

4) *The criteria for non-carcinogens were previously expressed as single-sample maximums, but FDEP proposed to change the expression to monthly averages. What is the appropriate duration expression of the criteria for non-carcinogens and what factors should be considered when making that decision?*

Consensus: Monthly averaging is appropriate (and conservative) for non-carcinogens.

VII) Method Detection Limits

Many of the proposed criteria may be below method detection limits, and Florida rules (Rule 62-4.246, F.A.C.), states that values below the detection limits shall be assessed as half the MDL or half the criterion, whichever is lower. For values between the MDL and the Practical Quantification Limit (PQL), the value is set at the MDL. Do you agree with this approach or do you have alternate statistical methods to account for the effect of analytical detection limits on practical implementation of HH WQC?

Consensus: Current approach in Rule 62-4.246 is appropriate.

VIII) Overview Questions (these were not discussed during the meeting but some panelists provided written comments)

1) *Is the proposed approach consistent with EPA guidance, with appropriate modifications to ensure adequate protection for Florida's residents?*

Some panelists answered "yes" and some did not comment in writing. One member stated that the TSD must be well organized and transparent with regard to assumptions and their application in the assessment, and that FDEP should consider a summary table that clearly lists the assumptions used and the rationale for each major input into the assessment.

2) *Did FDEP adequately address issues of uncertainty when deriving the HH WQC?*

Some panelists answered that use of the probabilistic approach largely addresses this issue and some did not comment in writing.

3) *Are there any Florida-specific conditions not in the current proposed approach that that need to be considered during derivation of the HH WQC, and if so, how?*

Some panelists answered that they knew of no additional information that would improve Florida's approach and some did not comment in writing.

Appendix B. Human Health-Based Water Quality Criteria: Chemical Classes and Uses.

Parameter	CAS	Also Known As	Chemical Formula	Chemical Class	Uses
1,1,1-Trichloroethane	71-55-6	Methyl chloroform	$C_2H_3Cl_3$	Chlorinated Hydrocarbon (Chlorinated alkane)	As a solvent for removing grease from machined metal products, in textile processing and dyeing and in aerosols.
1,1,2,2-Tetrachloroethane	79-34-5	Acetylene tetrachloride	$C_2H_2Cl_4$	Chlorinated Hydrocarbon (Chlorinated alkane)	As a refrigerant (R-130), solvent, an intermediate in production of other chemicals, used in pesticides (fumigant).
1,1,2-Trichloroethane	79-00-5		$C_2H_3Cl_3$	Chlorinated Hydrocarbon (Chlorinated alkane)	As a solvent, an intermediate in production of other chemicals.
1,1-Dichloroethylene	75-35-4	DCE; 1,1 DCE; Vinylidene chloride 1,1 Dichloroethene	$C_2H_2Cl_2$	Chlorinated Hydrocarbon (Chlorinated alkene)	Used in making adhesives, synthetic fibers, refrigerants, plastic wraps.
1,2,4-Trichlorobenzene	120-82-1	TCB; trichlorobenzene	$C_6H_3Cl_3$	Chlorinated Aromatic Hydrocarbon (Chlorinated benzene)	Dye carrier in textile industry, an intermediate to make herbicides, solvent, dielectric fluid, degreaser and lubricant. It used to be used as a soil treatment for termite control.
1,2-Dichlorobenzene	95-50-1		$C_6H_4Cl_2$	Chlorinated Aromatic Hydrocarbon (Chlorinated benzene)	An intermediate in synthesis of agricultural chemicals (herbicides), a solvent, making dyes, degreaser, coolant, deodorizer.
1,2-Dichloroethane	107062		$C_2H_4Cl_2$	Chlorinated Hydrocarbon (Chlorinated alkane)	Making chemicals involved in plastics, rubber, and synthetic textile fibers. Other uses include: as a solvent for resins and fats, photography, photocopying, cosmetics, drugs, and as a fumigant for grains and orchards.

Parameter	**CAS**	**Also Known As**	**Chemical Formula**	**Chemical Class**	**Uses**
1,2-Dichloropropane	78-87-5		$C_3H_6Cl_2$	Chlorinated Hydrocarbon (Chlorinated alkane)	The greatest use of 1,2-dichloropropane is as a chemical intermediate in the production of carbon tetrachloride and perchloroethylene, lead scavenger for antiknock fluids, solvent. Other uses have included: ion exchange resin manufacture, paper coating, scouring, spotting, metal degreasing agent, soil fumigant for nematodes, and insecticide for stored grain.
1,2-Diphenylhydrazine	122-66-7		$C_{12}H_{12}N_2$	Hydrazine	Once used in fabric dyes but now is only used to make certain medicines.
1,3-Dichlorobenzene	541-73-1		$C_6H_4Cl_2$	Chlorinated Aromatic Hydrocarbon (Chlorinated benzene)	Used in the production of herbicides, insecticides, pharmaceuticals, and dyes; however, its uses in registered pesticides have been cancelled.
1,3-Dichloropropene	542-7-56		$C_3H_4Cl_2$	Pesticide (Chlorinated Hydrocarbon - Chlorinated alkene)	Mainly in farming as a pesticide.
1,4-Dichlorobenzene	106-46-7		$C_6H_4Cl_2$	Chlorinated Aromatic Hydrocarbon (Chlorinated benzene)	Used to control moths, molds, and mildew. It is also utilized as a disinfectant.
2,4,6-Trichlorophenol	88-06-2		$C_6H_3Cl_3$	Chlorinated Aromatic Hydrocarbon (Chlorinated benzene)	No longer used in the United States. Previously used as an antiseptic; a pesticide for wood, leather, and glue preservation; and as an anti-mildew treatment. It was also used in the manufacture of other chemicals.

Parameter	CAS	Also Known As	Chemical Formula	Chemical Class	Uses
2,4-Dichlorophenol	120-83-2		$C_6H_4Cl_2O$	Chlorinated Phenol	Has been used in the synthesis of phenoxy acid herbicides, including 2,4-dichlorophenoxyacetic acid (2,4-D) and 2,4,5-trichlorophenoxyacetic acid. It can also be formed as a byproduct during the manufacturing of various chlorinated chemicals, the chlorination processes involving water treatment and wood pulp bleaching, and from the incineration or combustion of municipal solid waste, coal, and wood.
2,4-Dimethylphenol	105-67-9		$C_8H_{10}O$	Cresol	In making pharmaceuticals, insecticides, fungicides, dye stuffs, rubber chemicals, plastics.
2,4-Dinitrophenol	51-28-5		$C_6H_4N_2O_5$	Phenolic Compound	In the manufacture of dyes and wood preservatives, as a pesticide, and as an indicator for the detection of potassium and ammonium ions.
2,4-Dinitrotoluene	121-14-2		$C_7H_6N_2O_4$	Aromatic Hydrocarbon	Intermediate in the manufacture of polyurethanes. Also used for the production of explosives, for which it is a gelatinizing and waterproofing agent. An intermediate in dye processes and in smokeless gunpowders.
2-Chloronaphthalene	91-58-7		$C_{10}H_7Cl$	Chlorinated Aromatic Hydrocarbon	Solvent, wood preservative, immersion oil for testing refractive index and as additives in cable insulation, engine oil, electroplating compounds and capacitors. Used in producing dyes.
2-Chlorophenol	95-57-8		$C_6H_4Cl_2O$	Chlorinated Phenol	Intermediate in production of other chemicals.
2-methyl-4,6-dinitrophenol	534-52-1		$C_7H_6N_2O_5$	Pesticide (Cresol)	Insecticide, fungicide, herbicide, defoliant.

Parameter	CAS	Also Known As	Chemical Formula	Chemical Class	Uses
3,3'-Dichlorobenzidine	91941		$C_{12}H_{10}Cl_2N_2$	Aromatic amine	Used in the past in the production of dyes and pigments; it is no longer used to manufacture dyes in the United States.
4,4'-DDT (Dichlorodiphenyl trichloroethane)	50-29-3		$C_{14}H_9Cl_5$	Pesticide	Pesticide - banned
Acenaphthene	83-32-9		$C_{12}H_{10}$	Polycyclic Aromatic Hydrocarbon (PAH)	Used to make dyes, plastics, and pesticides.
Acrolein	107-02-8	Acrylic aldehyde	C_3H_4O	Aldehyde	Used as a pesticide to control algae, weeds, bacteria, and mollusks. It is also used to make other chemicals.
Acrylonitrile	107-13-1	Vinylcyanide	C_3H_3N	Nitrile	Primarily used in the manufacture of acrylic and modacrylic fibers. Also used as a raw material in the manufacture of plastics (acrylonitrile-butadiene-styrene and styrene-acrylonitrile resins), adiponitrile, acrylamide, and nitrile rubbers and barrier resins.
Aldrin	309-00-2		$C_{12}H_8Cl_6$	Pesticide	Soil insecticide to control root worms, beetles, and termites. Not used in the US.
Anthracene	120-12-7		$C_{14}H_{10}$	PAH (Polycyclic aromatic hydrocarbon)	In the production of the red dye alizarin and other dyes.
Antimony	7440-36-0		Sb	Metal	Primary use is in antimonial lead. Other uses of antimony alloys are for solder, sheet and pipe, bearing metals, castings, and type metal. Antimony oxides (primarily antimony trioxide) are used as fire retardants for plastics, textiles, rubber, adhesives, pigments, and paper.

Parameter	CAS	Also Known As	Chemical Formula	Chemical Class	Uses
b-BHC (b-hexachlorocyclohexane)	319-85-7	b-HCH	$C_6H_6Cl_6$	Pesticide	Byproduct in the production of the pesticide Lindane, found in Lindane.
Benzene	71-43-2		C_6H_6	Aromatic Hydrocarbon	As a constituent in motor fuels; as a solvent for fats, waxes, resins, oils, inks, paints, plastics, and rubber; in the extraction of oils from seeds and nuts; and in photogravure printing. It is also used as a chemical intermediate. Benzene is also used in the manufacture of detergents, explosives, pharmaceuticals, and dyestuffs.
Benzidine	92-87-5	Diphenylamine	$C_{12}H_{12}N_2$	Aromatic amine	To produce dyes for cloth, paper, and leather. It is no longer produced or used commercially in the U.S.
Benzo(a)anthracene	56-55-3	BA, Benz[a]anthracene, 1,2-benzanthracene, tetraphene	$C_{18}H_{12}$	Polycyclic Aromatic Hydrocarbon	Formed as a result of incomplete combustion of organic materials.
Benzo(a)pyrene	50-32-8	Benzo[d,e,f]chrysene, 3,4-benzopyrene, Benz[a]pyrene	$C_{20}H_{12}$	Polycyclic Aromatic Hydrocarbon	Formed as a result of incomplete combustion of organic materials.
Benzo(b)fluoranthene	205-99-2	2,3-benzofluoranthene, 3,4-benzofluoranthene	$C_{20}H_{12}$	Polycyclic Aromatic Hydrocarbon	Formed as a result of incomplete combustion of organic materials.
Benzo(k)fluoranthene	207-08-9	8,9-benzofluoranthene	$C_{20}H_{12}$	Polycyclic Aromatic Hydrocarbon	Formed as a result of incomplete combustion of organic materials.
Beryllium	7440-41-7		Be	Metal	Applications in electrical components, tools, structural components for aircraft, missiles, and satellites, and other metal-fabricating uses. Also used in consumer products, such as televisions, calculators, and personal computers.

Parameter	**CAS**	**Also Known As**	**Chemical Formula**	**Chemical Class**	**Uses**
Bis(2-Chloroethyl)ether	111-44-4	BCEE		Ether	Mainly used as a chemical intermediate to make pesticides, but some of it is used as a solvent and cleaner.
Bis(2-Chloro-1-Methylethyl) EtherBis(2-chloroisopropyl)ether	108-60-1		$C_6H_{12}Cl_2O$	Ether	Mainly used as a chemical intermediate to make pesticides, but some of it is used as a solvent and cleaner.
Bis(2-Ethylhexyl) Phthalate	117-81-7	BEHP	$C_{24}H_{38}O_4$	Phthalate ester	In the production of polyvinyl chloride (PVC).
Bromoform	75-25-2	Tribromomethane	$CHBr_3$	Trihalomethane (THM)	Fluid for mineral ore separation in geological tests, as a laboratory reagent, and in the electronics industry in quality assurance programs. Principal route of human exposure to bromoform is from drinking water that has been disinfected with chlorine, bromine, or bromine compounds. Bromoform was formerly used as a solvent for waxes, greases, and oils, as an ingredient in fire-resistant chemicals and in fluid gauges. It has also been used as an intermediate in chemical synthesis, as a sedative, and as a cough suppression agent.
Butylbenzyl Phthalate	85-68-7	BBP	$C_{19}H_{20}O_4$	Phthalate ester	Plasticizer in plastics used primarily in vinyl tiles, also in food conveyer belts, artificial leather, automotive trim, and traffic cones.
Carbon tetrachloride	56-23-5	Tetrachloro-methane, Freon 10	CCl_4	Chlorinated Hydrocarbon (Halomethane)	Was produced in large quantities to make refrigerants and propellants for aerosol cans, as a solvent for oils, fats, lacquers, varnishes, rubber waxes, and resins.

Parameter	CAS	Also Known As	Chemical Formula	Chemical Class	Uses
Chlordane	57-74-9	Ortho	$C_{10}H_6Cl_8$	Pesticide	Used as a pesticide in the United States from 1948 to 1988. In 1988, all approved uses of chlordane in the United States were canceled.
Chlorobenzene	108-90-7	Benzene chloride	C_6H_5Cl	Chlorinated Aromatic Hydrocarbon (Chlorinated benzene)	Primary uses are as a solvent for pesticide formulations, diisocyanate manufacture, and degreasing automobile parts and for the production of nitrochlorobenzene.
Chlorodibromomethane	124-48-1	Dibromochloro-methane	$CHBr_2Cl$	Trihalomethane (THM)	Used mainly as laboratory reagents. Most of the bromoform and dibromochloromethane that enters the environment is formed as byproducts when chlorine is added to drinking and waste water to kill bacteria.
Chloroform	67-66-3	TCM, Freon 20	$CHCL_3$	Trihalomethane (THM)	Majority produced in the United States is used to make HCFC-22. The rest is produced for export and for miscellaneous uses. May be released to the air from a large number of sources related to its manufacture and use, as well as its formation in the chlorination of drinking water, wastewater, and swimming pools.
Chloromethane	74-87-3	Methyl chloride Freon 40	CH_3Cl	Chlorinated Hydrocarbon (Halomethane)	Used mainly in the production of silicones where it is used to make methylate silicon. Also used in the production of agricultural chemicals, methyl cellulose, quaternary amines, and butyl rubber and for miscellaneous uses including tetramethyl lead.
Chlorophenoxy Herbicide (2,4-D)	94-75-7	2,4-dichlorophenoxyacetic acid	$C_8H_5Cl_2O_3(C_2H_7N)$	Herbicide	Used in agriculture and forestry; It is a selective herbicide which kills broad-leaved plants, but not grasses or conifers

Parameter	CAS	Also Known As	Chemical Formula	Chemical Class	Uses
Chlorophenoxy Herbicide (2,4,5-TP) [Silvex]	93-72-1		$C_9H_7Cl_3O_3$	Herbicide	The greatest use was as a postemergence herbicide for control of woody plants and broadleaf herbaceous weeds; also had aquatic uses to control weeds in ditches and waterways. All registered uses have been cancelled in the U. S. since Jan. 2nd 1985.
Chrysene	218-01-9	1,2-benzophenanthrene, benz[a]phenanthrene	$C1_8H_{12}$	Polycyclic Aromatic Hydrocarbon	Formed as a result of incomplete combustion of organic materials.
Cyanide	57-12-5		CN^-	Chemical group consisting of one atom of carbon connected to one atom of nitrogen by three molecular bonds	Steel, electroplating, mining, and chemical industries, established in uses as insecticides and fumigants, manufacture of synthetic fibers, various plastics, dyes, pigments, and nylon; can be found naturally in some foods
Dibenzo(a,h)anthracene	53-70-3	DBA, Dibenz[a,h]anthracene	$C_{22}H_{14}$	Polycyclic Aromatic Carbon	Formed as a result of incomplete combustion of organic materials.
Dichlorobromomethane	75-27-4	Bromodichloro-methane	$CHBrCl_2$	Trihalomethane (THM)	In laboratories or to make other chemicals. Most is formed as a by-product when chlorine is added to drinking and waste water to kill bacteria.
Dieldrin	60-57-1		$C_{12}H_8Cl_6O$	Pesticide	An insecticide and a by-product of the pesticide Aldrin.
Diethyl phthalate	84-66-2		$C_{12}H_{14}O_4$	Phthalate ester	Used to make plastics more flexible. Products in which it is found include

Parameter	**CAS**	**Also Known As**	**Chemical Formula**	**Chemical Class**	**Uses**
					toothbrushes, automobile parts, tools, toys, and food packaging.
Dimethyl phthalate	131-11-3		$C_{10}H_{10}O_4$	Phthalate ester	Used in solid rocket propellants, lacquers, plastics, safety glasses, rubber coating agents, molding powders, insect repellants, and pesticides.
Di-n-Butyl phthalate	84-74-2	DBP	$C_{16}H_{22}O_4$	Phthalate ester	Added to hard plastics to make them soft.
Endosulfan	(α)=959-98-8 (β)=33213-65-9		$C_9H_6Cl_6O_3S$	Pesticide	A pesticide to control insects on food and non-food crops and as a wood preservative. Registration has been cancelled and it is being phased out. A mixture of two isomers, alpha and beta Endosulfan.
Endosulfan sulfate	1031-07-8			Pesticide	A reaction product found in technical endosulfan.
Endrin	72-20-8		$C_{12}H_8Cl_6O$	Pesticide	A pesticide to control insects, rodents, and birds. It has not been produced or sold for general use in the US since 1986.
Endrin aldehyde	7421-93-4			Pesticide	An impurity and breakdown product of endrin, or endrin ketone, which is a product of endrin when it is exposed to light.
Ethylbenzene	100-41-4		C_8H_{10}	Aromatic Hydrocarbon	Primarily in the production of styrene. It is also used as a solvent, as a constituent of asphalt and naphtha, and in fuels.
Fluoranthene	206440		$C_{16}H_{10}$	PAH (Polycyclic aromatic hydrocarbon)	Found as a product of combustion.

Parameter	CAS	Also Known As	Chemical Formula	Chemical Class	Uses
Fluorene	86-73-7		$C_{13}H_{10}$	PAH (Polycyclic aromatic hydrocarbon)	Obtained from coal tar. Like most PAHs, fluorene is used to make dyes, plastics and pesticides.
gamma-BHC (Lindane)	58-89-9	gamma-HCH (gamma hexachloro cyclohexane)	$C_6H_6Cl_6$	Pesticide	Restricted in 1983, currently used primarily for treating wood-inhabiting beetles and seeds. It is also used as a dip for fleas and lice on pets, and livestock, for soil treatment, on the foliage of fruit and nut trees, vegetables, timber, ornamentals, and for wood protection.
Heptachlor	76-44-8		$C_{10}H_5Cl_7$	Pesticide	Restricted to controlling fire ants in power transformers.
Heptachlor epoxide	1024-57-3			Pesticide	Created when a substance called heptachlor is released to the environment and mixes with oxygen.
Hexachlorobenzene	118-74-1	Perchlorobenzene	C_6Cl_6	Pesticide	There are currently no commercial uses of hexachlorobenzene in the United States. Hexachlorobenzene was used as a pesticide until 1965 and was also used in the production of rubber, aluminum, and dyes and in wood preservation. Hexachlorobenzene is currently formed as a byproduct during the manufacture of other chemicals (mainly solvents) and pesticides.
Hexachlorobutadiene	87683		C_4Cl_6	Chlorinated Hydrocarbon (Chlorinated aliphatic diene)	To make rubber, it is used as a solvent and to make lubricants, in gyroscopes, as a heat transfer liquid, and as a hydraulic fluid.
Hexachlorocyclo-pentadiene	77474		C_5Cl_6	Chlorinated Hydrocarbon (Cyclodiene)	As a raw material in manufacturing other chemicals, including pesticides, flame retardants, resins, dyes, pharmaceuticals, plastics, etc. Hex has no end uses of its own.

Parameter	**CAS**	**Also Known As**	**Chemical Formula**	**Chemical Class**	**Uses**
Hexachloroethane	67-72-1	PCA Perchloroethanes	C_2Cl_6	Pesticide (Chlorinated Hydrocarbon - Chlorinated alkane)	In the United States, about half of the hexachloroethane is used by the military for smoke-producing devices. Another use is in pyrotechnics. Used as an anthelmintic (to destroy tapeworms) in sheep and cattle. It is also added to the feed of ruminants to prevent methanogenesis and increase feed efficiency, and it is used as an ingredient in some fungicides and insecticides. Hexachloroethane is used in metal and alloy production. Hexachloroethane has various applications as a polymer additive. It has flame-proofing qualities and increases affinity for dyes.
Indeno(1,2,3-cd)pyrene	193-39-5	Indenopyrene, IP	$C_{22}H_{12}$	Polycyclic Aromatic Hydrocarbon	Formed as a result of incomplete combustion of organic materials.

Parameter	**CAS**	**Also Known As**	**Chemical Formula**	**Chemical Class**	**Uses**
Isophorone	78-59-1		$C_9H_{14}O$	Cyclic ketone	Mainly as a solvent for concentrated vinyl chloride/acetate-based coating systems for metal cans, other metal paints, nitrocellulose finishes, and printing inks for plastics. Isophorone is also used in some herbicide and pesticide formulations and in adhesives for plastics, polyvinylchloride, and polystyrene materials. Isophorone is an intermediate in the synthesis of 3,5-xylenol, 3,3,5-trimethylcyclohexanol, and plant growth retardants.
Methyl bromide	74-83-9	Bromomethane	CH_3Br	Pesticide (Halomethane)	A soil fumigant and structural fumigant to control pests across a wide range of agricultural sectors.
Methylene chloride	75-09-2	Dichloromethane	CH_2Cl_2	Chlorinated Hydrocarbon (Halomethane)	As a solvent in paint strippers and removers; as a process solvent in the manufacture of drugs, pharmaceuticals, and film coatings; as a metal cleaning and finishing solvent in electronics manufacturing; and as an agent in urethane foam blowing. Also used as a propellant in aerosols for products such as paints, automotive products, and insect sprays. As an extraction solvent for spice oleoresins, hops, and for the removal of caffeine from coffee. However, due to concern over residual solvent, most decaffeinators no longer use methylene chloride. Approved for use as a postharvest fumigant for grains and strawberries

Parameter	**CAS**	**Also Known As**	**Chemical Formula**	**Chemical Class**	**Uses**
					and as a degreening agent for citrus fruit.
3-Methyl-4-Chlorophenol	59-50-7	4-chloro-3-methylphenol, chlorocresol, 4-chloro-m-cresol	C_7H_7ClO	Chlorinated phenol	Disinfectant and preservative, also is registered in the U.S. as an antimicrobial pesticide
Methoxychlor	72-43-5	DMDT, Marlate, Metox	$C_{16}H_{15}Cl_3O_2$	Insecticide	Used on agricultural crops and livestock, and in animal feed, barns and grain storage; effective against flies, mosquitoes, cockroaches, and a wide variety of other insects. All registered sources were cancelled in 2002 and all tolerances have been revoked.
Nitrobenzene	98-95-3		$C_6H_5NO_2$	Aromatic Hydrocarbon	The majority of nitrobenzene is used to manufacture aniline, which is a chemical used in the manufacture of polyurethane. Nitrobenzene is also used to produce lubricating oils and in the manufacture of dyes, drugs, pesticides, and synthetic rubber.
PCB	1336-36-3			Polychlorinated biphenyls (PCB)	Were used in hundreds of industrial and commercial applications including electrical, heat transfer, and hydraulic equipment; as plasticizers in paints, plastics, and rubber products; in pigments, dyes, and carbonless copy paper; and many other industrial applications.

Parameter	CAS	Also Known As	Chemical Formula	Chemical Class	Uses
Pentachlorobenzene	608-93-5		C_6HCl_5	Chlorinated hydrocarbon	Generated as a byproduct in a variety of industrial processes such as solid waste incineration and combustion of coal
Pentachlorophenol	87-86-5	PCP	C_6HCL_5O	Pesticide (Chlorinated Phenol)	Greatest use of pentachlorophenol is as a wood preservative (fungicide). Though once widely used as an herbicide, it was banned in 1987 for these and other uses, as well as for any over-the-counter sales.
Phenol	108-95-2	Carbolic acid, phenic acid, phenic alcohol	C_6H_6O	Pesticide	Both a manufactured chemical and produced naturally; used to make plastics, phenolic resins, in the manufacture of nylon and other synthetic fibers, and is also used as a disinfectant in household cleaning products and consumer products such as mouthwashes, gargles, and throat sprays. It is currently registered as a pesticide.
Pyrene	129-00-0		$C_{16}H_{10}$	PAH (Polycyclic aromatic hydrocarbon)	To make dyes, plastics and pesticides. It has also been used to make another PAH called benzo(a)pyrene. A product of incomplete combustion.
Selenium	7782-49-2		Se	Non-metal Element	Used in electronic and photocopier components, also used in glass, pigments, rubber, metal alloys, textiles, petroleum, medical therapeutic agents, and photographic emulsions.
Tetrachloroethene	127-18-4	PCE, Perchloroethylene Perc	C_2Cl_4	Chlorinated hydrocarbon (Chlorinated alkene)	For dry cleaning of fabrics and for metal-degreasing. It is also used to make other chemicals and is used in some consumer products.

Parameter	**CAS**	**Also Known As**	**Chemical Formula**	**Chemical Class**	**Uses**
Toluene	108-88-3		C_7H_8	Aromatic Hydrocarbon	Major use of toluene is as a mixture added to gasoline to improve octane ratings. Also used to produce benzene and as a solvent in paints, coatings, synthetic fragrances, adhesives, inks, and cleaning agents. Also used in the production of polymers used to make nylon, plastic soda bottles, and polyurethanes and for pharmaceuticals, dyes, cosmetic nail products, and the synthesis of organic chemicals.
Toxaphene	8001-35-2	Camphechlor, technical toxaphene	$C_{10}H_{10}Cl_8$ (approximately)	Pesticide	Toxaphene is a mixture of many different chlorinated compounds. It was primarily used as an insecticide on crops and to protect cattle from pests. It was banned for all uses in the United States in 1990.
trans-1,2-Dichloroethylene	156-60-5	1,2-DCE	$C_2H_2Cl_2$	Chlorinated Hydrocarbon (Chlorinated alkene)	As a solvent, an intermediate in production of other chemicals.
Trichloroethylene	79-01-6	TCE Trichloroethene	C_2Cl_6	Chlorinated Hydrocarbon (Chlorinated alkene)	Main use is in the vapor degreasing of metal parts. Also used as an extraction solvent for greases, oils, fats, waxes, and tars, a chemical intermediate in the production of other chemicals, and as a refrigerant. Used in consumer products such as typewriter correction fluids, paint removers/strippers, adhesives, spot removers, and rug-cleaning fluids.
Vinyl chloride	75-01-4	Chloroethene, VCM	C_2H_3Cl	Chlorinated Hydrocarbon (Chloroalkene)	To make polyvinyl chloride (PVC), a material used to manufacture a variety of plastic and vinyl products including pipes, wire and cable coatings, and

Parameter	CAS	Also Known As	Chemical Formula	Chemical Class	Uses
					packaging materials. Smaller amounts of vinyl chloride are used in furniture and automobile upholstery, wall coverings, housewares, and automotive parts.

Appendix C. List of the most recent oral reference doses and oral slope factors (cancer slope factors).

Table C-1. List of RfD and CSF factors by human health parameter. The list includes the most sensitive adverse health effect and the primary species used to characterize the effect. Additionally, the point of departures (NOAEL) and uncertainty factors used by EPA to arrive at the final RfD for non-carcinogens are summarized. Total uncertainty factors are calculated as the product of the individual uncertainty factors. The individual uncertainty factors are explained at the end of this table. Information regarding the critical sources used to derive the below RfDs, MRLs, and CSFs can be located in the individual chemical documents developed by the U.S. EPA available from https://www.epa.gov/wqc/national-recommended-water-quality-criteria-human-health-criteria-table.

Parameter	CAS	Oral RfD mg/kg-day	NOAEL mg/kg-day	UF	Non-Cancer Critical Effects	Primary species	Confidence	Oral slope factor (mg/kg-day)	Wt of Evidence	Cancer Effects	Primary Species
1,1,2,2-Tetrachloroethane	79-34-5	0.02	$BMDL_{1sd}$ = 15	1000 (10H, 10A, 3S, 3D)	Increased liver weight	Rats	Study-high; Database-medium; RfD-medium	0.2	Likely to be carcinogenic to humans	Hepatocellular carcinomas in females	Mice
1,1,2-Trichloroethane	79-00-5	0.004	3.9	1000 (10H, 10A, 10S)	Effects on the erythrocytes and depressed humoral immune status	Mice	Study-medium; Database-medium, RfD-medium	0.057	C. Possible Human carcinogen	Hepatocellular carcinomas	Mice
1,1-Dichloroethylene	75-35-4	0.05	$BMDL_{10}$= 4.6	100 (10H, 10A)	Development of liver toxicity and fatty changes	Rats	Medium	None	Exhibits "suggestive evidence" of carcinogenicity but not sufficient evidence to assess human carcinogenic potential		

Parameter	CAS	Oral RfD mg/kg-day	NOAEL mg/kg-day	UF	Non-Cancer Critical Effects	Primary species	Confidence	Oral slope factor (mg/kg-day)	Wt of Evidence	Cancer Effects	Primary Species
trans-1,2-dichloroethylene	156-60-5	0.02	BMDL$_{1sd}$ = 65	3000 (10H, 10A, 10S, 3D)	Decrease in the number of antibody-forming cells against sheep red blood cells in males	Mice	Study-medium; Database- low to medium; RfD- low	None	Inadequate information to assess carcinogenic potential		
1,2,4-Trichlorobenzene	120-82-1	0.01	14.8	1000 (10H, 10A, 10S)	Increased adrenal weights and vacuolization of the zona fasciculata in the cortex of the adrenal gland	Rats	Study-medium; Database-medium; RfD-medium	0.029	Likely to be carcinogenic to humans by the oral route of exposure	Hepatocellular carcinomas	Mice
1,2-Dichlorobenzene	95-50-1	0.3 (chronic oral MRL)	BMDL$_{10}$= 30.74	100 (10A, 10H)	Kidney Lesions (renal tubular degeneration)	Mice		None	D. Not classifiable as to human carcinogenicity		
1,3-Dichlorobenzene	541-73-1	0.002 (MRL, adjusted for Chronic lifetime exposure)	BMDL$_{10}$= 2.1	1000 (10A, 10H, 10 intermediate to chronic duration)	Development of pituitary lesions, consisting of cytoplasmic vacuolation of the pars distalis in males	Rats		None	D. Not classifiable as to human carcinogenicity		
1,4-Dichlorobenzene	106-46-7	0.07 (chronic oral MRL)	BMDL$_{10}$= 7.0	100 (10A, 10H)	Increased serum alkaline phosphatase levels in females	Dogs		None	D. Not classifiable as to human carcinogenicity		
1,2-Dichloroethane	107-06-2	0.078	BMDL$_{10}$= 78	1000 (10A, 10H, 10S and D)	Renal tubular regeneration in females	Rats		0.0033	B2. Probable human carcinogen	Development of mammary tumors in females	Mice
1,2-Dichloropropane	78-87-5	0.0893	LOAEL: 89.3	1000 (10A,10H ,10L)	Mammary gland hyperplasia in females	Rats		0.036	B2. Probable human carcinogen	Hepatocellular adenomas and carcinomas in males	Mice

Parameter	CAS	Oral RfD mg/kg-day	NOAEL mg/kg-day	UF	Non-Cancer Critical Effects	Primary species	Confidence	Oral slope factor (mg/kg-day)	Wt of Evidence	Cancer Effects	Primary Species
1,2-Diphenylhydrazine	122-66-7	None						0.8	B2. Probable human carcinogen	hepatocellular carcinomas and neoplastic nodules in males	Rat
1,3-Dichloropropene	542-75-6	0.025	2.5	100 (10H, 10A)	Basal cell hyperplasia of the nonglandular stomach in males	Rats		0.122	B2. Probable human carcinogen	Development of urinary bladder tumors	Mice
2,4,6-Trichlorophenol	88-06-2	0.001	3	3000 (10A, 10H, 10S, 3D)	Decrease in litter size	Rats		0.011	B2. Probable human carcinogen	Leukemia	Rats

2,4-Dichlorophenol	120-83-2	0.003	0.3	100 (10H, 10A)	Decreased delayed hypersensitivity response	Rats	Study-low;
							Database-low;
							RfD-low
								None	Incomplete evaluation		

2,4-Dimethylphenol	105-67-9	0.02	50	3000 (10H, 10A, 10S, 3D)	Lethargy, prostration, ataxia, and hematological changes	Mice	Study-medium;
							Database-low;
							RfD-low
								None	Incomplete evaluation		

2,4-dinitrophenol	51-28-5	0.002	LOAEL = 2	1000 (10H, 10S, 10L)	Cataract formation	Humans	Study-low;
							Database-low;
							RfD-low
								None	Incomplete evaluation		

Parameter	CAS	Oral RfD mg/kg-day	NOAEL mg/kg-day	UF	Non-Cancer Critical Effects	Primary species	Confidence	Oral slope factor (mg/kg-day)	Wt of Evidence	Cancer Effects	Primary Species
2,4-dinitrotoluene	121-14-2	0.002	0.2	100 (10H, 10A)	Development of neurotoxicity, Heinz bodies, and biliary tract hyperplasia	Dog	Study-high; Database-high; RfD-high	0.667	B2. probable human carcinogen	Development of mammary gland tumors in females	Rats
2-chloronaphthalene	91-58-7	0.08	250	3000 (10H, 10A, 10S, 3D)	Dyspnea, abnormal appearance, liver enlargement	Mice	Study-medium; Database-low; RfD-low	None	Incomplete evaluation		
2-chlorophenol	95-57-8	0.005	5	1000 (10H, 10A, 10S)	Reproductive effects in females	Rats	Study-low; Database-low; RfD-low	None	Incomplete evaluation		
3-methyl-4-chlorophenol	59-50-7	0.1	28 (LOEL)	300 (10A, 10H, 3L)	decreased brain weight in females	Rats		None	D. Not classifiable as to human carcinogenicity		
2-methyl-4,6-dinitrophenol	534-52-1	0.0003	LOAEL = 0.8	3000 (10H, 10L, 10D, 3S)	Reduced BW, excessive perspiration and fatigue, elevated basal metabolic rate (BMR) and body temperature, and the development of greenish-yellow coloration of the conjunctivae	Humans	Low	None			
3,3'-Dichlorobenzidine	91-94-1	None						0.45	B2. Probable human carcinogen	Mammary adenocarcinomas in females	Rats

Parameter	**CAS**	**Oral RfD mg/kg-day**	**NOAEL mg/kg-day**	**UF**	**Non-Cancer Critical Effects**	**Primary species**	**Confidence**	**Oral slope factor (mg/kg-day)**	**Wt of Evidence**	**Cancer Effects**	**Primary Species**
Acenaphthene	83-32-9	0.06	175	3000 (10H, 10A, 10S, 3D)	Hepatotoxicity	Mice	Study-low; Database-low; RfD-low	None	Not available.		
Acrolein	107-02-8	0.0005	0.05	100 (10H, 10A)	Decreased survival	Rats	Study-medium; Database-high; RfD- medium to high	None	Inadequate information to assess carcinogenic potential		
Acrylonitrile	107-13-1	None						0.54	B1. Probable human carcinogen	Brain and spinal cord astrocytomas, Zymbal gland carcinomas, and stomach papillomas and carcinomas	Rats
Aldrin	309-00-2	0.00003	LOAEL 0.025	1000 (10H, 10A, 10L)	Liver toxicity in males	Rats	Study-medium, Database-medium, RfD-medium	17	B2. Probable human carcinogen	Liver carcinomas	Mice

Parameter	**CAS**	**Oral RfD mg/kg-day**	**NOAEL mg/kg-day**	**UF**	**Non-Cancer Critical Effects**	**Primary species**	**Confidence**	**Oral slope factor (mg/kg-day)**	**Wt of Evidence**	**Cancer Effects**	**Primary Species**
Anthracene	120-12-7	0.3	1000	3000 (10H, 10A, 10S, 3D)	No observed effects	Mice	Study-low; Database-low; RfD-low	None	D. Not classifiable as to human carcinogenicity		
Antimony[3]	7440-36-0	0.0004	LOAEL 0.35	1000 (10H, 10A, 10L)	Longevity, blood glucose, cholesterol	Rats	Low	None	Incomplete evaluation		
Arsenic (Inorganic)	7440-38-2	0.0003	0.0008 (converted from 0.009)	3	Hyperpigmentation,keratosis, possible vascular complications	Humans	Medium	1.5	A. Human carcinogen	Internal organs, skin	Humans
b-BHC (b-hexachlorocyclohexane)	319-85-7	None						1.8	C. Possible Human carcinogen	Hepatic nodules and hepatocellular carcinomas	Mice
Benzene	71-43-2	chronic oral minimal risk level (MRL) of 0.0005	$BMDL_{0.25sd\ ADJ}$= 0.014	30 (3 route-to-route extrapolation, 10H)	Decreased B cell counts	Humans	Medium	0.015 to 0.055	A. Known human carcinogen	Leukemia	Humans
Benzidine	92-87-5	0.003	LOAEL = 2.7	1000 (10H, 10A, 10L)	Brain cell vacuolization, liver cell alterations in females	Mice	Study-medium; Database-medium; RfD-medium	230	A. Human carcinogen	Bladder tumors	Humans

Parameter	CAS	Oral RfD mg/kg-day	NOAEL mg/kg-day	UF	Non-Cancer Critical Effects	Primary species	Confidence	Oral slope factor (mg/kg-day)	Wt of Evidence	Cancer Effects	Primary Species
Beryllium[4]	7440-41-7	0.002	BMD_{10}= 0.46	300 (10H, 10A, 3D)	Small intestinal lesions	Dog	Low to medium	None	B1. Probable human carcinogen, Database inadequate (cannot be determined for ingested)	Lung	
Bis(2-Chloroethyl)ether	111-44-4	None						1.1	B2. Probable human carcinogen	Hepatomas	Mice
Bis(2-Chloro-1-Methylethyl) Ether	108-60-1	0.04	35.8	1000 (10H, 10A, 10D)	Decrease in hemoglobin and possible erythrocyte destruction	Mice	Study-medium, Database-low, RfD-low	None	Incomplete evaluation		
Bis(2-Ethylhexyl) Phthalate	117-81-7	chronic oral minimal risk level (MRL) of 0.06	5.8	100 (10A, 10H)	Testicular pathology in males	Rats		0.014	B2. Probable human carcinogen	Hepatocellular carcinomas and adenomas	Mice
Bromoform	75-25-2	0.03	$BMDL_{10}$ =2.6	100 (10H, 10A)	Hepatocellular vacuolization in the liver in males	Rats		0.0045	Likely to be carcinogenic to humans by all routes of exposure	Development of tumors in the large intestine in females	Mice and Rats
Butylbenzyl Phthalate	85-68-7	1.3		100 (10H, 10A)	Pancreatic lesions	Rats		0.0019	C. Possible Human carcinogen	Development pancreatic carcinogenesis	Rats

Parameter	CAS	Oral RfD mg/kg-day	NOAEL mg/kg-day	UF	Non-Cancer Critical Effects	Primary species	Confidence	Oral slope factor (mg/kg-day)	Wt of Evidence	Cancer Effects	Primary Species
Carbon tetrachloride	56-23-5	0.004	$BMDL_{2x\text{-}adj}$ = 3.9	1000 (10H, 10A, 3S, 3D)	Elevated serum sorbitol dehydrogenase (SDH)	Rats	Study-medium; Database-medium; RfD-medium	0.07	Likely to be carcinogenic to humans	Hepatocellular adenomas or carcinomas in females	Mice
Chlordane	57-74-9	0.0005	0.15	300 (10H, 10A, 3D)	Increased incidence of hepatic necrosis	Mice	Study-medium; Database-medium; RfD-medium	0.35	B2. Probable human carcinogen	Hepatocellular carcinomas	Mice
Chlorobenzene	108-90-7	0.02	27.25	1000 (10H, 10A, 10S)	Histopathologic changes in liver	Dogs	Study-medium; Database-medium; RfD-medium	None	D. Not classifiable as to human carcinogenicity		
Chlorodibromomethane	124-48-1	0.02	$BMDL_{10}$ =1.6	100 (10H, 10A)	Vacuolar fatty metamorphosis in the liver in males	Rats		0.04	Suggestive evidence of carcinogenic potential in humans	Development of liver tumors in females	Mice
Chloroform	67-66-3	0.01	BMDL=1	100 (10H, 10A)	Moderate to marked fatty cyst formation in the liver and elevated serum glutamate-pyruvate transaminase	Dogs	Study-medium; Database-medium; RfD-medium	None - use RfD (protective against cancer)	B2. Probable human carcinogen		
Chlorophenoxy Herbicide (2,4-D)	94-75-7	0.21	21	100 (10A, 10H)	Kidney toxicity and decreased BW	Rats		None	D. Not classifiable as to human carcinogenicity		

Parameter	CAS	Oral RfD mg/kg-day	NOAEL mg/kg-day	UF	Non-Cancer Critical Effects	Primary species	Confidence	Oral slope factor (mg/kg-day)	Wt of Evidence	Cancer Effects	Primary Species
Chlorophenoxy Herbicide (2,4,5-TP) [silvex]	93-72-1	0.008	0.75	100 (10A, 10H)	Histopathological changes in liver tissue	Dogs	Study-medium; Database-medium; RfD-medium	None	D. Not classifiable as to human carcinogenicity		
Cyanide	57-12-5	0.0006	BMDL_{1SD}= 1.9	3000 (10A, 10H, 10S, 3D)	Decreased cauda epididymis weight	Rats	Study-medium; Database- low to medium; RfD- low to medium	None	Inadequate information to assess the carcinogenic potential		
4,4'-DDT (Dichlorodiphenyl trichloroethane)	50-29-3	0.0005	0.05	100 (10H, 10A)	Liver lesions	Rats	Study-medium; Database-medium;RfD-medium	0.34	B2. Probable human carcinogen	Benign and malignant liver tumors	Mice and rats
Dichlorobromomethane	75-27-4	0.003	BMDL_{10} =0.8	300 (10H, 10A, 3D)	Fatty degeneration of the liver in males	Rats		0.034	Likely to be carcinogenic to humans	Development of renal tumors in males	Mice
Methylene chloride	75-09-2	0.006	0.19 (HED 1th percentile)	30 (3H, 3A, 3D)	Hepatic effects (hepatic vacuolation, liver foci) in both sexes	Rats	Study-high, Database-medium to high, RfD- high	0.002	Likely to be carcinogenic to humans	Hepatocellular carcinomas or adenomas in males	Mice
Dieldrin	60-57-1	0.00005	0.005	100 (10H, 10A)	Liver lesions in females	Rats	Study-low; Database-medium;RfD-medium	16	B2. Probable human carcinogen	Liver carcinomas	Mice

Parameter	CAS	Oral RfD mg/kg-day	NOAEL mg/kg-day	UF	Non-Cancer Critical Effects	Primary species	Confidence	Oral slope factor (mg/kg-day)	Wt of Evidence	Cancer Effects	Primary Species
Diethyl phthalate	84-66-2	0.8	750	1000 (10H, 10A, 10S)	Decreased growth weight, food consumption and altered organ weights	Rats	Study-Medium; Database-low; RfD-low	None	D. Not classifiable as to human carcinogenicity		
Dimethyl phthalate	131-11-3	10	1000	100 (10A, 10H)	Growth effect	Rats		None	D. Not classifiable as to human carcinogenicity		
Di-n-Butyl phthalate	84-74-2	0.1	125	1000 (10H, 10A, 10S)	Increased mortality	Rats	Study-low; Database-low; RfD-low	None	D. Not classifiable as to human carcinogenicity		
Endosulfan[2]	115-29-7	0.006	0.6	100 (10H, 10A)	Reduced BW gain and increased incidence of marked progressive glomerulonephrosis and blood vessel aneurysms in males	Rats		None	Not available		
Endosulfan sulfate[2]	1031-07-8	0.006	0.6	100 (10H, 10A)	Reduced BW gain and increased incidence of marked progressive glomerulonephrosis and blood vessel aneurysms in males	Rats		None	Not available		
Endrin[2]	72-20-8	0.0003	0.025	100 (10H, 10A)	Mild histological lesions in the liver and occasional convulsions	Dogs	Study-medium; Database-medium; RfD-medium	None	D. Not classifiable as to human carcinogenicity		

Parameter	CAS	Oral RfD mg/kg-day	NOAEL mg/kg-day	UF	Non-Cancer Critical Effects	Primary species	Confidence	Oral slope factor (mg/kg-day)	Wt of Evidence	Cancer Effects	Primary Species
Ethylbenzene	100-41-4	0.022	75 ppm (326 mg/m^3)	25 (2.5A, 10H)	Development of hyperplasia of the pituitary gland and liver cellular alterations	Mice		None	D. Not classifiable as to human carcinogenicity.		
Fluoranthene	206-44-0	0.04	125	3000 (10H, 10A, 10S, 3D)	Nephropathy, increased liver weights, hematological alterations, clinical effects	Mice	Study-medium; Database-low; RfD-low	None	D. Not classifiable as to human carcinogenicity.		
Fluorene	86-73-7	0.04	125	3000 (10H, 10A, 10S, 3D)	Decreased red blood cell counts, packed cell volume, and hemoglobin	Mice	Study-medium; Database-low; RfD-low	None	D. Not classifiable as to human carcinogenicity.		
Heptachlor	76-44-8	In place of an RfD, EPA selected an intermediate-duration oral minimal risk level (MRL) 0.0001	LOAEL 0.03	300 (10H, 10A, 3L)	Immunological and neurological effects	Rats	Low	4.1	B2. probable human carcinogen	Development of hepatocellular carcinoma in both sexes	Mice
Heptachlor epoxide	1024-57-3	0.000013	LOEL = 0.0125	1000 (10H, 10A, 10L)	Increased liver to body weight ratio in males and females	Dogs	Study-low; Database-medium; RfD-low	5.5	B2. probable human carcinogen	Development of hepatocellular carcinoma in both sexes	Mice

Parameter	CAS	Oral RfD mg/kg-day	NOAEL mg/kg-day	UF	Non-Cancer Critical Effects	Primary species	Confidence	Oral slope factor (mg/kg-day)	Wt of Evidence	Cancer Effects	Primary Species
Hexachlorobutadiene	87-68-3	0.0003	$BMDL_{10}$ = 0.1	300 (10H, 10A, 3D	Histopathological effects in the kidneys	Mice		0.04	C. Possible human carcinogen	Development of renal tubular adenomas and adenocarcinomas	Rats
Hexachlorocyclo-pentadiene	77-47-4	0.006	$BMDL_{10}$ = 6	1000 (10H, 10A, 3S, 3D)	Chronic irritation manifested by fore-stomach pathology	Rats	Study-medium; Database-low; RfD-low	None	Not available		
Hexachloroethane	67-72-1	0.0007	$BMDL_{10}$ = 0.728	1000 (10H, 10A, 3S, 3D)	Degeneration of the renal tubules in males	Rats	Low to medium	0.04	Likely to be carcinogenic	Renal adenomas and carcinomas in males	Rats
Isophorone	78-59-1	0.2	150 (NOEL)	1000 (10H, 10A, 10S)	No observed effects	Dogs	Study-medium; Database-low; RfD-low	0.00095	C. Possible human carcinogen	Preputial gland carcinomas in males	Rats
gamma-BHC (Lindane)[2]	58-89-9	0.0047	0.47	100 (10A, 10H)	Periacinar hepatocyte hypertrophy, increased liver/spleen weight, decreased platelets	Rats		None			
Methoxychlor	72-43-5	0.00002	LOAEL = 0.02	1000 (10H, 10A, 10L)	Increased prostate and seminal vesicle weights	Mice		None	D. Not classifiable as to human carcinogenicity.		

Parameter	**CAS**	**Oral RfD mg/kg-day**	**NOAEL mg/kg-day**	**UF**	**Non-Cancer Critical Effects**	**Primary species**	**Confidence**	**Oral slope factor (mg/kg-day)**	**Wt of Evidence**	**Cancer Effects**	**Primary Species**
Methyl bromide (Bromomethane)	74-83-9	0.02	2.2	100 (10H, 10A)	Decreased BW, rate of BW gain, and food consumption	Rats		None	D. Not classifiable as to human carcinogenicity.		
Nitrobenzene	98-95-3	0.002	$BMDL_{1SD}$ = 1.8	1000 (10H, 10A, 3S, 3D)	Increased methemoglobin levels	Rats	Study-high; Database-medium; RfD-medium	None	Not available		
PCB[1]	1336-36-3							2.0 upper bound	B2. probable human carcinogen	Liver	Rat
Pentachlorobenzene	608-93-5	0.0008	LOAEL = 8.3	10,000 (10A, 10H, 10S, 10L)	Liver and kidney toxicity	Rats	Study-medium; database-low; RfD-low	None	D. Not classifiable as to human carcinogenicity.		
Pentachlorophenol	87-86-5	0.005	LOAEL = 1.5	300 (10H, 10A, 3L)	Hepatotoxicity	Dogs	Study-medium; Database-high RfD-medium	0.4	Likely to be carcinogenic to humans	Development of hepatocellular adenomas or carcinomas and adrenal benign or malignant pheochromocytomas in males	Mice
Phenol[5]	108-95-2	0.6	60	100 (10A,10H)	Decreased maternal weight gain in females	Rats		None	Inadequate information to assess carcinogenic potential		

Parameter	CAS	Oral RfD mg/kg-day	NOAEL mg/kg-day	UF	Non-Cancer Critical Effects	Primary species	Confidence	Oral slope factor (mg/kg-day)	Wt of Evidence	Cancer Effects	Primary Species
Pyrene	129-00-0	0.03	75	3000 (10H, 10A, 10S, 3D)	Renal tubular pathology and decreased kidney weights	Mice	Study-medium; Database-low; RfD-low	None	D. Not classifiable as to human carcinogenicity.		
Selenium[2]	7782-49-2	0.005	0.015	3 (3H)	Clinical selenosis	Human	High	None	D. Not classifiable as to human carcinogenicity.		
Tetrachloroethene	127-18-4	0.006	LOAEL 9.7 & 2.6	1000 (10H, 10L, 10D)	Development of neurological effects (i.e., color vision changes and cognitive and reaction time changes)	Humans	Study-medium; Database-medium; RfD-medium	0.0021	Likely to be carcinogenic in humans by all routes of exposure	Hepatocellular adenomas or carcinomas in males	Mice
Toluene	108-88-3	0.0097	26 ppm (98mg/m^3)	10(10H)	Development of various neurological symptoms	Humans		None	Inadequate information to assess carcinogenic potential		
Toxaphene[2]	8001-35-2	0.00035	0.35	1000 (10A, 10H, 10S)	Increased hepatic microsomal enzymatic activities	Rats		1.1	B2. probable human carcinogen	Hepatocellular carcinomas and neoplastic nodules	Mice
Benzo(a)anthracene	56-55-3	None						0.73	B2. probable human carcinogen	Fore-stomach and squamous cell papillomas	Mice

Parameter	CAS	Oral RfD mg/kg-day	NOAEL mg/kg-day	UF	Non-Cancer Critical Effects	Primary species	Confidence	Oral slope factor (mg/kg-day)	Wt of Evidence	Cancer Effects	Primary Species
Benzo(a)pyrene	50-32-8	None						7.3	B2. probable human carcinogen	Fore-stomach and squamous cell papillomas	Mice
Benzo(b)fluoranthene	205-99-2	None						0.73	B2. probable human carcinogen	Fore-stomach and squamous cell papillomas	Mice
Benzo(k)fluoranthene	207-08-9	None						0.073	B2. probable human carcinogen	Fore-stomach and squamous cell papillomas	Mice
Chrysene	218-01-9	None						0.0073	B2. probable human carcinogen	Fore-stomach and squamous cell papillomas	Mice
Dibenzo(a,h)anthracene	53-70-3	None						7.3	B2. probable human carcinogen	Fore-stomach and squamous cell papillomas	Mice
Indeno(1,2,3-cd)pyrene	193-39-5	None						0.73	B2. probable human carcinogen	Fore-stomach and squamous cell papillomas	Mice
Trichloroethylene	79-01-6	0.0005	Multiple; See EPA's chemical-specific document	Multiple; See EPA's chemical-specific document	Decreased thymus weights, heart malformations, developmental immunological effects	Mice & Rats	Study – high-medium/medium/low-medium (for each endpoint individually, as described below) Data Base – high RfD – high	0.05	Carcinogenic to humans by all routes of exposure	Renal cell carcinoma	Humans

Parameter	CAS	Oral RfD mg/kg-day	NOAEL mg/kg-day	UF	Non-Cancer Critical Effects	Primary species	Confidence	Oral slope factor (mg/kg-day)	Wt of Evidence	Cancer Effects	Primary Species
Vinyl chloride	75-01-4	0.003	HED: 0.09	30 (10H, 3A)	Liver cell polymorphism	Rats	Study-high; Database-medium to high; RfD-medium	1.5	Known human carcinogen by the inhalation route of exposure and is also considered highly likely to be carcinogenic by the dermal route	Liver angiosarcomas, hepatocellular carcinomas, and neoplastic nodules	Rats
1,1,1-Trichloroethane	71-55-6	2	$BMDL_{10}$: 2155	1000 (10H, 10A, S3, D3)	Reduced body weight	Mice	Study-high; Database- low to medium; RfD low to medium	None	Inadequate information to assess carcinogenic potential		

Explanation of Reference Dose Uncertainty Factors:

A: Interspecies uncertainty
H: Intraspecies uncertainty
S: Subchronic to chronic extrapolation
L: Use of the LOAEL
D: Data base incomplete

<u>Table Footnotes</u>:

1. The EPA did not propose new human health criteria for PCBs as part of their 2015 recommendations. However, the department is proposing to update criteria for this parameter so it is consistent with EPA’s 2002 HHC recommendations (see http://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=20003IEI.txt).
2. Parameters that have more stringent aquatic life criteria include: selenium, endrin, gamma-HCH, alpha-endosulfan, beta-endosulfan, endosulfan sulfate, and toxaphene. The department is proposing to retain the current criteria in Rule 62-302.530, F.A.C., for these parameters because the aquatic life endpoint is more sensitive than human health and is therefore fully protective of all uses. Thus, information provided in this appendix for these parameters is for informational purposes.
3. The EPA did not propose new HHC for antimony as part of their 2015 recommendations. However, the department is proposing to update criteria for this parameter so it is consistent with EPA’s 2002 human health criteria recommendations (see http://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=20003IEI.txt).
4. The EPA did not propose new HHC for beryllium as part of their 2015 recommendations. However, the department is proposing to update criteria for this parameter so it is consistent with EPA’s most recent recommendations. Florida’s existing beryllium criteria were based on an assumption of carcinogenicity. U.S. EPA has withdrawn its cancer slope factors for this parameter and now considers ingested beryllium to be non-carcinogenic. The proposed criterion is based on EPA’s newer RfD (0.002) taken from IRIS and listed in the table above.

5. Phenol currently has organoleptic effect-based criteria (300 µg/L) contained in Chapter 62-302.530, F.A.C., that are more protective than the proposed HHC. Thus, this parameter is not proposed for revision. Thus, information provided in this appendix for phenol is for informational purposes.

Appendix D: Relative Source Contribution (RSC) Derivation for Non-carcinogenic Parameters Evaluated for Chapter 62-302, FAC, Human Health Criteria Revision

Purpose

The Relative Source Contribution (RSC) is a numeric value relevant to the derivation of human health ambient water quality criteria for non-carcinogenic compounds. Calculation of the RSC allows for a percentage of the non-carcinogen reference dose (RfD) to be attributed to ambient water exposure routes (*i.e*., consumption of drinking water and freshwater/ estuarine fish consumption). The remainder of the RfD is attributed to non-surface water exposures (e.g., food other than fresh and estuarine fish, inhalation, and dermal absorption while showering or swimming). The RSC is intended to ensure that total exposure for individuals does not exceed the RfD. It is also intended to maintain low exposures when exposures are already low; that is, to prevent overall exposures from increasing.

Methods

The USEPA's *Exposure Decision Tree for Defining Proposed RfD Apportionment* (Fig. 4-1, USEPA, 2000) was used as the basis for the development of protective RSCs for non-carcinogenic compounds. To develop RSCs, exposure information was assembled from literature sources to characterize the various potential exposure routes, including surface water sources (*i.e*., drinking water and fish consumption) and non-surface water sources. The primary steps/questions that must be addressed in EPA's Decision Tree approach are 1) identifying the populations of concern, 2) identifying relevant exposure pathways/sources, 3) determining if there are adequate data available to describe central tendencies and high-ends (i.e., upper percentiles) for relevant exposure sources/pathways, 4) determining if there are sufficient data, physical/chemical property information, fate and transport information, and/or generalized information available to characterize the likelihood of exposure to relevant sources, 5) identifying if there are significant known or potential uses/sources other than the source of concern, 6) determining if there is sufficient information available on each source to make a characterization of exposure, and 7) determining if exposures from multiple sources (due to a sum of sources or an individual source) are potentially at levels near (*i.e*., over 80%) or in excess of the RfD.

Literature Search Process Outline for Relative Source Contribution Derivation

The first step in the literary review process was to identify major entities that a) are responsible for or play a role in the protection of public health in relation to exposure science and risk assessment; and, b) would have reliable peer-reviewed data pertaining to chemical-specific population exposure. The primary entities targeted for literature/information searches were:

- The Agency for Toxic Substances and Disease Registry (ATSDR)
- The World Health Organization (WHO)
- The Centers for Disease Control and Prevention (CDC)
- The United States Environmental Protection Agency (USEPA)

- The United States Environmental Protection Agency's Toxic Release Inventory Explorer Tool
- The United States National Library of Medicine's Hazardous Substances Data Bank (HSDB)
- The International Programme on Chemical Safety (IPCS)
- The United States Geological Survey (USGS)
- The United States Food and Drug Administration (USFDA)
- The California Office of Environmental Health Hazard Assessment (OEHHA)
- Peer-reviewed literature sources
- The Watershed Assessment Program, Florida Department of Environmental Protection (FDEP)
- FDEP technical reports and technical support documents

To begin the analysis, the toxicological profile created by the ATSDR was reviewed for each chemical/compound for which this type of documentation was available. This source was chosen to begin the analysis because it provided a comprehensive overview of information such as chemical/physical characteristics, exposure routes, health effects by exposure route, average concentrations of chemicals received through each exposure route, levels monitored in the environment, explanation of chemical-specific environmental fate and release, and how exposures differ between the general population and occupational exposures. Where available, the ATSDR toxicological profiles acted as a foundation for RSC derivation by providing sound, peer-reviewed sources of data that often focused directly on the exposure factor of interest. In addition, uncertainty and variability associated with the data/exposure concentrations were often presented, which served to increase the department's confidence in the use of this source as a starting point of analysis. To fill in informational and data gaps, online resources and documents available from the entities listed above were reviewed and used to supplement necessary exposure information.

The types of documents reviewed for each major source included:

- ATSDR: toxicological profiles were used as the primary and initial literature resource. The documents were downloaded from the ATSDR website (http://www.atsdr.cdc.gov/toxprofiles/index.asp). Toxicological profiles are prepared in accordance with guidelines developed by the ATSDR and EPA. The ATSDR toxicological profiles are intended to succinctly characterize the toxicological and adverse health effects information for the hazardous substance being described. Each profile identifies and reviews the key peer-reviewed literature that describes a substance's toxicological properties.
- WHO: chemical-specific background documents for the development of WHO guidelines for drinking water quality. These WHO documents were reviewed after the ATSDR documents to support the information summarized by the ATSDR or to identify more recent data/information. The WHO documents were used to start the analysis in cases where the ATSDR had not developed a toxicological profile.
- CDC: National Reports of Human Exposure to Environmental Chemicals
- EPA: technical fact sheets, Ambient Water Quality Criteria Documents, National Air Toxics Assessment (NATA) data, Ambient Monitoring Archive (AMA) data, Contaminant Occurrence documents associated with the "Six-Year Reviews of Drinking Water Standards,"

National Emissions Inventory (NEI) data, IRIS, 2011 Exposure Factors Handbook for exposure/intake rates and body weight, and other chemical-specific documents and studies.

- EPA's Toxic Release Inventory (TRI) Tool was utilized to obtain data associated with on-site and off-site disposal and release of the chemicals included in the RSC derivation analysis. Release data for the most recently available 10-year period (2005 through 2014) were used to calculate the percentage of total releases in each category (*e.g.*, air, water, disposal well, landfill) for Florida, Alabama[1], Georgia[1], and the entire United States. The percentage calculated only included on-site and off-site disposal release, and did not include releases to treatment, recovery, or recycling. This TRI was chosen due to the fact that these data represent the most current and complete accounting of chemical disposal and release monitored by the EPA that is available, even though it is acknowledged as a non-exhaustive list of releases/disposals due to the fact that reporting requirements for facilities are not all-inclusive.
- IPCS: Chemical-specific Concise International Chemical Assessment Documents, chemical-specific Environmental Health Criteria, and chemical-specific Health and Safety Guides.
- USGS: chemical-specific water-based studies
- USFDA: Total Diet Study Market Baskets 1991-3 through 2003-4, Total Diet Study Market Baskets 2006 through 2011, and 21CFR165.110(b) FDA bottled water standards.
- CALEPA-OEHHA: Public Health Goals for Chemicals in Drinking Water (chemical-specific documents)
- FDEP: Impaired Waters Rule Run 50 database (http://publicfiles.dep.state.fl.us/dear/IWR/) and technical reports/technical support documents.
- The HSDB: Provides a variety of chemical-specific information such as human health effects, environmental fate and exposure, chemical/physical properties and was used as a repository to find additional peer-reviewed literature sources.

Data and information relevant to human exposures, particularly in the United States and Florida, were extracted from these resources as the primary or initial literature resources. The reference and citation lists from these resources were also analyzed, particularly from a number of the major source documents (*i.e.*, ATSDR Toxicological Profiles, IPCS documents, HSDB overviews). These references were then queried in the State Library of Florida's electronic database and requested for retrieval. The references were thoroughly reviewed to help substantiate information and data that were chosen to be included in the RSC derivation document; that is, these references were reviewed to ensure that the summaries provided in the major source documents were accurately characterized and interpreted by FDEP. Additionally, pertinent and often more recent peer-reviewed literature that referenced these sources were also queried and reviewed to determine whether new or revised information had become available since the publication of the major source documents.

---

[1] Alabama and Georgia will specifically evaluated because both states are immediately upstream of Florida and toxic releases in these two states potentially contribute to pollutant exposures in Florida.

A defined key word list was not used during this State Library of Florida literature review as this was an interactive process where searches would often build upon themes previously queried. Searches primarily included mention of the chemical/compound under analysis and the exposure route of focus (*e.g*., diet, fish, seafood, human exposure, drinking water, air, atmospheric) and/or author's names/titles of articles referenced in other sources. Literature either citing or cited by key resources was also reviewed for relevance.

Information/data was then compiled individually for each exposure route. To determine the RSC, several factors were taken into account such as: soundness of the study's approach and presence of potential bias, age of the data, sample size, regionality/representativeness, the level of conservatism of the exposure estimate, and the overall availability of data concerning chemical concentrations associated with exposure routes. A concerted effort was made to include the most current applicable data available, taking into account whether sample size was sufficient, exposure concentrations were measured in the United States or Florida, and the most relevant estimate of exposure was utilized to ensure that the public's health is fully protected. Preference was given to the inclusion of exposure data derived from Florida or the United States. However, in a few cases, exposure data, particularly dietary intake data, from outside the United States (Europe) were included if sufficient data were lacking for the United States. In cases when foreign population data were included in the assessment, it was apparent that either the foreign population had similar exposure patterns as in the U.S. or were highly likely to be conservative (*i.e*., overestimate exposure). When data adequacy was a concern and/or a major exposure route could not be quantified, the EPA's default RSC values of 0.8 or 0.2 were applied depending on the information available for that chemical/compound.

Unless otherwise noted for a given parameter, the most recent exposure factors (USEPA, 2011) were used in the calculations for RSC determination (**Tables 1 and 2**). **Table 2** provides marine fish consumption and trophic level specific fresh and marine fish consumption rates representative of Florida consumers. The fish consumption values were calculated from the rates published in Tables E-2, 13b, 14b, and 15b in USEPA (2014A) using mean (marine) and 90th percentile (fresh and estuarine fish) consumption rates for Gulf of Mexico, Atlantic Coast, and Inland South geographic units.

The geographic units used for RSC calculations are identical to those used to define fish consumption rates for human health criteria calculations. Geographic unit assignments were made based on Tiger Census Blocks in a manner consistent with the method used by USEPA (2014A). All Census Blocks within counties that bordered the coastal waters (Atlantic Ocean or Gulf of Mexico) were defined as being within the given geographic unit, respectively. Additionally, Census Blocks whose centroid was within 25 miles of the coastal waters were assigned to the nearest geographic unit (i.e., Atlantic Ocean or Gulf of Mexico). Census Blocks whose centroids were greater than 25 miles from coastal waters were assigned to the Inland South geographic unit. The total populations within Census Blocks were then totaled by geographic region and used to calculate the proportion of the Florida population that resides within each region.

It was determined that 44.8, 31.6, and 23.6% of the population resided with the Atlantic Coast, Gulf Coast, and Inland South geographic regions, respectively. These population percentages were then used as weighting factors in the calculation of weighted mean marine or 90th percentile fresh and estuarine fish consumption rates. For marine fish, the mean values from Table E-2 (USEPA, 2014A, Table 2) were used to calculate a weighted mean of 13.6 g/day, which was converted to a rate of 0.16 g/kg-day by dividing this value by a body weight of 80 kg.

Table 1. Exposure assumptions used to calculate relative source contribution values for individual non-carcinogenic human health parameters. Selected values are per capita means for the U.S. population.

Exposure Assumption	Value	Units	Source
Body Weight	80	Kg	Table 8-1, USEPA (2011)
Treated Potable Drinking Water	2.4	L/day	Table 3-23, USEPA (2011)
Daily Breathing rate	16	m^3/day	Table 6-1, USEPA (2011)
Indoor Breathing rate	12.878	m^3/day	Calculated[1]
Outdoor Breathing rate	3.122	m^3/day	Calculated[2]
Soil Ingestion	20	mg/day	Chapter 4, USEPA (2011)
Total Food Intake	29	g/kg-day	Table 14-1, , USEPA (2011)
Fruit	1.6	g/kg-day	Table 19-3, USEPA (2011)
Vegetable	2.9	g/kg-day	Table 19-3, USEPA (2011)
Meat	2	g/kg-day	Table 11-3, USEPA (2011)
Dairy	6.6	g/kg-day	Table 11-3, USEPA (2011)
Grain	2.6	g/kg-day	Table 12-3, USEPA (2011)
Marine Fish	0.16	g/kg-day	See table 2
Fats	1.2	g/kg-day	Table 11-31, USEPA (2011)

1. Calculated based on the fraction of time indoors (0.8) multiplied by daily inhalation (16 m^3/day). The multiplier of 80% was generated from Table 16-22 (USEPA, 2011) and was based on an average time spent indoors of 1159 minutes out of a 1440 minute day.
2. Calculated based on the fraction of time outdoors (0.2) multiplied by daily inhalation (16 m^3/day). The multiplier of 20% was generated from Table 16-22 (USEPA, 2011) and was based on an average time spent outdoors of 281 minutes out of a 1440 minute day.

Table 2. 90th percentile fish consumption rates for the Atlantic, Gulf, and Inland South regions and population weighting factors used to calculate weighted average trophic level specific 90th percentile fish consumption rates.

Geographic Unit	Weighting Factor	Trophic Level 2 (g/day)	Trophic Level 3 (g/day)	Trophic Level 4 (g/day)	Marine Fish (g/day)
Atlantic	0.448	15.1	21.6	34.5	15.6
Gulf	0.316	12.5	20.2	25.7	11.6
Inland South	0.236	8.7	5.9	23.7	9.8

Geographic Unit	Weighting Factor	Trophic Level 2 (g/day)	Trophic Level 3 (g/day)	Trophic Level 4 (g/day)	Marine Fish (g/day)
Weighted Value		12.8	17.5	29.2	13.0

The RSC can be derived through two primary methodologies: the subtraction and the percentage approaches. It is EPA's policy that the subtraction method cannot be used in cases where a pollutant is regulated for environmental releases under multiple programs (*e.g.*, treated drinking water, air), in which case the percentage method should be used. The percentage approach is usually considered to be the more conservative approach. The computational distinction between the two methodologies is often misunderstood. The misunderstanding is partially due to the fact that both approaches typically result in an RSC that is expressed as a percentage.

To derive an RSC using the subtraction approach, pollutant exposure sources other than drinking water and fish exposures are subtracted from the reference dose (RfD) to determine the RfD remainder that can be safely apportioned to the water and fish exposures. The RSC percentage is then calculated by dividing the RfD remainder by the RfD. To derive an RSC using the percentage approach, the sum of the exposure from drinking water and consumption of fish/shellfish from the ambient waterbody of concern is divided by the total of all known exposures.

An example will help illustrate the difference between the two methodologies. The RfD for a hypothetical pollutant X is 0.2 mg/kg/day (200 µg/kg/day) and the daily exposures for the general adult population are listed in **Table 3**. An RSC using the subtraction method would be calculated by summing the exposures other than drinking water and fish consumption (*i.e.*, all other foods, air, and other sources); subtracting this value ($RfD_{remainder}$) from the RfD; and, dividing the $RfD_{remainder}$ by the RfD. The computational steps are as follows:

3. RfD remainder = RfD – (Other food + Air + Other) = 200 – (20+2+1) =177
4. RSC = $RfD_{remainder}$/ RfD = 177/200=0.89.

A percentage method based RSC for pollutant X would be calculated by summing the exposures from fish consumption (FC) and drinking water (DW) and dividing this value by the sum of exposures from all exposures. The computation of the percentage based RSC is as follows:

RSC = (FC + DW)/(FCR + DW + Other Food + Air + Other) = (5+10)/(5+10+20+2+1) = 0.39

Table 3. General adult population exposures to pollutant X.

Exposure Route	Daily Exposure (µg/day)	Percent of Total Exposure
Drinking water	5	13.2%

Exposure Route	Daily Exposure (µg/day)	Percent of Total Exposure
Fish consumption	10	26.3%
All other foods	20	52.6%
Air	2	5.3%
Other sources	1	2.6%

It is EPA's policy that RSCs calculated using either method should be subject to a floor of 20% and a ceiling of 80%. Thus, for the hypothetical examples above, the subtraction method calculated RSC for pollutant X would need to be reduced to value of 0.8, while the percentage method calculated RSC is within the range and would not require further adjustment. Utilizing the 80% "ceiling" ensures that the criterion will be low enough to provide adequate protection for individuals whose total exposure to a contaminant is, due to dietary or other exposure, higher than currently indicated by available data. This approach, in effect, introduces an additional uncertainty factor and results in a lower criterion. It ensures that the criterion will result in no adverse effect with an adequate margin of safety (See Federal Register Vol, 50, N0. 97, 22068-22070, May 22, 1989).

Although the 20% floor is not applicable to the example above, EPA also recommends that states use a 20% floor value such that calculated RSC values less than 20% are set at 20%. EPA recommends this approach to prevent a situation where small fractional exposures are being controlled, noting that below the floor of 20%, it is more appropriate to reduce other sources of exposure rather than promulgating standards for *de minimus* reductions in overall exposure (USEPA, 2000).

The department assessed the potential development of parameter-specific RSCs as alternative**s** to EPA's national recommended values. An extensive literature review analysis was completed to locate exposure information for ten parameters (chloroform, toluene, nitrobenzene, selenium, acenaphthene, anthracene, fluoranthene, fluorene, pyrene, and dimethyl phthalate) in an effort to develop RSCs. The department attempted to locate Florida data to the maximum extent practicable, but did not limit the review to Florida data if these were insufficient, and so the analysis also relied on regional and national level data**,** and in some cases European data. FDEP selected these ten parameters to serve as a "proof of concept" analysis intended to determine whether 1) sufficient data and information were available to set quantitative RSCs; and, 2) quantitatively established RSCs would differ significantly from those used by U.S. EPA in their national recommendations**.** The data, information, and RSC analyses for these ten parameters are summarized in detail below.

Chloroform

Background

Chloroform (CASRN 67-66-3) is a colorless liquid with a pleasant, non-irritating odor and a slightly sweet taste. The majority of chloroform found in the environment comes from industry.

Chloroform was one of the first inhaled anesthetics to be used during surgery, but is no longer used for that purpose. Nearly all of the chloroform manufactured in the United States today is used in the synthesis of other chemicals. The primary application for chloroform is the production of HCFC-22 (R-22), which is used as a refrigerant and an intermediate in the production of the Teflon fluoropolymer (PTFE) (Glauser *et al.*, 2011). In 2011, an estimated 96% of the global consumption of chloroform was used in the manufacture of hydrochlorofluorocarbons. The remaining 4% of chloroform produced globally is used in the synthesis of pharmaceuticals, agricultural products, and as laboratory reagents. The potential for environmental release of chloroform is low since it is utilized as a chemical intermediate in closed systems.

Exposure to chloroform can occur through drinking water intake, dietary intake, inhalation, and through dermal contact with water (*e.g.*, while showering, bathing, cleaning, washing, swimming). Incidental dermal contact during recreational activities is considered a minor source of exposure. The chloroform exposure routes most likely to affect the general public are drinking water intake, inhalation of indoor air, and dietary intake. According to the ATSDR (1997), based on the vapor pressure of 159 mm Hg at 20^0C, chloroform is expected to exist almost entirely in the vapor phase in the atmosphere. Thus, the dominant fate process for chloroform in surface water and surface soils is volatilization. The low K_{ow} (1.97) of chloroform indicates that this parameter does not have a high potential for bioaccumulation in aquatic organisms. Select chemical and physical properties of chloroform are displayed below in **Table 4** adapted from the ATSDR Toxicological profile for chloroform (1997).

Table 4. Select Chemical and physical properties of chloroform

Chemical/ Physical Property	Quantitative Information	Original Reference
Molecular weight	119.38	Deshon 1979
Solubility (water at 25^0c; mg/L)	$7.22\cdot10^3$ $9.3\cdot10^3$ $7.43\cdot10^3$	Banerjee *et al.* 1980 Verschueren 1983 Merk 1989
Partition Coefficient (log K_{ow})	1.97	Hansch and Leo 1985, Verschueren 1983
Partition coefficient (log k_{oc})	1.65 2.40	Sabljic 1984 Aster 1996
Vapor Pressure (mmHg)	159 160 160	Boublik *et al.* 1984 Verschueren 1983 NFPA 1994
Henry's Law Constant (atm-m^3/mol)		
At 20^0C	$3.0\cdot10^{-3}$	Nicholson *et al.* 1984
At 24.8^0C	$3.67\cdot10^{-3}$	Gossett 1987

Chemical/ Physical Property	Quantitative Information	Original Reference
At 25^{0}C	$4.06 \cdot 10^{-3}$	SRC 1994

Exposure Source Determinations

Manufacturing and release

Chloroform is found in a variety of wastewaters where chlorine is added, including domestic sewage treatment plants, drinking water facilities, and paper mills. Chlorine is added to most drinking water supplies and many wastewaters to kill bacteria. Small amounts of chloroform are formed as an unwanted by-product during the process of adding chlorine to water. Chloroform can enter the air directly from factories that produce or utilize it in manufacturing processes and via evaporation from contaminated water and soils. Chloroform can enter water and soil when wastewater that contains chlorine is released into these types of environmental media. Chloroform may also enter water and soil from spills and waste site/storage tank leakage.

According to the EPA's Toxic Release Inventory (TRI) Explorer, total reported on-site disposal or other releases[2] of chloroform in 2014 in Florida accounted for 74,630.80 pounds, with the majority of release/disposal occurring through point source air emissions and fugitive air emissions (USEPA, 2015D). Review of the release data for the period from 2005 through 2014 for Florida, Alabama, Georgia, and the entire U.S. confirm that the vast majority of environmental releases of chloroform is via air emissions (**Table 5**). Surface water discharges account for only a small fraction (0.4-3.6%) of the emissions. However, information/data retrieved from the USEPA's TRI explorer tool does not represent an exhaustive list of disposals/releases of chemicals due to the fact that only certain types of facilities are required to report this type of information. In particular and significantly for chloroform, most sewage treatment plants are not required to report to the TRI. Chlorination of wastewater is known to result in the formation of chloroform and other byproducts, thus the estimated percent total emissions to surface water are most likely biased low.

---

[2] Total reported on-site disposal or other releases associated with TRI data include: underground injection to Class I wells, RCRA Subtitle C landfills, other on-site landfills (those not authorized under Subtitle C of RCRA to accept hazardous wastes), fugitive air emissions, point source air emissions, surface water discharges, underground injection Class II-V wells, land treatment, RCRA Subtitle C surface impoundments, other surface impoundments (those not authorized under RCRA to accept hazardous waste for disposal), and other land disposal (disposal to land that does not fall into one of the other on-site land release categories found in section 5.5.1 through 5.5.3 on the TRI From R).

Table 5. Summary of average annual percent total releases of chloroform to the environment from 2005 through 2014. Air releases include both stack and fugitive air emissions. Surface water discharge includes direct (on-site) releases to water, transfers to POTW for release, and transfers to POTW for treatment (metals only).

Geographic Area	Air Releases	Class I Well Disposal	Land Treatment	Landfill	Other Disposal	Surface Impoundment	Surface Water Discharge
Florida	99.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%
Alabama	95.9%	0.0%	0.0%	0.5%	0.0%	0.0%	3.6%
Georgia	97.4%	0.0%	0.0%	2.0%	0.0%	0.0%	0.7%
US Total	82.5%	7.1%	0.0%	0.4%	8.7%	0.0%	1.2%

Ambient Exposure Sources

Surface Waters

Staples *et al.*, (1985) summarized priority pollutant concentrations in the United States using the STORET Database. They reported a median chloroform (trichlormethane) concentration of 0.3 µg/L based on 11,928 samples with a 64% detection rate. Staples *et al.*, (1985) also reported median sediment and biota tissue concentrations of <5.0 µg/kg and 0.032 mg/kg, respectively. Ambient surface water data were queried from the IWR Run 50 database, and the range of measured concentrations over the ten-year period from 2005-2014 were evaluated. Out of 242 samples, there were only 15 values reported as greater than the method detection limit (MDL). The mean concentration for Florida surface waters was <0.20 µg/L, with 10th and 90th percentiles of <0.05 and 0.25 µg/L, respectively. The maximum observed concentration was 2.0 µg/L. The mean (<0.2 µg/L) and 90th percentile (0.25 µg/L) concentrations from the IWR database were used to estimate the typical range of expected chloroform concentrations in Florida waters for purposes of determining an RSC. These values were used both as an estimate of the expected range in Class I waters (ambient fraction of treated potable water) and to calculate the potential fish tissue concentration.

Ingestion of Freshwater and Estuarine Fish

FDEP conducted a survey of trihalomethanes, including chloroform in finfish near outfalls of domestic wastewater plants (FDEP, 2012). Thirteen (13) domestic wastewater facilities were identified for sampling. Four of the facilities discharged to freshwater, and nine discharged in predominately marine (estuarine) waters. Additionally, one freshwater and two marine background sites were selected for fish collection. The background sites were located far from any known discharges or other sources of THMs. At each facility, fish representing the three trophic levels were harvested near the wastewater discharges for the analysis of THMs in the edible muscle tissue. The study results for chloroform are summarized in **Figure 1**. Chloroform fish tissue results for the background sites were all below detection limits (MDL= 0.91-1.0 µg/kg). Tissue results for fish near wastewater plant discharge ranged from <0.9 to 29 µg/kg. The average fish tissue concentration for fish near wastewater plant discharges was 3.2 µg/kg or

2.9 µg/kg, using the MDL and one-half the MDL replacement, respectively, for results reported as less than detection**.**

The mean surface water chloroform concentration of 0.20 µg/L calculated from IWR Run 50 data was used in conjunction with the Florida Bioaccumulation Factors (BAFs) to estimate average Florida fish tissue concentrations for trophic level 2 through 4 fish. The trophic level specific BAFs used in the calculation were 2.7, 2.4, and 2.9 L/kg for trophic levels 2, 3, and 4, respectively. FDEP developed estimated average Florida fish tissue concentrations by multiplying the BAFs by the mean surface water concentration and applying a conversion factor (0.001) to convert the units to mg/kg-fish tissue. The estimated average Florida fish concentrations were calculated to be $6.89 \cdot 10^{-6}$, $8.38 \cdot 10^{-5}$, and $1.68 \cdot 10^{-5}$ mg/kg for trophic levels 2, 3, and 4, respectively.

FDEP used both the wastewater plant study data and the BAF calculated fish tissue concentrations to provide a range of average fish tissue concentrations for Florida waters. The range used was $7.15 \cdot 10^{-3}$ to 3.2 µg/kg. This range represents both ambient conditions and areas that are potentially influenced by wastewater discharges, and was used for purposes of determining an RSC for chloroform.

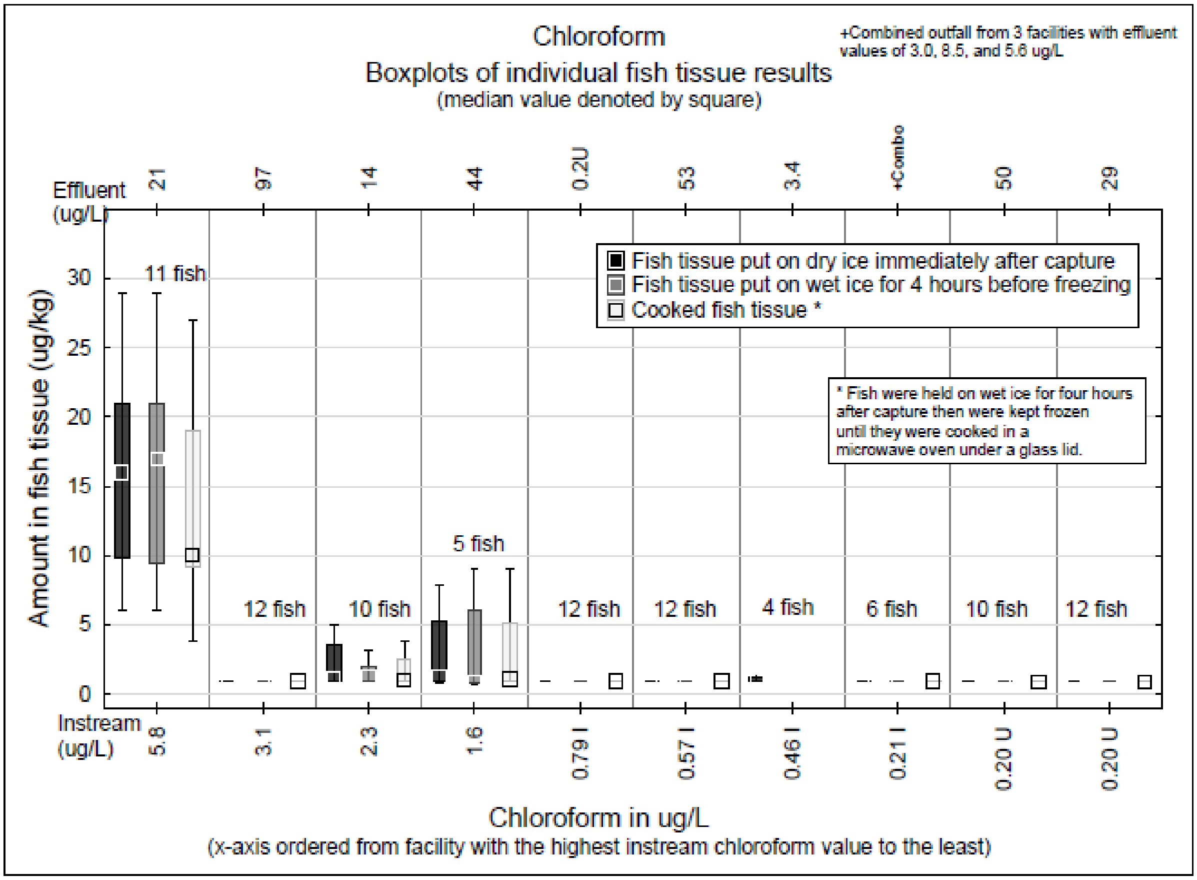


Figure 1. Chloroform found in Edible Fish Tissue Collected near Facility Outfalls. Figure taken from FDEP (2012).

Non-ambient Exposure Sources

Non-ambient sources of chloroform exposure considered as important and quantified by the USEPA (2003) include treated drinking water, indoor inhalation exposure, inhalation while showering, dermal exposure while showering, inhalation of outdoor air, and dietary exposures. In addition to other sources, chloroform concentrations for the various media from a previous USEPA chloroform RSC analysis were used as a supporting line of evidence in RSC derivation. This source was used to inform the RSC derivation for all exposure pathways because it was developed by the USEPA as a model of RSC analysis and succinctly analyzed toxicological endpoints and exposure assumptions of interest that are needed to develop a justifiable RSC estimate.

Treated drinking water

Chloroform is one of a number of chemical compounds classified as a trihalomethane (THM). This class of chemicals commonly appear as by-products generated through disinfection of drinking water supplies with chlorine or bromine. The reaction of chlorine with certain naturally occurring organic materials, when added to raw source waters, can lead to the formation of chloroform. The USEPA has estimated that a mean chloroform concentration of 24 µg/L exists in treated drinking water (USEPA, 2001). The USEPA regulates trihalomethanes in drinking water and has established a MCL for total trihalomethanes of 0.08 mg/L (USEPA, 2014B). A maximum contaminant level goal (MCLG) of 0.07 mg/L has also been established for chloroform. However, MCLGs are non-enforceable health goals. According to 21 CFR 165.110 (b), the FDA has also established an allowable concentration of total trihalomethanes in bottled water of 0.08 mg/L.

As part of the U.S. Geological Survey's National Water Quality Assessment (NAWQA) program, VOCs in drinking water supply wells were analyzed. Samples of untreated ground water from drinking water supply wells (1,096 public and 2,400 domestic wells) were analyzed for THMs and other VOCs during 1986-2001 or compiled from other studies (Ivahnenko and Zogorski, 2006). Of the THMs and VOCs assessed, chloroform was the most frequently detected VOC in both public and private well samples. In addition to intentional discharges of chlorinated water for activities such as irrigation and wastewater discharges, potential sources of THMs in public and domestic wells can also include use of septic systems, leakage of chlorinated water from swimming pools, or leakage from drinking water or wastewater distribution systems (Ivahnenko and Zogorski, 2006).

Drinking water facility data for the period between 2004 and 2014 were queried from the State's Drinking Water Database (http://www.dep.state.fl.us/water/drinkingwater/download.htm) and used to calculate average contaminant levels in finished drinking water. Data for each parameter were extracted from the database along with facility information, including sample types, water source, and total population served. Total population served weighted average concentrations were calculated for facilities that a) relied solely on surface water sources, b) relied solely on groundwater sources, and c) all facilities regardless of source. Only samples reported as being taken from the distribution system (sample type = D) were used to calculate the weighted averages, as these are most representative of the potential human exposure levels. The results for chloroform are summarized in **Table 6**.

Table 6. Summary of chloroform concentrations within the distribution systems of Florida drinking water facilities for the period from 2004 to 2014.

Water Source	Number of Samples	Weighted Mean Concentration (µg/L)
Surface Water	522	14.7
Ground Water	1487	16.6
All	2009	15.8

A concentration of 16 µg/L, based on the average of all facilities, was used to estimate the typical exposure from treated potable water. Although the exposure via treated potable water can be considered an ambient exposure for many parameters, it must be handled differently for chloroform because the treatment process creates chloroform as a byproduct of disinfection. The concentration of chloroform in treated water cannot be assumed to be equivalent to ambient levels. In fact, because a majority of chloroform is generated as part of the treatment process and not ambient conditions, it is most appropriate to apportion the treated potable water exposure to non-ambient exposures in the RSC calculation. FDEP adjusted the treated potable water average by deducting the ambient exposure fraction to avoid double exposure accounting. The deduction was accomplished by converting both the treated potable water concentration (16 µg/L) and ambient fraction of treated potable water (0.2 to 0.25 µg/L) into mg exposure per day, based on a consumption of 2.4 L/day drinking water, and then subtracting the ambient fraction from the non-ambient. The non-ambient drinking water exposure was calculated to be between 0.0378 and 0.0379 mg/day. The ambient drinking exposure was calculated to be between $4.8 \cdot 10^{-4}$ and $6.0 \cdot 10^{-4}$ mg/day.

Air

The USEPA considers chloroform to be a hazardous air pollutant (USEPA, 2013C). The high vapor pressure of chloroform signifies the potential for volatilization of chloroform to be an important fate process. According to the ATSDR (1997), typical median indoor air concentrations of chloroform range from approximately $2 \cdot 10^{-4}$ to $4 \cdot 10^{-4}$ ppm (or 0.98 to 1.95 µg/m^3). Significant indoor sources of chloroform are chlorinated tap water, taking showers, and breathing air where chloroform has been released from shower water. The ATSDR (1997) also reported typical levels of atmospheric chloroform exposure in remote, urban, and source-dominated areas ranging from $2 \cdot 10^{-5}$ ppm to $5 \cdot 10^{-5}$ ppm (or 0.098 to 0.24 µg/m^3), $6 \cdot 10^{-5}$ to $2 \cdot 10^{-3}$ (or 0.31 to 10.4 µg/m^3), and $8.2 \cdot 10^{-4}$ to $2.2 \cdot 10^{-2}$ ppm (or 4.3 to 116 µg/m^3), respectively.

According to the USEPA's 2011 National Air Toxics Assessment, the total ambient modeled air concentration of chloroform for Florida was 0.0019 µg/m^3. The total ambient modeled chloroform concentrations estimated for Florida counties ranged from a minimum of 0 µg/m^3 for a number of counties to a maximum of 0.294 µg/m^3 in Miami-Dade County (USEPA, 2015C).

EPA's Ambient Monitoring Archive (AMA) also contained chloroform air monitoring data for Florida. Data were reported from two different studies: a 10-city pilot study in which air was monitored in Pinellas County, and a BP oil spill monitoring study in which air was monitored in Bay County in St. Andrews State Park, Panama City Beach, FL. Data reported from the 10-city pilot study was from 2001, and data reported from the BP oil spill study was from 2010. Data entries that were missing reported sample concentrations were screened out of the dataset. After data screening, there were forty-four data points from the BP oil spill air monitoring study and eight data points from the 10-city pilot study. The average air concentration of chloroform from the BP oil spill air monitoring data is approximately 0.0285 ppb, with a minimum of 0.013 ppb and a maximum reported concentration of 0.042 ppb. The average air concentration of chloroform from the 10-city Pilot study data is 0.055 ppb (0.27 µg/m^3), with a minimum of 0.02 ppb (0.098 µg/m^3) and a maximum reported concentration of 0.11 ppb (0.54 µg/m^3). The average air concentration for the entire dataset is approximately 0.0326 ppb (0.16 µg/m^3), with a minimum of 0.013 ppb (0.063 µg/m^3) and a maximum reported concentration of 0.11 ppb (0.54 µg/m^3) (USEPA, 2015A).

Chloroform was among the Volatile Organic Compounds (VOCs) included in the most recent 2012 National Monitoring Programs Annual Report (UATMP, NATTS, CSATAM) dated September 2014 (USEPA, 2014C). This report analyzed air quality measurements collected at monitoring sites participating in the Urban Air Toxics Monitoring Program (UATMP), the National Air Toxics Trend Station Network (NATTS), and the Community-Scale Air Toxics Ambient Monitoring Network (CASATAM). Thirty monitoring sites established across the United States measured VOC concentrations in ambient air during the 2012 sampling period. No monitoring sites in this VOC analysis occurred in Florida. Sampling and analyses were performed using EPA Compendium Method TO-15. **Table 7** below details the summary statistics associated with the monitoring effort across all 30 sites. The average chloroform across the 30 site National monitoring network was 0.049 ppbv (0.239 µg/m^3).

Table 7. Statistical Summaries of the Chloroform Concentrations Detected at 30 Sites across the United States Assessed as Part of EPA's 2012 National Monitoring Programs Annual Report (UATMP, NATTS, CSATAM)

Pollutant	# of Measured Detections[1]	# of Non-Detects[1]	Minimum[2] (ppbv)	Maximum (ppbv)	Arithmetic Mean (ppbv)	Median (ppbv)	Mode (ppbv)	First Quartile (ppbv)	Third Quartile (ppbv)	Standard Deviation (ppbv)
Chloroform	948	518	0.010	9.37	0.049	0.019	0	0	0.032	0.350

[1] Out of 1,466 valid samples

[2] Excludes zeros for non-detects

Inhalation and dermal exposure through showering

Inhalation and dermal exposures while showering of 0.14 and 0.12 µg/kg-day ($1.4 \cdot 10^{-4}$ and $1.2 \cdot 10^{-4}$ mg/kg-day), respectively, were calculated by the USEPA (2003). FDEP updated both estimates based on more recently available information. The showering inhalation exposure was calculated based on assumptions of a mean concentration of chloroform in the air while showering of 190 µg/m^3, an average breathing rate of 0.67 m^3/hr, average shower duration of 17 minutes/day (EFH Table 16-1), and mean body weight of 80 kg. The estimate of showering time includes both actual shower duration and exposure to chloroform in the bathroom air immediately following the showering activity. The calculation of dermal exposure was based on a mean chloroform concentration of 16 µg/L, dermal absorption of water $3.52 \cdot 10^{-6}$ µg per µg/L per cm^2-min., 17 minute shower duration (EFH Table 16-1), and an average body surface of 19,500 cm^2, which was calculated from the sample weighted adult average from Table 7-9 in the 2011 Exposure Factors Handbook. Using an updated body weight of 80 kg, which was selected to derive EPA's 2015 final human health criteria, the calculated inhalation and dermal exposures while showering were 0.45 and 0.23 µg/kg-day, respectively.

Diet (other than fresh or estuarine fish)

The USEPA (2003) summarized dietary exposure to chloroform from a variety of major food items. FDEP averaged these foods into several broader categories including fruits, vegetables, total meat, dairy, grain, and (marine) fish. The food items were averaged to correspond with food categories provided in the latest edition of the USEPA's Exposure Factors Handbook (USEPA, 2011). The estimates were based on mean contamination levels and ingestion rates (**Table 8**). Dairy and grain products were estimated to contribute the largest intakes. The total exposure of 0.065 mg/day was used to estimate the average exposure via dietary sources other than fresh and estuarine fish.

Table 8. Average concentration of chloroform in various food categories.

Food Category	Mean Concentration µg/g	Consumption (g/kg-day)	Exposure (mg/kg-day)
Fruits	0.010	1.6	$1.6 \cdot 10^{-5}$
Vegetables	0.02	2.9	$5.8 \cdot 10^{-5}$
Total Meat*	0.0486	2	$9.7 \cdot 10^{-5}$
Dairy	0.079	6.6	$5.2 \cdot 10^{-4}$
Grain	0.045	2.6	$1.2 \cdot 10^{-4}$
Marine Fish	0.052	0.16	$8.4 \cdot 10^{-6}$
		Total	$8.18 \cdot 10^{-4}$

*Represents the average of the summed concentrations for beef, pork, lamb, sausage, and poultry

RSC Derivation

EPA (2015G) recommended an RSC of 20 percent (0.20) for chloroform. EPA determined that, based on the physical properties and available exposure information for chloroform, the potentially significant sources are air, drinking water, and non-fish food. EPA followed the

Exposure Decision Tree in USEPA (2000) to determine that significant potential sources other than fish and shellfish from inland and nearshore waters and water ingestion exist (Box 8A in the Decision Tree); however, they found that information was not available to quantitatively characterize exposure from those different sources (Box 8B in the Decision Tree).

FDEP summarized the available data and information (**Table 9**), some of which is Florida-specific, and used it to calculate an applicable RSC using the percentage method for both Class I and Class III waters. Class I waters include ambient exposures via both the fish (fresh and estuarine fish) and the ambient source of drinking water. Class III waters, which also include Class III-Limited and Class II, only include ambient exposures via the consumption of fresh and estuarine fish. The RSCs were calculated by summing the ambient and non-ambient exposures and then dividing the ambient by the total exposure. The summations were done individually for both the lower and upper exposure estimates to provide an estimate of the range of uncertainty. For Class III waters, the percentage-based RSC ranged from 0.017 to 0.11%. The percentage based RSC for Class I waters ranged from 0.28 to 0.46%. Both percentage-based RSC ranges are well below the floor of 0.20 (20%); therefore, the applicable RSC for both Class I and III waters should be 0.20, which is consistent with the value used in EPA (2015G).

Table 9. Summary of major ambient and non-ambient chloroform exposures to the general adult Florida population. Exposures were used in the RSC calculations.

Source Type (Ambient/Non-Ambient)	**Exposure Route**	**Lower Exposure Estimate (mg/kg-day)**	**Upper Exposure Estimate (mg/kg-day)**
Ambient	Fresh and Estuarine Fish	$4.02 \cdot 10^{-7}$	$2.38 \cdot 10^{-6}$
Ambient	Drinking Water	$6.00 \cdot 10^{-6}$	$7.50 \cdot 10^{-6}$
Non-Ambient	Diet	$8.18 \cdot 10^{-4}$	$8.18 \cdot 10^{-4}$
Non-Ambient	Indoor Air	$1.58 \cdot 10^{-4}$	$3.14 \cdot 10^{-4}$
Non-Ambient	Outdoor Air	$7.41 \cdot 10^{-8}$	$1.05 \cdot 10^{-5}$
Non-Ambient	Showering	$6.83 \cdot 10^{-4}$	$6.83 \cdot 10^{-4}$
Non-Ambient	Treated Drinking Water	$4.74 \cdot 10^{-4}$	$4.73 \cdot 10^{-4}$

Toluene

Background

Toluene (CASRN108-88-3) exists as a clear liquid absent of any distinguishable color. Where toluene exists at higher concentrations, it can be identified through a distinct smell distinguishable at air concentrations of 8 ppm and taste in water at concentrations ranging from 0.04 to 1.0 ppm (ATSDR, 2000). Toluene is produced in the process of making gasoline and other fuels from crude oil, in making coke from coal, and as a by-product in the manufacture of styrene (ATSDR, 2000). It is used in a wide variety of commercial products such as paints, paint thinners, fingernail polishes, lacquers, adhesive, rubbers, glues, solvents, and has been promoted as a safer alternative to benzene (Fishbein, 1988). Individuals can be exposed to toluene through ingestion of foods or drinking water, inhalation of volatilized toluene from gasoline, consumer products, or dermal adsorption. However, according to the ATSDR (1993), dermal exposure usually only causes skin irritation. When contact with the solvent is unusually extensive and prolonged, some systemic absorption can occur (ATSDR, 1993). The primary pathway of exposure to toluene is through inhalation.

Toluene is a significantly volatile lipid-soluble substance that is also subject to microbial degradation in soils. Atmospheric degradation of toluene occurs through reactions with atomic oxygen, peroxy or hydroxyl radicals, and ozone (WHO, 2004). According to the ATSDR (2000), the biodegradation half-life of toluene was estimated to range from 4 to 22 days in surface waters and from 7 to 28 days in groundwaters. Due to these characteristics, which occur in multiple types of environmental media (air, soil, water), the tendency for toluene to build up in the environment is minimal (ATSDR, 2000). Select physical and chemical properties of toluene are provided below in **Table 10** adapted from the ATSDR Toxicological profile for toluene (2000).

Table 10. Select Chemical and Physical Properties of Toluene

Chemical/ Physical Property	Quantitative Information	Original Reference
Molecular weight	92.14	Weast 1989
Solubility (water at 25^{0}c)	534.8 mg/L	Howard 1990
Partition Coefficient (low K_{ow})	2.72	Howard 1990
Partition coefficient (log k_{oc})	1.57-2.25	Howard 1990
Vapor Pressure	28.4 mm/Hg	Howard 1990
Henry's Law Constant	$5.94 \cdot 10^{-3}$ atm-m^3/mol	Howard 1990

Exposure Source Determinations

Manufacturing and Release

Toluene is a substance common to the manufacturing of many products and is released to the environment through anthropogenic activities. The largest source of toluene release occurs during the production, transport, and use of gasoline (OEHHA, 1999). According to the USEPA's Toxic Release Inventory (TRI) Explorer, the reported on-site disposal or other releases of toluene in Florida in 2014 totaled 212,906.70 pounds, with a majority of release/disposal occurring through point source air emissions and fugitive air emissions. Total offsite disposal or other releases accounted for 24,175 pounds of toluene in 2014, with a majority of disposal occurring through waste brokers[13] Thus, the total on and offsite disposal or other releases of toluene in Florida in 2014 was 237,081.70 pounds (USEPA, 2015D).

---

[13] Chemicals in waste sent to a broker where the broker sends the waste for disposal, but the facility sending the waste does not know the location of the disposal site and; therefore, reported the name of the waste broker instead.

Review of the release data for 2005 through 2014 for Florida, Alabama, Georgia, and the entire U.S., confirm that the vast majority of environmental releases of toluene are via air emissions (**Table 11**). Surface water discharges account for only a small fraction (0-0.68%) of the emissions. However, information/data retrieved from the USEPA's TRI explorer tool does not represent an exhaustive list of disposals/releases of chemicals due to the fact that only certain types of facilities are required to report this type of information.

Table 11. Summary of average annual percent total releases of toluene to the environment from 2005 through 2014. Air releases include both stack and fugitive air emissions. Surface water discharge includes direct (on-site) releases to water, transfers to POTW for release, and transfers to POTW for treatment (metals only).

Geographic Area	Air Releases	Class I Well Disposal	Land Treatment	Landfill	Other Disposal	Surface Impoundment	Surface Water Discharge
Florida	95.11%	0.00%	0.00%	0.08%	4.79%	0.00%	0.02%
Alabama	93.36%	0.45%	0.02%	1.54%	4.60%	0.03%	0.00%
Georgia	96.60%	0.00%	0.00%	0.18%	2.53%	0.00%	0.68%
U.S. Total	90.99%	1.63%	0.14%	3.99%	2.89%	0.30%	0.06%

Ambient Exposure Sources

Surface Waters

The National Water Quality Assessment Program data analysis spanning 1992-2001 shows that 1,394 samples were collected at 182 surface water sites, of which 69.4% of samples and 60.4% of sites detected toluene (USEPA, 2009A). This analysis also reported a median surface water toluene concentration of 0.06 µg/L, 95th percentile concentration of 0.42 µg/L, and a 99th percentile concentration of 1.289 µg/L (USEPA, 2009A).

Ambient surface water data were queried from the IWR Run 50 database, and the range of measured concentrations from 2005-2014 were assessed. Of the 208 samples, there were only 7 reported toluene results above the MDL. The mean concentration for Florida surface waters was < 0.23 µg/L, with 10th and 90th percentiles of 0.20 and 0.25 µg/L, respectively. The maximum observed concentration was 0.63 µg/L.

Ingestion of Freshwater and Estuarine Fish

Toluene exposures can also occur through ingestion of fish. According to the WHO (2004), toluene concentrations of 1.0 mg/kg have been reported in fish. Toluene is often taken up by aquatic organisms, but metabolism by aquatic biota often limits tissue accumulation of toluene (ATSDR, 2000). Bioaccumulation of toluene is ultimately dependent on the metabolic mechanisms and lipid content of the organism due to the fact that toluene is lipid-soluble.

Because neither Florida specific nor surrogate fish tissue data for toluene could be located, the mean surface water toluene concentration of < 0.23 µg/L calculated from IWR Run 50 data was used in conjunction with EPA's BAFs to estimate average Florida fish tissue concentrations for trophic level 2 through 4 fish. The trophic level specific BAFs used in the calculation were 10, 8, and 11 L/kg for trophic levels 2, 3, and 4, respectively. FDEP estimated average Florida fish tissue concentrations by multiplying the BAFs by the mean surface water concentration and applying a conversion factor (0.001) to convert the units to mg/kg-fish tissue. The estimated average Florida fish concentrations were calculated to be $2.94 \cdot 10^{-5}$, $3.57 \cdot 10^{-5}$, and $7.38 \cdot 10^{-5}$ mg/kg for trophic levels 2, 3, and 4, respectively. FDEP used the total BAF calculated fish tissue concentration ($1.39 \cdot 10^{-4}$) to provide an estimate of exposure through the consumption of fresh and estuarine fish caught in Florida waters.

Non-ambient Exposure Sources

Treated drinking water

According to Fishbein (1988), low levels of toluene, generally ranging from 1-5 µg/L, have been found in a number of American surface, tap, and drinking waters, although levels up to 12 µg/L have been reported in the drinking water and tap water of New Orleans, Louisiana. An MCL for toluene of 1,000 µg/L (1.0 mg/L) has been established by the EPA (USEPA, 2014B). According to 21 CFR 165.110(b), the FDA also established an allowable concentration of toluene in bottled water of 1.0 mg/L.

Because of the physical properties of toluene, it is expected to favor the vapor state, thus promoting evaporation from water. Toluene is regulated as a VOC in drinking water, and all non-purchased community water systems (CWSs) and non-transient non-community water systems (NTNCWSs) are required to sample for VOCs (USEPA, 2009A). In the *Contaminant Occurrence Support Document for Category 1 Contaminants for the Second Six- Year Review of National Primary Drinking Water Regulations*, the USEPA analyzed the reported toluene VOC data from 50,451 public water systems (PWSs) across the United States during the period from 1998 to 2005 (USEPA, 2009A). Of the 50,451 systems, 4,258 facilities utilize surface water as their source water. FDEP analyzed the Six Year Review 2 Contaminant Occurrence Data available for toluene and calculated summary statistics (**Table 12**). Only surface water samples denoted as "SW" in the source water data column were used. Samples denoted as "GU," groundwater under direct influence of surface water, were not used in this assessment even though EPA chose to classify these samples as surface water samples. The following summary statistics were based on reported values and incorporate data from 45 states. Within this dataset, 66 samples were reported from Florida, one of which was reported as a detected concentration of 0.09 µg/L.

Table 12. Toluene Summary Statistics for all "SW" Data

Summary Statistics	Quantitative Result (µg/L)
Number of Samples	81,015
Minimum	0.002
Maximum	740
Average	0.527
90th percentile	0.5
95th percentile	0.5

Drinking water facility data for the period between 2004 and 2014 were queried from the State's Drinking Water Database (http://www.dep.state.fl.us/water/drinkingwater/download.htm) and used to calculate average contaminant levels in finished drinking water. Data for each parameter were extracted from the database along with facility information, including sample types, water source, and total population served. Total population served weighted average concentrations were calculated for facilities that a) relied solely on surface water sources, b) relied solely on groundwater sources, and c) all facilities regardless of source. Only samples reported as being taken from the distribution system (sample type=D) were used to calculate the weighted averages, as these are most representative of the potential human exposure levels. The results for toluene are summarized in **Table 13**.

Table 13. Summary of toluene concentrations within the distribution systems of Florida drinking water facilities for the period from 2004 to 2014.

Water Source	Number of Samples	Weighted Mean Concentration (µg/L)
Surface Water	84	0
Ground Water	829	0.00093
All	913	0.00055

A concentration of 0.00055 µg/L, based on the average of all Florida drinking water facilities, was used to estimate the typical exposure from treated potable water. The ambient drinking exposure was calculated to be $1.32 \cdot 10^{-6}$ mg/day.

Groundwater

Toluene in groundwater exists as an artifact of improper/uncontained waste disposal, chemical spills, or leaks originating from systems such as underground gasoline storage tanks. According to the WHO (2004), point source contamination of groundwater can cause toluene concentrations to reach concentrations ranging from 0.2–1.1 mg/L. In approximately 1% of groundwater-derived public drinking-water systems in the U.S., toluene levels are above 0.5 µg/L (WHO, 2004). In the *Contaminant Occurrence Support Document for Category 1 Contaminants for the Second Six- Year Review of National Primary Drinking Water Regulations*, the USEPA analyzed the reported toluene VOC data from 50,451 public water systems (PWSs) across the U.S. during the period from 1998 to 2005 (USEPA, 2009A). Of the 50,451 systems, 46,193 facilities utilize groundwater as their source water. FDEP assessed the Six Year Review 2 Contaminant Occurrence Data available for toluene and calculated summary statistics (**Table 14**). Only groundwater samples denoted as "GW" in the source water data column were used. The following summary statistics were based on reported values and incorporate data from 45 states. Within this dataset, 4,089 samples were reported from Florida, 39 of which were reported as detects ranging in concentration from 0.05-11 µg/L.

Table 14. Toluene Summary Statistics for All "GW" Data

Summary Statistics	**Quantitative Result (µg/L)**
Number of Samples	289635
Minimum	0.0077
Maximum	5100
Average	0.591
90th percentile	0.5
95th percentile	0.5

<u>Air</u>

Toluene is a significantly volatile substance, thus ambient air exposures are of particular concern. This substance is estimated to have an atmospheric half-life of approximately 13 hours (ATSDR, 2000). Automobile emissions are the primary source of toluene in ambient air (ATSDR, 2000). However, given the extensive presence of toluene in consumer and household products, indoor air possesses higher toluene concentrations than ambient outdoor air. The EPA has established an Inhalation Reference Concentration (RfC) for toluene of 5 mg/m^3 (USEPA IRIS). Additionally, EPA classifies toluene as a hazardous air pollutant (USEPA, 2013C).

Several sources of information were used to estimate concentrations of airbone toluene. In 1996, the mean statewide concentration for airborne toluene in California was estimated as 2.26 ppb (OEHHA, 1999). According to the USEPA's 2011 National Air Toxics Assessment, the total modeled ambient estimated air concentration of toluene for Florida was 1.297 µg/m^3. The total ambient toluene concentrations estimated for Florida counties ranged from a minimum of 0 µg/m^3 for a number of counties to a maximum of 9.153 µg/m^3 in Alachua County (USEPA, 2015C). EPA's Ambient Monitoring Archive (AMA) also contained toluene air monitoring data for Florida. Data were reported from a BP oil spill monitoring study whereby air was monitored in Bay County in St. Andrews State Park, Panama City Beach, FL. Data reported from the BP oil spill study were from 2010. Data entries that were missing reported sample concentrations were screened out of the dataset. After data screening, there were forty-four data points from the BP oil spill air monitoring study. The average air concentration for the dataset was approximately 0.2086 ppb, with a minimum of 0.071 ppb and a maximum reported concentration of 0.391 ppb (USEPA, 2015A).

Toluene was among the Volatile Organic Compounds (VOCs) included in the most recent 2012 National Monitoring Programs Annual Report (UATMP, NATTS, CSATAM) dated September 2014 (USEPA, 2014C). This report analyzed air quality measurements collected at monitoring sites participating in the Urban Air Toxics Monitoring Program (UATMP), the National Air Toxics Trend Station Network (NATTS), and the Community-Scale Air Toxics Ambient Monitoring Network (CASATAM). Thirty monitoring sites established across the US measured VOC concentrations in ambient air during 2012. No monitoring sites in this VOC analysis occurred in Florida. Sampling and analyses were performed using EPA Compendium Method TO-15. **Table 15** below details the summary statistics associated with the monitoring effort across all 30 sites.

Table 15. Statistical Summaries of the Toluene Concentrations Detected at 30 Sites across the United States Assessed as Part of EPA's 2012 National Monitoring Programs Annual Report (UATMP, NATTS, CSATAM)

Pollutant	# of Measured Detections[1]	# of Non-Detects[1]	Minimum[2] (ppbv)	Maximum (ppbv)	Arithmetic Mean (ppbv)	Median (ppbv)	Mode (ppbv)	First Quartile (ppbv)	Third Quartile (ppbv)	Standard Deviation (ppbv)
Toluene	1,466	0	0.017	5.70	0.596	0.362	0.092	0.176	0.737	0.683

[1] Out of 1,466 valid samples

[2] Excludes zeros for non-detects

Toluene concentrations detected in both ambient air and in indoor environments are influenced by seasonal changes, ventilation, and the presence of individuals who smoke. Heroux *et al.* (2010) assessed seasonal (summer and winter) concentrations of indoor air pollutants, including toluene, in Canadian homes to analyze the impacts of occupant activities and housing characteristics on pollutant levels. Levels of VOCs were measured for one 24-hour period per season. During the summer season, a mean toluene concentration of 23.54 µg/m^3 and geometric mean concentration of 11.26 µg/m^3 were calculated for 105 homes. 108 outdoor measurements were also taken during the summer season, resulting in a mean toluene concentration of 1.94 µg/m^3 and a geometric mean concentration of 1.01 µg/m^3. During the winter season, a mean toluene concentration of 21.33 µg/m^3 and a geometric mean of 8.40 µg/m^3 were calculated for 105 homes. 108 outdoor measurements were also taken during the winter season, resulting in a mean concentration of 1.66 µg/m^3 and geometric mean of 1.08 µg/m^3. According to subsequent multivariate modeling, “during the summer, increased levels of toluene were found to result from attached garages, the presence of new furniture or rugs and the use of air conditioning with open windows decreased levels of toluene. However, in the winter the only predictor was the building age, with higher levels in newer homes.” **Table 16** below provides a summary of the toluene data collected during the study and is adapted from Table 2 in Heroux *et al.* (2010).

Table 16. Seasonal Indoor and Outdoor Toluene Concentrations (µg/m^3) Adapted from Heroux *et al.* (2010)

Summer

Site	N	Min	Max	Mean	Std.	Geo Mean	Geo Std.
All homes	105	0.77	314.8	23.54	44.48	11.26	2.97
Non-smoking	91	0.77	314.8	24.76	46.98	11.62	3.02
Outside	108	0.17	61.93	1.94	6.01	1.01	2.47

Winter

Site	N	Min	Max	Mean	Std.	Geo Mean	Geo Std.
All homes	105	0.02	625.2	21.33	76.85	8.40	3.01
Non-smoking	84	0.02	497.5	16.40	54.18	7.89	2.92
Outside	94	0.23	14.82	1.66	2.25	1.08	2.27

Jia *et al.* (2008) conducted indoor and outdoor VOC sampling during two seasons at 159 residences in suburban (Ann Arbor), urban (Ypsilanti), and industrial/urban (Dearborn) cities in southeast Michigan. Ambient average toluene concentrations in each of the cities during summer and winter were 1.15 and 2.46 µg/ m^3, 1.56 and 1.42 µg/ m^3, and 3.98 and 4.28 µg/ m^3 for Ann Arbor, Ypsilanti, and Dearborn respectively. Indoor residential average toluene concentrations in each of the cities during summer and winter were 16.54 and 12.22 µg/ m^3, 28.0 and 11.74 µg/ m^3, and 13.08 and 15.0 µg/ m^3 for Ann Arbor, Ypsilanti, and Dearborn respectively. **Table 17** and **18** below contain summary statistics of toluene concentrations measured in ambient air and in residences adapted from Table 1 and Table 2 in Jia *et al*. (2008).

Table 17. Toluene Concentrations (µg/ m^3) in Ambient Air by City and Season adapted from Jia *et al*. (2008)

Site	Season	Sample Size (N)	Ave	Med	Max
Overall	All Seasons	226	2.61	1.78	21.55
Ann Arbor	Summer	40	1.15	0.78	
Ann Arbor	Winter	42	2.46	1.59	
Ypsilanti	Summer	30	1.56	1.42	
Ypsilanti	Winter	29	1.42	1.37	
Dearborn	Spring	40	3.98	3.36	
Dearborn	Fall	45	4.28	3.68	

Table 18. Toluene Concentrations (µg/ m^3) in Residences by City and Season adapted from Jia *et al*. (2008)

Site	Season	Sample Size (N)	Ave	Med	Max
Overall	All Seasons	252	15.56	6.82	197.32
Ann Arbor	Summer	46	16.54	5.62	
Ann Arbor	Winter	50	12.22	5.99	
Ypsilanti	Summer	30	28.0	13.96	
Ypsilanti	Winter	29	11.74	9.06	
Dearborn	Spring	45	13.08	7.56	
Dearborn	Fall	52	15.0	6.43	

Chan *et al.* (1991) conducted an assessment of commuter exposures to VOCs, including toluene, in Boston Massachusetts. Methods of commuting that were assessed were driving of personal cars, use of public transit (electric trains), walking, and biking. Twenty-five individuals were selected for the study, which was conducted from November 2, 1989 to January, 18 1990, of which nine commuters drove cars to work, seven took public transportation, six walked, and three biked. Resultant mean concentrations of toluene exposure by commuting type are found below in **Table 19** and are adapted from Table 1 in Chan *et al*. (1991).

Table 19. Toluene Concentrations by Commuting Type adapted from Chan et al (1991)

Commuting Type	Sample Size	Mean Toluene Concentration (µg/m^3)
In-vehicle	40	33.1
Subway	37	30.8
Walking	31	19.8
Biking	11	16.3

The USEPA reports that levels of toluene measured in rural, urban, and indoor air average 1.3, 10.8, and 31.5 µg/m^3, respectively (USEPA, 2012B; ATSDR, 2000).

FDEP used an average indoor and outdoor air exposure concentration of 0.0196 mg/m^3 and 0.001297 mg/m^3, respectively, for purposes of RSC calculations for toluene. The indoor air concentration was selected as the mid-point between the range (0.01556 to 0.02354 mg/m^3) reported by Heroux *et al*. (2010) and Jia *et al.* (2008) for indoor air. The outdoor number was selected based on the total modeled ambient toluene concentration reported by the USEPA's National Air Toxics Assessment (USEPA, 2011).

Oceanic/ marine levels

Information on typical concentrations of toluene detected in oceanic environments could not be located.

Soil

The tendency for toluene to exist in the adsorbed state within soils is dependent upon soil pH (IPCS, 1985). According to the WHO (2004), the extent to which toluene is biodegraded in soil ranges from 63% to 86% after 20 days. Information regarding typical toluene concentrations in soils could not be located. According to the ATSDR (2000), in the absence of continuous releases from a waste site, it is expected that toluene would not persist for long periods in soil, due to its volatility, susceptibility to biodegradation, and water solubility. Therefore, under typical exposure scenarios, exposure through soil ingestion is estimated to be negligible.

Diet (other than fresh or estuarine fish)

Residual concentrations of toluene are detected in a wide variety of food types. Toluene is also classified as an indirect food additive for use only as a component of adhesives (HSDB No. 131). The United States Food and Drug Administration conducted an analysis of pesticide residuals in specific food types through their Total Diet Study program. The information summarized in this analysis pertains to Total Diet Study market baskets 1991-3 through 2003-4 collected between September 1991 and October 2003 (USFDA, 2006). FDEP analyzed each specific food type for reported toluene concentrations. Each food type was then separated into a distinct category: fruits, vegetables, meats, dairy, grain, fish (marine), and fats. Foods not included from the analysis were considered to be composite foods (*e.g.*, Quarter-pound hamburger on bun; Frozen dinner of Salisbury steak with gravy, potatoes, and vegetables; beef chow mein, from Chinese carry-out) covered by each previously delineated category. Toluene concentrations for each food category were then averaged and are provided in **Table 20**. The dietary exposure estimates in **Table 20** were used for purposes of RSC calculation.

Table 20. Estimated average toluene concentrations from FDA's Total Diet Study market baskets 1991-3 through 2003-4.

Food Category	Average Concentration (µg/g)
Fruits	0.002131
Vegetables	0.00336
Meats	0.0179
Dairy	0.0215
Fish (marine)	0.0267
Grains	0.00656
Fats	0.0155

Exposures for potentially highly exposed individuals

Certain individuals may be exposed to higher concentrations of toluene than received by the general public. Occupations that require individuals to work with gasoline, paints, lacquers, or solvents may be exposed to higher concentrations of toluene on a daily basis due to the composition of these substances and the inherent nature of toluene to volatilize. Individuals who smoke cigarettes expose themselves to higher concentrations of toluene than found in ambient air. Smoking may contribute 1,000 µg/day or more of toluene to an individual's daily exposure (ATSDR, 2000). The dangerous and abusive habit of sniffing glues may increase an individual's exposure to toluene if it does not outright kill them first. Proximity to hazardous waste sites may also increase exposures to toluene.

RSC Derivation

Based on the physical properties and available exposure information for toluene, EPA determined that air and drinking water are potentially significant sources. Following the Exposure Decision Tree in EPA's 2000 Methodology (USEPA, 2000), significant potential sources other than fish and shellfish from inland and nearshore waters and water ingestion exist (Box 8A in the Decision Tree); however, information is not available to quantitatively characterize exposure from those different sources (Box 8B in the Decision Tree). Therefore, EPA recommends an RSC of 20 percent (0.20) for toluene (USEPA, 2015M).

FDEP summarized the available data and information (**Table 21**), some of which are Florida specific, and used it to calculate an applicable RSC using the percentage method for both Class I and Class III waters. Class I waters include ambient exposures via both the fish (fresh and estuarine fish) and the ambient drinking water sources. Class III waters, which also include Class III-Limited and Class II, only included ambient exposures via the consumption of fresh and estuarine fish. The percentage method based RSCs were calculated by summing the ambient and non-ambient exposures and then dividing the ambient by the total exposure. The calculated RSCs for both Class I and III waters were 0.039 (3.9%); therefore, the applicable RSC for both Class I and III waters should be set at the floor of 0.20, which is consistent with the value used by EPA (2015M).

Table 21. Summary of major ambient and non-ambient toluene exposures to the general adult Florida populations. Exposures were used in the RSC calculations.

Source Type (Ambient/Non-Ambient)	Exposure Route	Exposure Estimate (mg/kg-day)
Ambient	Fresh and Estuarine Fish	$1.74 \cdot 10^{-6}$
Ambient	Drinking Water	$1.65 \cdot 10^{-8}$
Non-Ambient	Diet	$2.31 \cdot 10^{-4}$
Non-Ambient	Indoor Air	$5.06 \cdot 10^{-5}$
Non-Ambient	Outdoor Air	$2.31 \cdot 10^{-4}$

Nitrobenzene

Background

Nitrobenzene (CASRN 98-95-3) is a synthetic colorless to pale yellow, oily liquid with an odor resembling that of bitter almonds or shoe polish. Ninety-five percent of nitrobenzene is used in the production of aniline, a major chemical intermediate that is used in the manufacture of polyurethanes. Nitrobenzene is also used as a solvent in petroleum refining, as a solvent in the manufacture of cellulose ethers and acetates, in the manufacture of dinitrobenzenes and dichloroanilines, and in the synthesis of other organic compounds, including acetaminophen. Nitrobenzene had some use in the early 20th century as a food additive (substitute for almond essence) as well as extensive use as a solvent in various proprietary products, including boot polish, inks and several disinfectants. Most (97% to 98%) of the nitrobenzene produced is retained in closed systems for use in synthesis of aniline and other substituted nitrobenzenes and anilines, thus limiting its release into air (ATSDR, 1990).

There was a significant increase in annual production of nitrobenzene between the 1950's and 1990's (ATSDR, 1990). The demand for nitrobenzene has increased steadily from 73,000 metric tons in 1960 to 1,390,000 metric tons in 2007 (IARC, 1996; Bizzari and Kishi, 2007). In 1995, nitrobenzene ranked 49th in volume among chemicals produced in the U.S. (Kirschner, 1996). In 2009, there were 5 U.S. producers and 20 U.S. suppliers of nitrobenzene (SRI, 2009). Imports and exports of nitrobenzene are reported to be negligible (ATSDR, 1990; HSDB, No.104).

Nitrobenzene has a vapor pressure of 0.245 mm Hg at 25° C indicating that the compound exists solely as a vapor in the atmosphere. Vapor-phase nitrobenzene is degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals. The half-life for this reaction in air is estimated to be 115 days. In the atmosphere, nitrobenzene should degrade primarily by photolysis (38% degradation in 5 hr).

Volatilization is expected to be an important fate process in both water and soil based upon the compound's Henry's Law constant. If released to soil, nitrobenzene is expected to have very high to moderate mobility based upon K_{oc} values of 30.6 to 370. Estimated volatilization half-lives for a model river and model lake were 44 hours and 17 days, respectively. Additionally, nitrobenzene is expected to biodegrade under both aerobic and anaerobic conditions in both soil and water. Nitrobenzene was rapidly biodegraded after a lag phase of 70 to 85 days in an aerobic aquifer test done with groundwater and sediment from 8 locations over a 149-day incubation period. Nitrobenzene may be degraded in water by photolysis (a half-life of 133 days), reaction with hydrated electrons in eutrophic lakes (a half-life of 22 days), or reaction with sunlight and nitrate (a measured half-life of 11 hours).

The general population can be exposed to nitrobenzene in air and possibly drinking-water. There is also potential exposure from consumer products, but accurate information is lacking. Based on air studies and on estimates of releases during manufacture, only populations in the vicinity of manufacturing activities and petroleum refining plants are likely to have any significant exposure to nitrobenzene (ATSDR, 1990). However, people living in and around abandoned hazardous waste sites may also have the potential for higher exposure, due to possible groundwater and soil contamination and uptake of nitrobenzene by plants. Exposure is mitigated by environmental degradation, including photolysis and microbial biodegradation. Nitrobenzene is poorly bioaccumulated and not biomagnified through the food chain (ATSDR, 1990). Select physical and chemical properties of nitrobenzene are displayed below in **Table 22** adapted from the ATSDR Toxicological profile for nitrobenzene (1990).

Table 22 Select Chemical and Physical Properties of Nitrobenzene

Chemical/ Physical Property	Quantitative Information	Original Reference
Molecular weight	123.11	Weast 1985
Solubility (water at 20^0c)	1900 mg/L	Mabey *et al.* 1982
Partition Coefficient (low K_{ow})	1.87	Mabey *et al.* 1982
Partition coefficient (log k_{oc})	1.56	Mabey *et al.* 1982
Vapor Pressure at 20^0C	0.15 mmHg	Mabey *et al.* 1982
Henry's Law Constant	$1.31 \cdot 10^{-5}$ atm-m^3/mol	Mabey *et al.* 1982

Exposure Source Determinations

Manufacturing and release

The US EPA's Toxic Release Inventory (TRI) Explorer did not include any data for nitrobenzene disposal or other releases in Florida for 2014, thus release data were obtained for EPA Region 4 (USEPA, 2015D). Total on-site disposal or other releases in EPA Region 4 in 2014 accounted for 11,343 pounds of nitrobenzene, with the majority of the disposal/ release occurring through fugitive and point source air emissions. Total off-site disposal and other releases in EPA Region 4 in 2014 accounted for 65 pounds of nitrobenzene. Thus, total on and off-site disposal and other releases that occurred in 2014 in EPA Region 4 accounted for 11,408 pounds of nitrobenzene. Information/data retrieved from the USEPA's TRI explorer tool does not represent an exhaustive list of disposals/releases of chemicals due to the fact that only certain types of facilities are required to report this type of information.

Review of the release data for the period from 2005 through 2014 for Florida, Alabama, Georgia, and the entire U.S., shows the vast majority of environmental releases of nitrobenzene are either to air or Class I disposal wells (**Table 23**). There were no reported emissions within the states of Florida or Georgia for the period.

Table 23. Summary of average annual percent total releases of nitrobenzene to the environment from 2005 through 2014. Air releases include both stack and fugitive air emissions. Surface water discharge includes direct (on-site) releases to water, transfers to POTW for release, and transfers to POTW for treatment (metals only).

Geographic Area	Air Releases	Class I Well Disposal	Land Treatment	Landfill	Other Disposal	Surface Impoundment	Surface Water Discharge
Florida		-	-	-	-	-	-
Alabama	100%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Georgia	-	-	-	-	-	-	-
US Total	11.13%	88.20%	0.07%	0.47%	0.10%	0.00%	0.03%

Ambient Exposure Sources

Surface Waters

Staples *et al.*, (1985) summarized priority pollutant concentrations in the U.S. using the STORET Database, and reported a median nitrobenzene concentration of <10 µg/L based on 836 samples with a 0.04% detection rate. FDEP queried the ambient surface water data from the IWR Run 50 database, and there were no reported detections of nitrobenzene out of 201 samples from 2005-2014. Sample MDLs averaged 1.2 µg/L, with a range from 0.13 to 2.3 µg/L. The mean surface water concentration was calculated to be <0.6 µg/L based on ½ MDL replacement for values reported below the detection limit. The department assumed a range of ambient surface water concentrations ranging from 0 to < 0.6 µg/L for purposes of RSC calculations.

Ingestion of Freshwater and Estuarine Fish

Nitrobenzene is infrequently reported in fish tissue. It has not been detected as a bioaccumulated material in fish samples based on a review of STORET data (Staples *et al.* 1985). Surveys of nitrobenzene in fish were carried out in Japan in 1991. Nitrobenzene was detected in 4 of 147 fish samples at a level of 11–26 µg/kg (detection limit 8.7 µg/kg) (Environment Agency Japan, 1992).

Fresh and estuarine fish tissue nitrobenzene concentration data from Florida or the U.S. in general could not be located. Therefore, the mean surface water nitrobenzene concentration of < 0.6 µg/L calculated from IWR Run 50 data was used in conjunction with the Florida BAFs to estimate average Florida fish tissue concentrations for trophic level 2 through 4 fish. The trophic level specific BAFs used in the calculation were 2.2, 2.0, and 2.4 L/kg for trophic levels 2, 3, and 4, respectively. FDEP developed estimated average Florida fish tissue concentrations by multiplying the BAFs by the mean surface water concentration and applying a conversion factor (0.001) to convert the units to mg/kg-fish tissue. The estimated average Florida fish nitrobenzene concentrations were calculated to be $1.69 \cdot 10^{-5}$, $2.09 \cdot 10^{-5}$, and $4.20 \cdot 10^{-5}$ mg/kg for trophic levels 2, 3, and 4, respectively. FDEP used the total BAF calculated fish tissue concentration ($7.98 \cdot 10^{-4}$ mg/kg) to provide an estimate of exposure through the consumption of fresh and estuarine fish caught in Florida waters. Given that there have been no reported nitrobenzene releases to either Florida waters or upstream waters (Table 25), it can be assumed that exposure via the consumption of fresh and marine fish is negligible or nearly zero. For this reason FDEP used lower and upper bound exposures estimates of 0 and $7.98 \cdot 10^{-4}$ mg/kg for purposes of the calculating the RSC.

Non-ambient Exposure Sources

Treated Drinking Water

Kopfler *et al*. (1977) listed nitrobenzene as one of the chemicals found in finished tap water in the U.S., but did not report its concentrations or locations. Nitrobenzene was detected in 1 of 14 samples of treated water in the United Kingdom. The positive sample was water derived from an upland reservoir (Fielding *et al.,* 1981). In a survey of 30 Canadian potable water treatment facilities, nitrobenzene was not detected in either raw or treated water (detection limit 5 µg/L) (Otson *et al.,* 1982).

Nitrobenzene is currently not regulated in drinking water in the U.S., but does occur on EPA's Contaminant Candidate List 3 (CCL 3). This is a list of contaminants that are currently not subject to any proposed or promulgated national primary drinking water regulations, are known or anticipated to occur in public water systems, and which may require regulation under the Safe Drinking Water Act (SDWA). FDEP used the mean surface water concentration (<0.6 µg/L) from the IWR Run 50 database as the basis of an upper end exposure estimate for treated drinking water. It also assumed that the lower exposure was near 0 µg/L.

Groundwater

Nitrobenzene is infrequently reported in groundwater. It was detected in groundwater at 3 of 862 hazardous waste sites in the U.S. at a geometric mean concentration of 1400 µg/L, according to the Contract Laboratory Program Statistical Database (CLPSD, 1988). Nitrobenzene was not detected (<1.13 µg/L) in groundwater at an explosives manufacturing site in the U.S., although the aquifer at the site was known to be contaminated with explosives residues (Dennis *et al*., 1990; Wujcik *et al*., 1992). Nitrobenzene was also detected at a level of 210–250 µg/L in groundwater from Gibbstown, New Jersey (Rosen *et al.,* 1992).

Air

The USEPA considers nitrobenzene to be a hazardous air pollutant (USEPA, 2013C). Direct release of nitrobenzene to air during its manufacture is minimized by the passage of contaminated air through activated charcoal (USEPA, 1983), and its subsequent use in closed systems as an intermediate limits direct exposure during industrial processing. Much of the information on nitrobenzene levels in air is derived from a series of reports from New Jersey in which ambient air in urban, rural, and waste disposal areas was monitored extensively. In the initial study by Bozzelli *et al*., (1980), nitrobenzene was not detected above 0.05 µg/m^3 in about 260 samples collected in 1979. In 1978, nitrobenzene levels averaged 2.0 µg/m^3 in industrial areas and 0.1 µg/m^3 and 0.46 µg/m^3 in two residential areas; in 1982, levels in residential areas were approximately 1.5 µg/m^3 or less, whereas levels in industrial areas were 46 µg/m^3 or more (Bozzelli and Kebbekus, 1982).

Little information is available for other areas of the U.S. Pellizzari (1978) found only one positive value of 107 ng/m^3 at a plant site in Louisiana. The USEPA (1985) summarized data showing that less than 25% of U.S. air samples were above detection, with a median concentration of about 0.05 µg/m^3. USEPA found that mean levels measured in urban areas are generally low (<1 µg/m^3), whereas slightly higher levels (mean 2.0 µg/m^3) have been measured in industrial areas.

Harkov *et al*. (1983, 1984) carried out a seasonal comparison of concentrations of VOCs detected at three urban New Jersey sites (Newark, Elizabeth, and Camden). Samples were collected as part of the New Jersey Airborne Toxic Elements and Organic Substances (ATEOS) program on a 24-hour basis, seven days a week for six weeks during summer and winter. In summer, the geometric mean levels detected at the three sites were 0.07 ppb, 0.10 ppb, and 0.07 ppb. In winter, the geometric means reported for nitrobenzene at all 3 sites were all zero. Hunt *et al*., (1986), using the data collected by Harkov *et al.* (1984), calculated the arithmetic means for the three sites as 0.96, 1.56 and 2.1 µg/m^3 in the summer and 0.050, 0.050 and 0.10 µg/m^3 in the winter.

Table 24 summarizes ambient air-based nitrobenzene concentrations from a number of studies. The overall mean of U.S. studies is 0.742 µg/m^3, which translates to a daily inhalation exposure of 0.15 µg/kg-day. The inhalation exposure was calculated based on 80 kg body weight and 16 m^3/day inhalation volume (USEPA, 2011). This inhalation exposure estimate represents an extremely conservative value for Florida because it is biased towards highly industrialized areas in New Jersey.

Table 24. Measured levels of nitrobenzene in air from various literature sources.

Location (samples)	Mean level (µg/m^3)	Reference
Camden, USA, July–August 1981 (24-h average)	0.96 (max. 10.0)	Hunt *et al.*, 1986
Camden, USA, January–February 1982 (24-h average)	0.050 (max. 0.75)	Hunt *et al.*, 1986

Location (samples)	**Mean level (µg/m^3)**	**Reference**
Elizabeth, USA, July–August 1981 (24-h average)	1.56 (max. 24.1)	Hunt *et al.*, 1986
Elizabeth, USA, January–February 1982 (24-h average)	0.050 (max. 0.35)	Hunt *et al.*, 1986
Newark, USA, July–August 1981 (24-h average)	2.1 (max. 37.5)	Hunt *et al.*, 1986
Newark, USA, July–August 1982 (24-h average)	0.10 (max. 1.26)	Hunt *et al.*, 1986
Six sites in New Jersey, USA (sampled every 6 days for 1–2 years)	<0.050	Bozzelli & Kebbekus, 1982
Industrial site, New Jersey, USA (241 samples)	2.0	Bozzelli & Kebbekus, 1982
Residential site, New Jersey, USA (49 samples)	0.10	Bozzelli & Kebbekus, 1982
Residential site, New Jersey, USA (40 samples)	0.45	Bozzelli & Kebbekus, 1982
Japan	0.14 (range 0.0022–0.16)	Environment Agency Japan, 1992

Emissions and modeled nitrobenzene concentrations were queried from the EPA National-Scale Air Toxics Assessment (NATA; USEPA, 2015C). NATA is EPA's ongoing comprehensive evaluation of air toxics in the U.S. EPA developed NATA as a state-of-the-science screening tool for state/local/tribal agencies to prioritize pollutants, emission sources, and locations of interest for further study in order to gain a better understanding of risks. NATA assessments do not incorporate refined information about emission sources, but rather, use general information about sources to develop estimates of risks that are more likely to overestimate impacts than underestimate them. The resulting risk estimates are purposefully more likely to be overestimates of health impacts than underestimates, and thus they are protective.

FDEP downloaded the most recent 2011 NATA results (USEPA, 2015C). Data for all Florida and New Jersey counties were queried from the database (https://www.epa.gov/national-air-toxics-assessment/2011-nata-assessment-results). New Jersey was queried because the majority of nitrobenzene studies have been conducted in the state and there was an interest in evaluating the degree by which New Jersey-based estimates would overestimate conditions in Florida. **Table 25** summarizes the statewide total (combined point and nonpoint sources) and maximum by county nitrobenzene air concentration estimates for each state. Average daily exposures were calculated for both Florida and New Jersey (**Table 25**). These estimates suggest that average and maximum nitrobenzene concentrations in the air are 3,405 and 76,923 times, respectively, greater in New Jersey than in Florida (**Table 25**).

Table 25. Total ambient modeled and maximum air concentrations across all Florida and New Jersey Counties based on data from NATA (2011). Total concentrations are based on the statewide estimates, while the maxima represent the highest county value reported in NATA (2011). Average daily intakes were calculated based on average concentrations, a daily inhalation volume of 16 m^3/day, and a body weight of 80 kg (USEPA, 2011).

State	Total ambient modeled Air Concentration (μg/m^3)	Maximum Air Concentration (μg/m^3)	Average Intake (μg/kg-day)
FL	$1.58 \cdot 10^{-8}$	$2.99 \cdot 10^{-7}$	$3.16 \cdot 10^{-9}$
NJ	$5.38 \cdot 10^{-5}$	0.023	$1.08 \cdot 10^{-5}$

EPA's ambient monitoring archive did not contain any nitrobenzene concentrations from monitoring conducted in Florida.

Oceanic/marine Levels

Information on nitrobenzene levels in marine fish and shellfish was not found in the literature. Data and information on nitrobenzene levels in marine waters is also limited. Weigal *et al*., (2005) quantified pesticides and industrial chemicals in the North Sea. They reported nitrobenzene concentrations ranging from 0.26 to 4.4 ng/L. The highest concentrations (2.5-4.4 ng/L) were in areas influenced by the river Elbe. Concentrations within the central regions of the North Seas were typically around 0.7 ng/L. A conservative estimate of nitrobenzene concentrations in marine fish tissue can be calculated using the trophic level 4 BAF of 3.1 g/L multiplied by a conservative ocean water concentration of 4.4 ng/L, resulting in an estimated ocean fish tissue concentration of $1.36 \cdot 10^{-5}$ mg/kg. This estimated exposure is highly conservative for the general population and assumes that all fish consumed originate from the most highly contaminated waters.

Soil

As a potential nitrobenzene exposure source, soil is less important than air or groundwater. Nelson and Hites (1980) reported a nitrobenzene concentration of 8 mg/kg in the soil of a former dye manufacturing site along the bank of the industrially polluted Buffalo River in New York, but failed to detect nitrobenzene in river sediments. Exposure via soil intake is unlikely to be a source for the general population given that only low concentrations have been detected at former manufacturing sites at which the general population has extremely limited access. Additionally, given the extremely low atmospheric concentrations ($1.05 \cdot 10^{-6}$ μg/m^3), atmospheric deposition is expected to be negligible outside of manufacturing areas; thus, soils outside of manufacturing sites are highly unlikely to be contaminated and the estimated exposure can be assumed to be negligible.

Other sources

Nitrobenzene has not been found in other environmental media. Data on nitrobenzene occurrence in foods was not located in the available literature. No monitoring of plant tissues has been reported, even though uptake of nitrobenzene by plants has been observed (McFarlane *et al.* 1987A, 1987B). General population exposure via diet is expected to negligible for the same reasons as soils.

RSC Derivation

EPA (2015L) recommended an RSC of 20 percent (0.20) for nitrobenzene based on the physical properties and available exposure information for nitrobenzene indicating air is a potentially significant source. Following the Exposure Decision Tree in EPA's 2000 Methodology (USEPA 2000), a significant potential source other than fish and shellfish from inland and nearshore waters and water ingestion exists (Box 8A in the Decision Tree); however, information is not available to quantitatively characterize exposure from this source (Box 8B in the Decision Tree).

FDEP summarized the available data and information (**Table 26**), some of which are Florida-specific, and used it to calculate an applicable RSC using the percentage method for both Class I and Class III waters. Class I waters included ambient exposures through the consumption of fish and shellfish, and consumption of drinking water. Class III waters, which also include Class III-Limited and Class II, only included ambient exposures via the consumption of fresh and estuarine fish. The percentage method based RSCs were calculated by summing the ambient and non-ambient exposures and then dividing the ambient exposures by the total exposures. For both Class I and III waters, the percentage based RSC ranged from 0 to 99.9%. The extremely wide range in the percentage method RSCs is due to the high level of uncertainty in existing ambient concentrations and exposures; that is, there is insufficient information to adequately characterize the exposure. Therefore, following the Decision Tree would lead to an RSC of 0.2.

Table 26. Summary of major ambient and non-ambient nitrobenzene exposures to the general adult Florida populations. Exposures were used in the RSC calculations.

Source Type (Ambient/Non-Ambient)	Exposure Route	Exposure Estimate (mg/kg-day)
Ambient	Fresh and Estuarine Fish	$0 – 9.98 \cdot 10^{-7}$
Ambient	Drinking Water	$0 – 1.80 \cdot 10^{-5}$
Non-Ambient	Diet[1]	$2.20 \cdot 10^{-9}$
Non-Ambient	Indoor Air	negligible
Non-Ambient	Outdoor Air	$4.20 \cdot 10^{-10}$
Non-Ambient	Soil	negligible

[1] Dietary value solely based on estimated consumption of marine fish. The inputs to calculate this exposure estimate include an estimated exposure concentration of $1.36 \cdot 10^{-5}$ mg/kg and a marine fish intake of 0.16 g/kg-day.

Selenium

Background

Selenium (CASRN 7782-49-2) is classified as a naturally occurring, solid metalloid substance within the earth's crust, rocks, and soil (IPCS, 1987). Distribution of selenium varies regionally and it is found more commonly at higher concentrations in drier regions of the western and mid-western United States (ATSDR, 2003). In the environment, pure elemental selenium is rare, while selenium compounds incorporating substances such as oxygen and sulfides predominate. According to the ATSDR (2003), selenium is produced commercially, primarily as a byproduct of copper refining. Selenium is also found in a wide range of consumer products such as plastics, paints, dietary supplements and anti-dandruff shampoos and is important to a wide variety of industries including electronic, pharmaceutical, and agricultural sectors (Barceloux, 1999).

Selenium is an essential micronutrient supporting human life and primary exposure occurs orally through dietary consumption followed by water intake and air exposure (Barceloux, 1999). Environmental processes such as weathering and erosion play a role in the distribution of selenium in the environment. These processes lead to the dispersion of airborne particulate matter/ aerosols and deposition of selenium into waterways, which has the capacity to promote subsequent vegetative uptake and/or bioaccumulation in aquatic species. Sodium selenate is the most water soluble selenium species (ATSDR, 2003). Anthropogenic release triggered by activities such as the burning of coal emits selenium compounds to the atmosphere. According to the OEHHA (2010), selenium has the capacity to exist in three distinct states within the atmosphere: the vapor phase, as a gas, or as a component of precipitation. The mobility and ultimate fate and transport of selenium and selenium compounds within soils is reliant on soil acidity and oxygen interactions (ATSDR, 2003). Dose and responses to selenium exposures are also influenced by factors such as profession/occupational setting, dietary consumption patterns, and place of residence.

Exposure Source Determinations

Manufacturing and Release

Many industrial sectors use selenium and/or selenium-based compounds as a component of their manufacturing processes including applications such as manufacturing of ceramics, steel, vulcanization of rubber, and the production of pigments (Barceloux, 1999).

According to the USEPA's Toxic Release Inventory (TRI) Explorer, total reported on-site disposal or other releases of selenium in Florida in 2014 accounted for 8,375 pounds, with a majority of release/disposal occurring through point source air emissions and other onsite landfills (USEPA, 2015D). There was no reported offsite disposal or other releases of selenium in Florida in 2014. Additionally, there were no reported releases for the period from 2005 through 2014 for Florida, Alabama, or Georgia. The majority of environmental releases nationally were to landfills, with only a small fraction (0.4%) to surface water discharges (**Table 27**).

Table 27. Summary of average annual percent total releases of selenium to the environment from 2005 through 2014. Air releases includes both stack and fugitive air. Surface water discharge includes direct (on-site) releases to water, transfers to POTW for release, and transfers to POTW for treatment (metals only). NOTE: There were no reported releases of selenium for the states of Alabama, Florida, and Georgia.

Geographic Area	Air Releases	Class I Well Disposal	Land Treatment	Landfill	Other Disposal	Surface Impoundment	Surface Water Discharge
US Total	8.15%	0.64%	0.00%	83.89%	2.84%	0.03%	0.41%

Ambient Exposure Sources

Surface Waters

Selenium levels in the majority of U.S. surface water bodies are relatively low. As documented by the ATSDR (2003), Lakin and Davidson 1967 conducted a study of selenium concentrations in major watersheds of the U.S. and detected selenium in only 2 of 535 samples (<0.5%) at a concentration greater than the lowest detection limit of 0.010 mg/L. The National Water Quality Assessment Program data analysis spanning 1992-2001 found that 3,269 surface water samples were collected at 462 sites, of which 28.2% of samples and 23.4% of sites detected selenium (USEPA, 2009B). This analysis also reported a median surface water selenium concentration of 2.155 µg/L, a 95th percentile concentration of 17 µg/L, and a 99th percentile concentration of 78 µg/L (USEPA, 2009B).

Ambient surface water data from Florida were queried from the IWR Run 50 database, and the range of measured concentrations over the ten-year period from 2005-2014 were evaluated. Out of 23,482 samples, 1,294 results were above the detection limit, and the mean concentration for Florida surface waters was 2.5 µg/L, with 10th and 90th percentiles of 0.31 and 2.52 µg/L, respectively. The maximum observed concentration was 95 µg/L. The mean concentration was used both as an estimate of the expected range in Class I waters (ambient fraction of treated potable water) and to calculate potential fish tissue concentration.

Ingestion of Freshwater and Estuarine Fish

Aquatic biota have the potential to bioaccumulate selenium within their own tissues and biomagnify selenium concentrations through trophic chains (ATSDR, 2003). NOAA’s Mussel Watch Survey has detected selenium in fish and shellfish (NOAA, 2014), but it does not appear that selenium was a parameter assessed in fish tissue during the National Lake Fish Tissue Study. According to Presser (2010), selenium toxicity arises when dissolved selenium is transformed to organic selenium after uptake by bacteria, algae, fungi, and plants and then passed through food webs.

Fresh and estuarine fish tissue concentration data could not be located. Therefore, the mean surface water selenium concentration of 2.5 µg/L, calculated from IWR Run 50 data, was used in conjunction with the selenium BCF (4.8) to estimate an average Florida fish tissue concentration.

FDEP developed estimated average Florida fish tissue concentrations by multiplying the BAFs by the mean surface water concentration and applying a conversion factor (0.001) to convert the units to mg/kg-fish tissue. The estimated average Florida fish concentration was estimated to be $7.13 \cdot 10^{-4}$ mg/kg.

Non-ambient Exposure Sources

Treated drinking water

Selenium concentrations in treated/municipal drinking water tend to be very low. The U.S. EPA has established a Maximum Contaminant Level (MCL) for selenium in drinking water of 0.05 mg/L (US EPA, 2014B). The FDA has also established an allowable concentration of selenium in bottled water of 0.05 mg/L (21 CFR 165.110 (b)). According to the ATSDR (2003), selenium levels were less than 10 µg/L in 99.5% of drinking water sources tested. According to the USEPA, selenium concentrations in trace amounts ranging from non-detect to 0.01 mg/L are routinely found in drinking water (USEPA, N.D.).

Selenium is regulated as an inorganic chemical (IOC) in drinking water, and all community water systems (CWSs) and non-transient non-community water systems (NTNCWSs) are required to sample for the IOCs. In the *Contaminant Occurrence Support Document for Category 2 Contaminants for the Second Six-Year Review of National Primary Drinking Water Regulations*, the U.S. EPA analyzed the reported selenium IOC data from 48,925 public water systems (PWSs) across the U.S. from 1998 to 2005 (USEPA, 2009). Of the 48,925 systems, 4,001 facilities utilize surface water as their source water. The department assessed the Six Year Review 2 Contaminant Occurrence Data available for selenium and calculated summary statistics (**Table 28)**. Only surface water samples denoted as “SW” in the source water data column were used. Samples denoted as “GU,” groundwater under direct influence of surface water, were not used in this assessment even though EPA chose to classify these samples as surface water samples. Four additional samples that were reported as non-detect were screened and removed from the dataset because of anomalously high reported values that were very different from other samples reported by the same facilities. The summary statistics were based on reported values and incorporate data from 45 states. Within this dataset, 61 samples were reported from Florida, six of which were reported as detects ranging in concentration from 0.001-0.004 mg/L.

Table 28. Selenium Summary Statistics for All "SW" Data

Summary Statistics	Quantitative Result (mg/L)
Number of Samples	38,265
Minimum	0.000003
Maximum	0.20
Average	0.0046
90th percentile	0.0052
95th percentile	0.01

Drinking water facility data for the period between 2004 and 2014 were queried from the State's Drinking Water Database (http://www.dep.state.fl.us/water/drinkingwater/download.htm) and used to calculate average contaminant levels for Florida finished drinking water. Data for each parameter were extracted from the database along with facility information, including sample types, water source, and total population served. Total population served weighted average concentrations were calculated for facilities that relied solely on surface water sources, facilities that relied solely on groundwater sources, and all facilities regardless of source. Only samples reported as being taken from the distribution system (sample type = D) were used to calculate the weighted averages, as these are most representative of the potential human exposure levels. The results for selenium are summarized in **Table 29**.

Table 29. Weighted mean selenium concentrations in finished drinking water for Florida facilities for the period from 2004 through 2014.

Water Source	Number of Samples	Weighted Mean Concentration (µg/L)
Surface Water	37	0.77
Ground Water	485	0.51
All	522	0.61

Concentrations from 0.61 to 2.5 µg/L were used to estimate the typical exposure from treated potable water. The range is based on the mean value in ambient waters (2.5 µg/L) and the weighted mean for all drinking water facilities in Florida (Table 32). The ambient drinking exposure was calculated to range from $1.46\cdot 10^{-3}$ to $6.00\cdot 10^{-3}$ mg/day.

Groundwater

In select cases, groundwater wells in seleniferous areas of the U.S. have higher levels of selenium. Seleniferous soils and areas that are susceptible to selenium contamination in water bodies due to mobilization from soils are concentrated in the Western U.S. Underlying geology that influences the composition of parent materials generated from bed rock and evaporative indexes influence susceptibility to selenium contamination (USGS, 1997). The Eastern U.S. has evaporative indexes of less than 2.0, making selenium contamination through this pathway negligible (USGS, 1997). However, in combination with their underlying geology, the Western U.S. has evaporative indexes greater than 2.5, thus putting states such as Texas, North Dakota, Oklahoma, Kansas, South Dakota, New Mexico, Colorado, Wyoming, Montana, Utah, California, and Arizona at much higher risk of selenium contamination in surface waterbodies due to soil mobilization (USGS, 1997). Agricultural drainage has been shown to increase selenium levels in groundwater in low lying areas (Su *et al.*, 2007). Moreover, processes involved in natural gas extraction have been shown to increase selenium levels in private wells in the north Texas area (Fontenot *et al.*, 2013). Thus, geochemical processes and anthropogenic activities have the potential to increase selenium concentrations in drinking water above trace amounts.

In the *Contaminant Occurrence Support Document for Category 2 Contaminants for the Second Six-Year Review of National Primary Drinking Water Regulations*, the U.S. EPA also analyzed public water systems (PWSs) across the U.S. from 1998 to 2005 that use groundwater as their source water (USEPA, 2009B). Of the 48,925 systems assessed, 44,924 facilities utilized groundwater as their source water. The department assessed the Six Year Review 2 Contaminant Occurrence Data available for selenium and calculated summary statistics (**Table 30)**. Only groundwater samples denoted as "GW" in the source water data column were used. The following summary statistics were based on reported values and incorporate data from 45 states. Within this data, 2,072 samples were reported from Florida, 387 of which were reported as detects ranging in concentration from 0.0001-0.03 mg/L.

Table 30. Selenium Summary Statistics for All "GW" Data

Summary Statistics	Quantitative Result (mg/L)
Number of Samples	141,387
Minimum	0.000001
Maximum	17.7
Average	0.005753
90th percentile	0.01
95th percentile	0.011

Air

Selenium was not included on EPA's Clean Air Act Amendments of 1990 List of Hazardous air Pollutants (USEPA, 2013C). However, multiple sources provided a range of recordings of atmospheric selenium concentrations. According to the ATSDR (2003), exposure to ambient air through the inhalation pathway is minimal due to the fact that ambient air concentrations are generally less than 10 ng/m^3. As documented by the World Health Organization (2011), Zoller and Reamer (1976) conducted a study that found that urban air concentrations of selenium ranged from 0.1 to 10 ng/m^3. Dose received through the inhalation exposure route seems to be dependent upon location with respect to proximity to industrial sites, such as copper smelters, and specific regions of the world. According to U.S. EPA's 2011 National Air Toxics Assessment data, the total modeled ambient air concentration of selenium compounds in Florida was 0.00022 µg/m^3 (USEPA, 2015C). The total modeled ambient selenium compound concentrations estimated for Florida counties ranged from a minimum of 0 µg/m^3 reported in a number of counties to a maximum of 0.00074 µg/m^3 in Citrus County. FDEP used the average value from the NATA data source to estimate human exposure via inhalation.

EPA's Ambient Monitoring Archive (AMA) also contained air monitoring data for Florida. Data were reported from two different monitoring initiatives: the PM 2.5 Speciation Network from a site in Davie, FL in Broward County and data from the Interagency Monitoring of Protected Visual Environments (IMPROVE) network from a site in St. Marks in Wakulla County. Data reported from the PM 2.5 Speciation Network were from 2006, and data from the IMPROVE Network were from 2013. Data entries that were missing reported sample concentrations were screened out of the dataset. For the PM 2.5 Speciation Network data, three additional samples were screened from the dataset, two of which were qualified as "5," which denotes outliers, and one sample was qualified as "IM," which denoted the sample concentration was measured during a prescribed burn. After removal of the qualified data, 40 samples from the PM 2.5 Speciation Network remained. The approximate average concentration of the reported values was 0.00175 µg/m^3 (LC; local conditions, refers to ambient PM measurements), with a minimum of 0 µg/m^3 (LC) and a maximum reported concentration of 0.00992 µg/m^3 (LC) (USEPA, 2015). For the IMPROVE Network, one sample was screened out of the dataset that was qualified as "NEG" (negative value entered). All of the IMPROVE Network data was also qualified as "NM" (normal), which is a null data qualifier, thus the summary statistics are provided for informational purposes only. After screening, 23 data points from the IMPROVE Network remained. The approximated average concentration of the reported values was 0.000283 µg/m^3 (LC), with a minimum of 0 µg/m^3 (LC), and a maximum reported value of 0.00062 µg/m^3 (LC) (USEPA, 2015A).

A large-scale air toxics study was conducted in Birmingham, Alabama from 2005 to 2006 for chemicals of concern. For each of the four study sites, which were noted for their industrial proximity or proximity to high traffic areas, selenium did not exceed the chronic non-cancer hazard threshold (Jefferson County Health Department, 2009). Keeler and Pirrone (1996) conducted a study to determine ambient concentrations and estimates of dry deposition flux of trace elements to Lake Erie from urban areas. Two sites, one of which was in downtown Detroit located downwind of a highly industrialized area (Site 1) and the second of which was located in a mixed residential/industrial area that is downwind of the largest municipal solid wastes incinerator facility operating in Detroit (Site 5) were selected for a 10-day intensive study in April of 1992. A second 18-day study, using only the second site (Site 5) was also conducted. **Table 31** below provides the ambient mean selenium concentrations measured during the April 1992 and March 1994 studies adapted from Keeler and Pirrone (1996).

Table 31. Means and Standard Deviations of Measured Ambient Selenium Concentrations (ng/m^3) Adapted from Keeler and Pirrone (1996).

April 1992 Sampling	April 1992 Sampling	April 1992 Sampling	April 1992 Sampling	March 1994 Sampling	March 1994 Sampling
Site 1	Site 1	Site 5	Site 5	Site 5	Site 5

April 1992 Sampling	April 1992 Sampling	April 1992 Sampling	April 1992 Sampling	March 1994 Sampling	March 1994 Sampling
(< 2.5 µm)	(> 2.5 µm)	(< 2.5 µm)	(> 2.5 µm)	(< 2.5 µm)	(> 2.5 µm)
1.5 ± 1.3	0.25 ± 0.15	2.3 ±1.9	0.3 ± 0.2	2.8 ± 2.9	2.9 ± 2.7

* Value below site number indicates either the fine (< 2.5 µm) or coarse (> 2.5 µm) fraction

Selenium was among the parameters included in the most recent 2012 National Monitoring Programs Annual Report (UATMP, NATTS, CSATAM) dated September 2014 (USEPA, 2014C). This report analyzed air quality measurements collected at monitoring sites participating in the Urban Air Toxics Monitoring Program (UATMP), the National Air Toxics Trend Station Network (NATTS), and the Community-Scale Air Toxics Ambient Monitoring Network (CASATAM). Nineteen monitoring sites established across the U.S. monitored metal concentrations in ambient air during the 2012 sampling period. One of the nineteen monitoring sites was located in Orlando, FL. Sampling and analysis was performed using EPA Compendium Method IO-3.5. **Table 32** below details the summary statistics associated with the monitoring efforts across all nineteen sites.

Table 32. Statistical Summary of the Selenium Concentrations Detected at 19 Sites across the United States Assessed as Part of EPA's 2012 National Monitoring Programs Annual Report (UATMP, NATTS, CSATAM)

Pollutant	# of Measured Detections[2,3]	# of Non-Detects[2,3]	Minimum[4] (ng/m^3)	Maximum (ng/m^3)	Arithmetic Mean (ng/m^3)	Median (ng/m^3)	Mode (ng/m^3)	First Quartile (ng/m^3)	Third Quartile (ng/m^3)	Standard Deviation (ng/m^3)
Selenium (PM_{10})	730	30	0.0001	4.92	0.610	0.410	0	0.204	0.840	0.594
Selenium (TSP)[1]	296	0	0.113	2.88	0.766	0.721	0.702	0.434	0.975	0.426

[1] TSP: Total Suspended Particulate
[2] For PM10, out of 760 valid samples
[3] For TSP, out of 296 valid samples
[4] Excludes zeros for non-detects

Although selenium concentrations measured in ambient air in the U.S. tend to be very low, studies in overseas countries such as China and Turkey have shown selenium concentrations in ambient air can far exceed concentrations measured in the U.S. (ATSDR, 2003; OEHHA, 2010). The majority of selenium found in ambient air is removed by wet and dry deposition (ATSDR, 2003).

FDEP used the average ($2.2 \cdot 10^{-7}$ mg/m^3) value from the NATA data source to estimate human exposure via inhalation. The estimated daily exposure, based on a daily inhalation of 16 m^3/day is $1.46 \cdot 10^{-7}$ mg/day.

Oceanic/ marine Levels

Selenium concentrations in sea water range from 0.052-0.50 µg/L (USEPA, 2013A), with an average of $9.0 \cdot 10^{-5}$ mg/L (0.09 µg selenium/L) (ATSDR, 2003). Higher concentrations are suspected to occur in marine biota due to the bioaccumulative nature of selenium. According to the USEPA (N.D.), samples of marine fish meal have been documented to contain selenium concentrations of approximately 2 ppm.

Soil

Adsorption and retention of selenium in soils is dependent on pH, redox conditions within soils, and composition of the soil (McLean and Bledsoe, 1992). Selenium becomes more mobile as soil alkalinity increases, which positively influences the risk of human exposure (Breckenridge and Crockett, 1995). According to Su *et al.* (2007), the majority of soils in the U.S. contain a selenium concentration ranging from 0.1-2.0 mg/kg; however, certain soils generated from Upper Cretaceous marine sedimentary rocks (shale) show regionally elevated selenium concentrations in about 80,000 km^2 of land in the 17 western states of the United States. Additionally, by-products and waste discharges from uranium mills, surface coal mining, and waste rock from phosphate mining have been found to increase soil selenium and subsequently groundwater selenium concentrations (Su *et al.*, 2007).

Florida-specific soils were reported to contain selenium concentration slightly lower than those reported by Su *et al*. (2007), with values ranging from 0.01-4.62 mg/kg, a median concentration of 0.082 mg/kg, an arithmetic mean of 0.25 mg/kg, and a geometric mean of 0.10 mg/kg (Chen *et al*., 1999). These Florida-specific concentrations were calculated from 445 Florida surface soil horizons and originates from a study that was conducted to establish baseline concentrations of trace elements in Florida soils. The soil horizons that were delineated and sampled during the study used USDA soil survey conventions and procedures as guidelines. The mean value soil concentration from Chen et al., 1999 (0.25 mg/kg), a soil ingestion rate of 20 mg/day, and a body weight of 80 Kg were used to estimate daily selenium exposures (5.00×10^{-6} mg/day) via the ingestion of soil for Florida residents.

Diet (other than fresh or estuarine fish)

Dietary consumption of selenium through food sources is considered to be the primary route of exposure, with estimated daily intake ranging from 0.071 to 0.152 milligrams (USEPA, 2013D). Many studies have attempted to quantify the selenium content of individual food types.

Selenium content is dependent on the type of foodstuff and the place of production of that food source. Selenium is present in many different types of foodstuffs, with the highest concentrations in foods with higher protein levels (Finley, 2006). The World Health Organization (2011) suggests the most important dietary sources of selenium are meats and seafood (0.3-0.5 mg/kg) and cereals (0.1-10 mg/kg). The United States Food and Drug Administration conducted an analysis of toxic and nutritional elements in specific food types through their Total Diet Study program. The information summarized in this analysis pertains to Total Diet Study market baskets 2006 through 2011 (USFDA, 2014). FDEP analyzed each specific food type for reported selenium concentrations. Each food type was then separated into a distinct category: fruits, vegetables, meats, dairy, grain, fish (marine), and fats. Foods not included from the analysis were considered to be composite foods (*e.g.*, Quarter-pound hamburger on bun; Frozen dinner of Salisbury steak with gravy, potatoes, and vegetables; beef chow mein, from Chinese carry-out) covered by each previously delineated category. Selenium concentrations for each food category were then averaged and are provided in **Table 33**. These values were used to calculate an RSC for selenium.

Table 33. Estimated Average Selenium Concentrations from FDA's Total Diet Study Market Baskets 2006-2011

Food Category	Estimated Average Concentration (mg/kg)
Fruits	0.00056
Vegetables	0.01120
Meats	0.29755
Dairy	0.09445
Fish (marine)	0.34267
Grains	0.15364
Fats	0.01029

The recommended daily allowance for selenium is 55 µg/day for adult males and females (Finley, 2006), 60 or 70 µg/day for pregnant and lactating women, respectively; 15 µg/day for young infants; and 30 µg/day for children between the ages of 4 and 8 years old (WHO, 2011). According to the ATSDR (2003), the Tolerable Upper Intake Level (UL) is 0.4 mg/day for adult-based selenium consumption. According to Bialostosky, *et al.* (2002), NHANES III dietary intake data spanning the years from 1988 to 1994 revealed that the mean selenium intake for the total population sampled was 114 µg/day. The U.S. EPA's Integrated Risk Information System (IRIS) reported the oral reference dose (RfD) for selenium as 0.005 mg/kg-day, with a NOAEL of 0.015 mg/kg-day and LOAEL of 0.023 mg/kg-day (USEPA IRIS).

Exposures for potentially highly exposed individuals

A number of factors make certain individuals more sensitive to selenium exposure and/or susceptible to receiving higher levels of exposure to selenium than the general public. Individuals living in close proximity to hazardous waste sites or in the western United States, which more commonly possess seleniferous soils, have the potential to receive higher selenium exposures. Individuals in certain occupations, such as coal mining, also may be exposed to greater selenium levels. Diets consisting primarily of locally grown or self-caught foodstuffs in areas of high selenium concentrations have the potential to result in higher exposure. Children, which have a recommended daily allowance of 30 µg/day, have a lower threshold for selenium exposure and may be more sensitive to selenium doses that distinguish between deficiency and toxicity.

RSC Derivation

EPA updated the National Recommendation for selenium in 2002. The recommendation did not include an RSC; that is, the RSC was assumed to be 1.0. FDEP review of the available information shows that there is a significant potential for human exposure from sources other than fish and shellfish from inland and nearshore waters and water ingestion. FDEP summarized the available data and information (**Table 34**), including Florida-specific information, and used it to calculate an applicable RSC using the percentage method for both Class I and Class III waters. Class I waters include ambient exposures via both the fish (fresh and estuarine fish) and the ambient source to treated drinking water. Class III waters, which also include Class III-Limited and Class II, only included ambient exposures via the consumption of fresh and estuarine fish. The percentage method based RSCs were calculated by summing the ambient and non-ambient exposures and then dividing the ambient by the total exposures. For Class III waters the percentage based RSC ranged from 0.491 to 0.51%. The percentage based RSC for Class I waters ranges from 1.6 to 4.7%. Both percentage based RSC ranges are well below the floor of 0.20, therefore, the applicable RSC for both Class I and III waters should be set at 0.20.

Table 34. Summary of major ambient and non-ambient selenium exposures to the general adult Florida populations. Exposures were used in the RSC calculations.

Source Type (Ambient/Non-Ambient)	Exposure Route	Lower Exposure Estimate (mg/kg-day)	Upper Exposure Estimate (mg/kg-day)
Ambient	Fresh and Estuarine Fish	$8.91 \cdot 10^{-6}$	$8.91 \cdot 10^{-6}$
Ambient	Drinking Water	$1.83 \cdot 10^{-5}$	$7.50 \cdot 10^{-5}$
Non-Ambient	Soil	$6.25 \cdot 10^{-8}$	$6.25 \cdot 10^{-8}$
Non-Ambient	Diet	$6.25 \cdot 10^{-8}$	$6.25 \cdot 10^{-8}$
Non-Ambient	Outdoor Air	$4.40 \cdot 10^{-8}$	$4.40 \cdot 10^{-8}$

Polycyclic Aromatic Hydrocarbons: Acenaphthene, Anthracene, Fluoranthene, Fluorene, and Pyrene

Background

Polycyclic aromatic hydrocarbons (PAHs) constitute a large class of approximately 100 compounds. The U.S. EPA regulates 17 of these compounds and considers 5 to be primarily non-carcinogenic. PAHs are typically formed during incomplete combustion or pyrolysis of organic matter (*e.g.*, coal, oil, gas, wood, garbage, tobacco, charbroiled meat) and generally occur as complex mixtures, not as single compounds. As pure chemicals, PAHs generally exist as colorless, white, or pale yellow-green solids. They can have a faint, pleasant odor. A few PAHs are used in medicines and to make dyes, plastics, and pesticides. Others are contained in asphalt used in road construction. They can also be found in substances such as crude oil, coal, coal tar pitch, creosote, and roofing tar and are found throughout the environment in the air, water, and soil. They can occur in the air, either attached to dust particles or as solids, in soil or sediment. At typical ambient temperatures, PAHs are solids. The general characteristics common to this class of compounds are high melting- and boiling-points, low vapor pressure, and very low water solubility, which tends to decrease with increasing molecular mass. PAHs are soluble in many organic solvents and are highly lipophilic.

Anthropogenic activities, such as combustion of fossil fuels, wood, and solid wastes, are the main inputs of PAHs to the environment (Baek *et al*., 1991). The annual emissions of PAHs have been estimated to be 8,600 tons in the U.S. (Kabziński, *et al*., 2002). Natural sources of PAHs, such as volcanic eruptions, forest fires, diagenesis of organic matter, and biochemical synthesis, are minor contributors of PAHs to the environment (Wilcke, 2000 and 2007). Among the anthropogenic sources, the petrogenic sources of PAHs include unburned petroleum and its products (gasoline, kerosene, diesel, and lubricating oil), whereas pyrogenic sources include high-temperature combustion products such as incomplete combustion of organic materials (combustion of fossil fuel, vehicular engine combustion, smelting, waste incinerators). The main anthropogenic sources of PAHs are power plants and house heating (51%). Incinerating plants and outdoor combustion are responsible for 28% of emissions to the atmosphere, industry (aluminum and steel foundries and gas engineering) for 20%, and transportation (cars) is responsible for 0.9% of emissions (Skupinska *et al*., 2004). Zang and Tao (2009) reported that, similar to other developed countries, consumer product use[14] (35.1%) and automotive oil combustion (23%) were the major PAH emission sources in the United States, followed by waste incineration (9.5%), biofuel combustion (9.1%), and petroleum refining (8.7%).

Since PAHs have low vapor pressure and high octanol/air partition coefficients (log K_{ow} ~3 to 6), they tend to sorb strongly onto the soil mass and persist for a longer period of time (Wilcke, 2000). PAH concentrations in water tend to be extremely low (<100 ng/L) and instead accumulate in sediments and aquatic organisms (Skupinska *et al.*, 2004). For instance, Wild and Jones (1995) reported that 90% of the PAHs are strongly fixed and hence stored in the soils.

The greatest sources of exposure to PAHs for most Americans is through active or passive inhalation of the compounds in tobacco smoke, wood smoke, and contaminated air, and ingestion of these compounds in foodstuffs. Smoking one pack of cigarettes a day has been estimated to result in exposure to carcinogenic PAHs of up to 5 µg/day (Menzie *et al*., 1992). These compounds are also in the exhaust from automobiles, coal, coal tar, and at hazardous waste sites. Exposure to other PAHs can occur by eating foods grown in contaminated soil or by eating meat

---

[14] Includes personal care products, household products, automotive aftermarket products, adhesives and sealants, Federal Insecticide, Fungicide, and Rodenticide Act regulated products, and coatings.

or other food that is grilled. The contribution of motor vehicles to global PAH emissions is less than biomass burning and wildfires (Zhang and Tao, 2009). However, motor vehicle emissions occur mostly in urban areas where population densities are much higher. Consequently, relative contribution of PAHs from motor vehicles to human exposure risk is much greater than its contribution to total emissions. Select chemical and physical properties of the five PAH parameters are provided in **Table 35** adapted from the ATSDR Toxicological profile for PAHs (1995).

Table 35. Select Chemical and Physical Properties of Acenaphthene, Anthracene, Fluoranthene, Fluorene, and Pyrene

Chemical/physical property	Acenaphthene	Anthracene	Fluoranthene	Fluorene	Pyrene
Molecular weight	154.21	178.2[5]	202.26	166.2[6]	202.3[5]
Solubility (mg/L)	1.93 [1]	0.076 [1]	0.20-0.26 [6]	1.68-1.98[6]	0.077 [7]
Partition coefficient (Kow)	3.98[2]	4.45[2]	4.9[2]	4.18[2]	4.88[2]
Partition coefficient (Koc)	3.66[2]	4.15[2]	4.58[2]	3.86[2]	4.58[2]
Vapor pressure (mm Hg)	$2.5 \cdot 10^{-3}$ at 25^{0}C[3]	$1.7 \cdot 10^{-5}$ at 25^{0} C[2]	$5.0 \cdot 10^{-6}$ at 25^{0} C[2]	$3.2 \cdot 10^{-4}$ at 20^{0} C[7]	$2.5 \cdot 10^{-6}$ at 25^{0} C[2]
Henry's Law (atm-m^3/mol)	$7.91 \cdot 10^{-5}$ [4]	$1.77 \cdot 10^{-5}$ [2]	$6.5 \cdot 10^{-6}$ [2]	$1.0 \cdot 10^{-4}$ [4]	$1.14 \cdot 10^{-5}$ [4]

Quantitative results without a specific superscript value originate from HSDB. 1) Yalkowsky *et al.* 1993, 2) Mabey *et al* 1982, 3) EPA 1987, 4) Nirmalakhandan and Speece 1988, 5) IARC 1973, 6) IARC 1983, 7) HSDB 1994

Exposure Source Determinations

Manufacturing and Release

Manufacturing and environmental release information/data for the individual PAHs under analysis could not be located utilizing the USEPA's Toxic Release Inventory (TRI) explorer tool. However, acenaphthene, anthracene, fluoranthene, fluorene, and pyrene emissions data from Florida for 2011 was available through EPA's National Emissions Inventory (NEI) Database. The NEI is a national compilation of emissions sources collected from state, local, and tribal air agencies as well as emissions information from the EPA emissions programs, including the TRI, emissions trading programs such as the acid rain program, and data collected as part of EPA regulatory development for reducing emissions of air toxics (USEPA, 2013B). The NEI is updated on a three-year cycle, with 2011 data published in 2013. **Table 36** below provides the

Florida-specific emissions data available for acenaphthene, anthracene, fluoranthene, fluorene, and pyrene in 2011.

Table 36. Florida National Emissions Inventory Data (LBS) for Acenaphthene, Anthracene, Fluoranthene, Fluorene, and Pyrene in 2011[1]

Emission Sector	Acenaphthene	Anthracene	Fluoranthene	Fluorene	Pyrene
Commercial Cooking	117.0012	728.3833	1158.392	725.5042	1681.845143
Fires - Agricultural Field Burning	----	2066.065	4147.267	----	3628.868172
Fires - Prescribed Fires	----	38943.89	52418.47	----	72357.74047
Fires - Wildfires	----	10637	14317.41	----	19763.54904
Fuel Comb - Comm/Institutional - Biomass	0.116014	0.382465	0.020398	0.433461	0.4717072
Fuel Comb - Comm/Institutional - Coal	0	0	0	0	----
Fuel Comb - Comm/Institutional - Natural Gas	----	----	0.182854	0.170664	0.317283457
Fuel Comb - Comm/Institutional - Oil	0.22741	0.148206	0.605597	2.218315	0.386005238
Fuel Comb - Comm/Institutional - Other	----	----	0.000242	0.000226	0.000402873
Fuel Comb - Electric Generation - Biomass	0.212744	0.701353	0.037405	0.794867	0.8650012
Fuel Comb - Electric Generation - Coal	11.8451	4.879666	16.50721	21.13592	7.65809076
Fuel Comb - Electric Generation - Natural Gas	0.003102	0.00413	0.469791	0.438462	0.041727021
Fuel Comb - Electric Generation - Oil	0.161985	0.039435	0.284907	0.034316	0.137378011

Emission Sector	Acenaphthene	Anthracene	Fluoranthene	Fluorene	Pyrene
Fuel Comb - Electric Generation - Other	0.477736	0.196869	0.666731	0.8531	0.309741
Fuel Comb - Industrial Boilers, ICEs - Biomass	0.098493	0.324703	0.017317	0.367996	0.4004665
Fuel Comb - Industrial Boilers, ICEs - Coal	0.012834	0.005297	0.017919	0.022944	0.00835409
Fuel Comb - Industrial Boilers, ICEs - Natural Gas	4.330507	0.576379	3.421384	16.37548	4.409091911
Fuel Comb - Industrial Boilers, ICEs - Oil	4.546022	2.252944	8.66919	30.90201	6.128321819
Fuel Comb - Residential - Natural Gas	----	0.002878	0.047924	0.044729	0.079873491
Fuel Comb - Residential - Oil	0.04962	----	0.011578	0.010586	0.009923907
Fuel Comb - Residential - Other	----	----	0.030109	0.028102	0.050181874
Fuel Comb - Residential - Wood	832.2395	1095.174	95.4153	1880.781	90.25705645
Mobile - Aircraft	444.6856	517.8881	554.5828	919.8293	755.6598019
Mobile - Commercial Marine Vessels	18.47702	28.4891	16.93875	37.72762	30.02739629
Mobile - Locomotives	18.07997	59.60704	44.07962	83.08588	62.24651909
Mobile - Non-Road Equipment - Diesel	1224.841	5.266816	208.2229	1224.841	35.52037994
Mobile - Non-Road Equipment - Gasoline	781.9568	1352.774	2783.688	3223.662	3479.772254
Mobile - On-Road Diesel Heavy Duty Vehicles	5256.533	5604.385	11886.99	11220.49	15637.18156
Mobile - On-Road Diesel Light Duty Vehicles	1638.178	1395.742	2352.073	2855.985	2923.159664

Emission Sector	Acenaphthene	Anthracene	Fluoranthene	Fluorene	Pyrene
Mobile - On-Road non-Diesel Heavy Duty Vehicles	129.5029	110.0262	186.5581	262.33	213.0479068
Mobile - On-Road non-Diesel Light Duty Vehicles	8048.502	6833.612	11577.86	16302.99	13220.16962
Waste Disposal	141.7049	338.0139	750.6263	674.6252	891.08594

[1] Additional information regarding descriptions of the emissions sectors listed above can be located in EPA's 2011 National Emissions Inventory, Version 2 Technical Support Document dated August 2015 cited in the reference section of this document (USEPA, 2015B).

Ambient Exposure Sources

Surface Water

Staples *et al*., (1985) summarized priority pollutant concentration in the U.S. using results from the STORET Database. They reported median ambient surface water concentrations of PAHs < 10.0 µg/L, with a four percent detection rate for all five non-carcinogenic PAHs. National sample sizes ranged from 776 for anthracene to 904 for pyrene. Ambient surface water data for the ten-year period from 2005-2014 were queried from the IWR Run 50 database. The arithmetic mean of these data and associated detection limits are summarized in **Table 37**.

Table 37. Summary of PAH concentrations in Florida surface waters. Data were taken from the IWR Run 50 database for the period from 2005 to 2014.

PAH	Number of Samples	Detections	Mean Result (µg/L)	Minimum Detection Limit (µg/L)	Average Detection Limit (µg/L)
Acenaphthene	174	0	<0.13	0.04	0.26
Anthracene	210	0	<0.17	0.03	0.32
Fluoranthene	210	6	<0.17	0.022	0.32
Fluorene	209	1	<0.16	0.04	0.32
Pyrene	210	7	<0.17	0.021	0.32

Ingestion of Freshwater and Estuarine Fish

Staples *et al*., (1985) reported biota tissue priority pollutant concentrations using STORET data. They reported median tissue concentrations of <2.5 mg/kg for acenaphthene, anthracene, fluoranthene, fluorene, and pyrene, with no detections. In 2011, FDEP undertook a study to determine if the water quality of Clam Bayou located in Pinellas County, had degraded over time. The department assessed the biological, chemical, sediment, and physical characteristics of Clam Bayou. A total of 63 chemicals, including PAHs, were analyzed for in 36 fish tissue samples (12 individual fish samples of three different species from Clam Bayou fish representing the different trophic levels and feeding strategies). Average fish tissue concentrations for the non-carcinogenic PAH concentrations are summarized in **Table 38**. The study found detectable concentrations of PAHs in the tissues of fish across all three trophic levels, indicating that the PAHs in question 1) do bioaccumulate in fish; and, 2) the consumption of fish and shellfish does represent a potential human exposure route.

Two sets of values were used to calculate the exposure through the consumption of Florida fresh and estuarine fish for purposes of RSC determination. These two estimates provide a range of potential exposures. The first estimate provides a lower bound to the range and was developed using the data collected by the department in Clam Bayou (**Table 38**). Exposures were calculated by multiplying the measured mean fish tissue concentration for each species by the corresponding trophic level specific consumption rate. The second estimate provides an upper bound estimate, and was calculated using mean surface water concentrations from the IWR Run 50 database in conjunction with the parameter specific Florida BCFs or BAF to estimate an average Florida fish tissue concentration. FDEP developed estimated average Florida fish tissue concentrations by multiplying the BCF or BAFs by the mean surface water concentration and applying a conversion factor (0.001) to convert the units to mg/kg-fish tissue. The mean surface water concentrations, BFCs, and total fish tissue concentrations for the five PAHs are provided in **Table 39**.

Table 38. Chemical analysis of fish tissue samples collected from Clam Bayou on September 29, 2011. Trophic level (TL2-TL3) specific exposures were calculated by multiplying the fish tissue concentration by the trophic level specific consumption rate. Striped mullet, sheepshead, and common snook represent trophic level 2, 3, and 4 fish, respectively.

PAH	***Mugil cephalus* (Striped mullet) (mg/kg)**	***Archosargus probatocephalus* (Sheepshead) (mg/kg)**	***Centropomus undecimalis* (Common snook) (mg/kg)**	**TL2 Exposure (mg/day)**	**TL3 Exposure (mg/day)**	**TL4 Exposure (mg/day)**	**Total Exposure (mg/day)**
Acenaphthene	0.00193	0.00063	0.00055	$2.46\cdot10^{-5}$	$1.1\cdot10^{-5}$	$1.6\cdot10^{-5}$	$5.17\cdot10^{-5}$
Anthracene	0.00067	0.00054	0.0005	$8.55\cdot10^{-6}$	$9.42\cdot10^{-6}$	$1.46\cdot10^{-5}$	$3.26\cdot10^{-5}$
Fluoranthene	0.00475	0.002	0.00089	$6.06\cdot10^{-5}$	$3.49\cdot10^{-5}$	$2.6\cdot10^{-5}$	$1.22\cdot10^{-4}$
Fluorene	0.00255	0.00145	0.0015	$3.26\cdot10^{-5}$	$2.53\cdot10^{-5}$	$4.38\cdot10^{-5}$	$1.02\cdot10^{-4}$
Pyrene	0.00182	0.00176	0.00066	$2.32\cdot10^{-5}$	$3.07\cdot10^{-5}$	$1.93\cdot10^{-5}$	$7.32\cdot10^{-5}$

Table 39. Estimated mean fish tissue PAH concentrations based on mean Florida surface water concentrations and Florida BCFs.

PAH	**Mean Surface Water Concentration (µg/L)**	**BCF**	**Fish Tissue (mg/kg)**	**Exposure (mg/day)**
Acenaphthene	<0.13	290	0.0377	$2.24\cdot10^{-3}$
Anthracene	<0.17	440	0.0748	$4.44\cdot10^{-3}$
Fluoranthene	<0.17	1300	0.221	$1.31\cdot10^{-2}$

PAH	Mean Surface Water Concentration (µg/L)	BCF	Fish Tissue (mg/kg)	Exposure (mg/day)
Fluorene	<0.16	BAF[1]	0.0336-0.0736[2]	$3.30 \cdot 10^{-3}$
Pyrene	<0.17	590	0.1003	$5.96 \cdot 10^{-3}$

1. Fluorene has trophic level specific BAFs rather and a single BCF. The BAFs for trophic level 2, 3, and 4 are 210, 260, and 440, respectively.
2. Trophic level 2, 3, and 4 fish tissue concentrations (mg/kg) are 0.0336, 0.0416, and 0.0736 mg/kg, respectively.

Non-ambient Exposure Sources

Treated Drinking Water

Drinking water facility data for the period between 2004 and 2014 were queried from the State's Drinking Water Database (http://www.dep.state.fl.us/water/drinkingwater/download.htm). There were no monitoring results reported in the database for the five non-carcinogenic PAHs.

Acenaphthene, anthracene, fluoranthene, fluorene, and pyrene are not regulated under the Safe Drinking Water Act and do not have FDA bottled water standards. Santodonato *et al.*, (1981) summarized work by Basu and Saxena (1978) and reported that the average total PAH level in U.S. drinking water is 13.5 ng/L. Santodonato noted that EPA also conducted the National Organic Monitoring Survey to determine the frequency of occurrence and the levels of PAHs in U.S. drinking water supplies. Of the 110 water samples analyzed, none showed any PAHs other than fluoranthene. Seventeen out of 110 samples analyzed showed positive fluoranthene values with an average concentration of 20 ng/L. Kabziński *et al.*, (2002) provided estimates of individual PAH concentrations in drinking water from several Polish Cites (**Table 40**). Although the level of fluoranthene in Polish drinking water is very similar to the EPA calculated average for the U.S., the individual PAH values from the Polish study are all greater than the total PAH estimate provided by Santodonato *et al.*, (1981) for the U.S.

The Florida-specific mean ambient concentrations reported in **Table 37** and the drinking water concentrations provided by Kabziński *et al.*, (2002) were used to calculate ranges of estimated daily intake values via the consumption of treated drinking water for each PAH for purposes of RSC calculation (see **Table 55**). The concentrations from Kabziński *et al.*, (2002) were used in the derivation of the RSCs because they represented conservative estimates of exposure via treated potable water. Furthermore, this study represents the only available literature on detectable concentrations of individual non-carcinogenic PAHs in treated potable water supplies. The Florida ambient conditions represent potential Florida-specific drinking water concentrations, although they are likely to be biased high since the estimate does not account for treatment related reductions.

Table 40. Mean drinking water PAH concentrations (ng/L) reported by Kabziński *et al.*, (2002). The average concentrations were calculated from the reported means and an estimate of parameter specific intake was calculated from this average.

PAH	Łódź-Chojny Area (ng/L)	Łódź-Stoki Area (ng/L)	Tomaszów Mazowiecki Area (ng/L)	Average (ng/L)	Intake[1] (mg/kg-day)
Acenaphthene	38	25	39	34	$1.02 \cdot 10^{-6}$
Anthracene	69	56	71	65	$1.95 \cdot 10^{-6}$
Fluoranthene	22	19	20	20	$6.0 \cdot 10^{-7}$
Fluorene	175	133	141	150	$4.5 \cdot 10^{-6}$
Pyrene	22	19	20	20	$6.0 \cdot 10^{-7}$

1. Calculated based on average concentration, 80 kg body weight, and daily drinking water intake of 2.4 L.

Air

PAHs occur in the atmosphere in both the particle phase and the vapor phase. Three-ring PAH compounds are found in the atmosphere primarily in the gaseous phase, whereas, five- and six-ring PAHs are found mainly in the particle phase; four-ring PAH compounds are found in both phases. To fully characterize atmospheric PAH levels, both particle- and vapor-phase samples must be collected. Many early monitoring studies used filter sampling methods, which provided information on particle-phase PAH concentrations only and did not account for losses of some of the lower molecular weight PAHs by volatilization. As a result, the early use of particulate samples may have resulted in an underestimation of total PAH concentrations. More recent monitoring studies often use sampling methods that collect both particle- and vapor-phase PAHs that prevent or minimize volatilization losses, thus providing more reliable characterization of total atmospheric PAH concentrations (ATSDR, 1995).

Deposition of PAH compounds directly to Tampa Bay was studied by Poor (2002) and Poor *et al.*, (2004). In the 2002 study, measurements were made from March to October 2001. The average concentration for the total PAH in the ambient air was 14 ng/m^3. Dry deposition of gas and particles was estimated to be about 2 µg/m^2-day, and wet deposition of gas and particles was estimated to be about 0.1 µg/m^2-day, assuming no flux of PAHs from the water to the air. A comparison of these rates with others reported in the literature indicated that the rates in Tampa Bay are in the range of deposition rates at both rural and urban sites in the eastern coastal U.S. (Poor, 2002). Poor *et al.* (2004) used a sampling method that improved capture of gas and particle-phase PAH compounds with lower molecular weights. Based on sampling between May and August 2002, the concentrations of total PAHs were between 80 and 190 ng/m^3, and dry deposition flux of gas and particles was estimated to be 11.5 µg/m^2-day, assuming no flux of PAH from the water to the air. The 2004 study reported both gas-phase and particle-phase ambient air concentrations for individual PAHs. The mean values are reproduced in **Table 41**. Additionally, FDEP calculated estimated daily exposures for the general population using the total concentration for each PAH. The air concentration values listed in **Table 41** are comparable, although higher if summed, to the total PAH ambient air concentration of 10.9 ng/m^3 provided by Santodonato *et al*., (1981). The differences may be related to the fact that the value reported by Santodonato was based on the sum of annual geometric means, rather than arithmetic means, only included 14 individual PAHs, and did not include acenaphthene or fluorene.

Table 41. Average daily ambient air concentrations of gas- and particle-phase PAHs measured by Poor *et al*., (2004) at the Grandy Bridge in Tampa, FL.

PAH	**Mean gas-phase (ng/m^3)**	**Mean particle-phase (ng/m^3)**	**Total gas- and particle-phase (ng/m^3)**	**Intake[1] (mg/kg-day)**
Acenaphthene	4.07	0.20	4.27	$1.67\cdot10^{-7}$
Anthracene	0.50	0.00	0.50	$1.95\cdot10^{-8}$
Fluoranthene	4.91	0.99	5.90	$2.30\cdot10^{-7}$
Fluorene	6.15	0.27	6.42	$2.51\cdot10^{-7}$
Pyrene	1.74	0.61	2.35	$9.17\cdot10^{-8}$

1. Calculated from total gas- and particle-phase concentration, an assumption of a daily outdoor inhalation volume of 3.122 m^3, and body weight of 80 Kg.

Sheldon *et al*., (1993) summarized a 1992 study of indoor air pollution in 280 California homes. Housing units were selected to represent homes in specific source categories based on both the presence and expected use of several combustion sources, including fireplaces, woodstoves, gas heating, and tobacco smokers (**Table 42**). Li *et al*., (2005) conducted a survey of indoor PAHs in residential air of ten Chicago area non-smoker homes. Mean indoor air concentrations were interpolated from a figure presented in Li *et al*., (2005) and are summarized in **Table 43**. They also reported that the mean total indoor air PAH concentration, excluding naphthalene (15 compounds), was 36 ng/m^3. Following naphthalene, anthracene was found to have the second highest indoor air concentration. FDEP calculated daily indoor inhalation exposures for the general population using the total concentration provided by both Sheldon *et al.*, (1993) and Li *et al*., (2005) for each PAH.

Table 42. Average indoor PAH air concentrations (ng/m^3) by combustion source category from Sheldon *et al*., (1993).

Compound	**Smoking (ng/m^3)**	**Smoking/ Fireplace (ng/m^3)**	**Fireplace (ng/m^3)**	**Woodstove (ng/m^3)**	**Woodstove/ Gas Heat (ng/m^3)**	**Gas Heat (ng/m^3)**	**No Source (ng/m^3)**	**Max (ng/m^3)**	**Intake[1] (mg/kg-day)**
Anthracene	2.3	2.2	2.9	3.2	2.4	2.2	2.7	3.2	$5.15\cdot10^{-7}$
Fluoranthene	5.3	4.5	5.3	7	4.6	4.7	5.2	7	$1.13\cdot10^{-6}$
Pyrene	5.3	4.9	5.1	6.5	4.2	4.5	5	6.5	$1.05\cdot10^{-6}$

[1] Calculated from total gas- and particle-phase concentration, an assumption of a daily indoor inhalation volume of 12.878 m^3, and a body weight of 80 Kg.

Table 43. Average indoor air PAH concentrations detected in ten Chicago-area non-smoker homes from Li *et al*., (2005).

Compound	**Mean Indoor Air Concentration (ng/m^3)**	**Intake[1] (mg/kg-day)**
Acenaphthene	3.8	$6.12 \cdot 10^{-7}$
Fluorene	4.6	$7.40 \cdot 10^{-7}$
Anthracene	9.7	$1.56 \cdot 10^{-6}$
Fluoranthene	2.2	$3.54 \cdot 10^{-7}$
Pyrene	1.2	$1.93 \cdot 10^{-7}$
Total PAH	36	$5.80 \cdot 10^{-6}$

[1] Calculated from total gas- and particle-phase concentration, an assumption of a daily indoor inhalation volume of 12.878 m^3, and a body weight of 80 Kg.

PAHs are often assessed as part of EPA’s Air Toxics-Urban Air Toxics Monitoring Program. Acenaphthene, anthracene, fluoranthene, fluorene, and pyrene were among the parameters included in the most recent 2012 National Monitoring Programs Annual Report (UATMP, NATTS, CSATAM) dated September 2014 (USEPA, 2014C). This report analyzed air quality measurements collected at monitoring sites participating in the Urban Air Toxics Monitoring Program (UATMP), the National Air Toxics Trend Station Network (NATTS), and the Community-Scale Air Toxics Ambient Monitoring Network (CASATAM). Twenty-five monitoring sites established across the U.S. monitored PAH concentrations in ambient air during the 2012 sampling period. Two of the twenty-five monitoring sites were located in Florida, with one located in Pinellas Park and a second in Valrico. Sampling and analyses were performed using EPA Compendium Method TO-13A. **Table 44** below details the summary statistics associated with the monitoring effort across all 25 sites.

Table 44. Statistical Summary of the Acenaphthene, Anthracene, Fluoranthene, Fluorene, and Pyrene Concentrations Detected at 25 Sites across the U.S. Assessed as Part of EPA's 2012 National Monitoring Programs Annual Report (UATMP, NATTS, CSATAM)

Pollutant	# of Measured Detections	# of Non-Detects[1]	Minimum[2] (ng/m^3)	Maximum (ng/m^3)	Arithmetic Mean (ng/m^3)	Median (ng/m^3)	Mode (ng/m^3)	First Quartile (ng/m^3)	Third Quartile (ng/m^3)	Standard Deviation (ng/m^3)
Acenaphthene	1,277	19	0.081	182	5.0	2.28	0	1.12	4.67	9.87
Anthracene	1,020	276	0.028	18.9	0.396	0.207	0	0.07	0.459	0.949
Fluoranthene	1,296	0	0.078	42.9	2.34	1.32	1.04	0.745	2.51	3.38
Fluorene	1,280	16	0.338	93.4	5.16	3.08	0	1.80	5.35	7.10
Pyrene	1,296	0	0.046	17.4	1.30	0.797	1.03	0.454	1.51	1.57

[1] Out of 1,296 samples

[2] Excludes zeros for non-detects

Acenaphthene, anthracene, fluoranthene, fluorene, and pyrene were also among the parameters assessed during the large-scale Relationships of Indoor, Outdoor, and Personal Air (RIOPA) study, which took place during two 48-hour sampling periods in different seasons between the summer of 1999 and the spring of 2001. The study sampled approximately 100 homes with 100 residents in three different cities, Los Angeles, CA, Houston, TX, and Elizabeth, NJ (Turpin *et al*, 2007). Mean and median concentrations of anthracene, fluoranthene, and pyrene measured during the study in the three different locations are provided in **Table 45**. Significant breakthrough (23% to 56% expressed as a percentage of the PAH mass on the backup PUF) was observed for the PAHs with the lowest molecular weights, including acenaphthene and fluorene. The authors chose to not report the concentrations of the PAHs with significant breakthrough.

Table 45. Mean and Median Outdoor and Indoor Air Concentrations of Anthracene, Fluoranthene, and Pyrene Collected During the RIOPA Study (Turpin *et al*. 2007)

Parameter	Los Angeles, CA Outdoor Mean/Median	Los Angeles, CA Indoor Mean/Median	Houston, TX Outdoor Mean/Median	Houston, TX Indoor Mean/Median	Elizabeth, NJ Outdoor Mean/Median	Elizabeth, NJ Indoor Mean/Median
Anthracene	0.67/0.44	1.0/0.47	1.0/0.69	1.7/0.97	1.7/1.3	1.1/1.0
Fluoranthene	1.9/1.5	1.6/1.2	3.9/3.1	3.0/2.4	5.6/3.8	3.6/2.5
Pyrene	1.8/1.6	1.9/1.5	2.8/2.4	2.9/2.4	3.8/3.0	2.9/2.3

Lin *et al*. (2011) conducted an assessment from November 2005 through December 2006 to determine the ambient concentrations of 16 PAHs in four sites in New Jersey, three of which were located in Paterson, NJ and dominated by either industrial, commercial, or mobile emissions sources. The fourth site used in the assessment was a comparison background site in Chester, NJ, which is located approximately 58 Km west/ southwest of Paterson. **Tables 46-49** provide the ambient concentrations (mean, standard deviation, minimum, and maximum) of acenaphthene, anthracene, fluoranthene, fluorene and pyrene measured during the sampling period at all four sites adapted from Lin *et al* (2011). Concentrations of PAHs assessed during this study were found to be significantly higher at the three sites in Paterson, NJ, which were closer in proximity to either industrial, commercial, or mobile emission sources, than those measured at the background site in Chester, NJ.

Table 46-49. Ambient concentrations (ng/m^3) of acenaphthene, anthracene, fluoranthene, fluorene, and pyrene detected at the four New Jersey Sampling Sites (Background (n=54), Commercial (n=50), Industrial (n=49), and Mobile (n=44)) Adapted from Lin *et al* (2011).

Table 46.

Parameter	Mean	SD	Min	Max
Acenaphthene	1.94	3.88	0.01	25.51
Anthracene	0.23	0.70	0.01	5.10
Fluoranthene	0.56	0.36	0.01	2.01
Fluorene	6.00	8.84	0.02	45.31

Parameter	Mean	SD	Min	Max
Pyrene	0.22	0.18	0.03	0.94

Table 47.

Parameter	Mean	SD	Min	Max
Acenaphthene	3.50	4.28	0.05	21.23
Anthracene	2.02	6.81	0.09	48.68
Fluoranthene	2.37	1.61	0.48	7.00
Fluorene	20.10	49.82	0.76	335
Pyrene	1.51	1.06	0.22	5.63

Table 48.

Parameter	Mean	SD	Min	Max
Acenaphthene	3.51	4.30	0.02	17.36
Anthracene	0.98	1.54	0.05	10.1
Fluoranthene	2.16	2.13	0.09	13.31
Fluorene	15.24	27.84	0.04	155
Pyrene	1.27	1.38	0.03	8.56

Table 49.

Parameter	Mean	SD	Min	Max
Acenaphthene	3.77	7.42	0.02	48.4
Anthracene	1.07	1.65	0.03	10.6
Fluoranthene	2.71	2.76	0.11	16.11
Fluorene	15.88	42.83	0.06	288
Pyrene	1.43	1.57	0.08	7.91

FDEP used the information for the total gas and particle phase values from Poor *et al*., (2004), and EPA's Air Toxics-Urban Air Toxics Monitoring Program as the basis for assessing outdoor air exposures. These values were used to estimate the upper and lower bounds of exposures (**Tables 41 and 44)**. The estimates Li *et al*., (2005) were used to estimate indoor air exposures (**Table 43**).

Diet (other than fresh or estuarine fish)

Food is the main source of non-occupational exposure to PAHs for humans. Unprocessed foods do not typically contain high levels of PAHs. In areas isolated from urban or industrial activities, the levels of total PAHs found in unprocessed foods (0.01-1 µg/kg) reflect the background contamination, which originates from long distance airborne transportation of contaminated particles and natural emissions from volcanoes and forest fires. In the vicinity of industrial areas or along highways, the contamination of vegetation can be ten-fold higher than in rural areas (Larsson and Sahlberg, 1982).

Processing of food (*e.g.*, cooking, drying, smoking) and cooking of foods at high temperatures (*e.g.*, grilling, roasting, frying) are major sources of PAHs (Guillen *et al.*, 1997; Phillips, 1999). Although not precisely known, it is likely that there are several mechanisms associated with the formation of PAHs. These mechanisms could include examples such as melted fat that undergoes pyrolysis when dripping onto the heat and pyrolysis of the meat due to the high temperature. (Lijinsky and Shubik, 1965A, 1965B). Individual PAH concentrations as high as 200 µg/kg have been detected in smoked fish and meat. PAH concentrations of 130 µg/kg have been reported in barbecued meats, whereas the average background values are usually in the range of 0.01-1 µg/kg in uncooked foods. A comparison of PAH levels in duck breast steaks, undergoing various processing and cooking treatments for 0.5 hours to 1.5 hours, showed that charcoal-grilled samples without skin contained the highest amount of total PAHs (320 µg/kg), followed by charcoal grilling with skin (300 µg/kg), smoking (210 µg/kg), roasting (130 µg/kg), steaming (8.6 µg/kg) and liquid smoke flavoring (0.3 µg/kg).

Gomaa *et al*., (1993) reported the results of a study to screen smoked foods, including turkey, pork, chicken, beef, fish products, and commercial liquid smoke flavorings, for carcinogenic and non-carcinogenic PAHs. All smoked meat products and liquid smoke seasonings were purchased from local supermarkets in Michigan. Total PAH concentrations in smoked red meat products ranged from 2.6 µg/kg in cooked ham to 29.8 µg/kg in grilled pork chops, while those in smoked poultry products ranged from 2.8 µg/kg in smoked turkey breast to 22.4 µg/kg in barbecued chicken wings. Total PAH concentrations in smoked fish products ranged from 9.3 µg/kg in smoked shrimp to 86.6 µg/kg in smoked salmon. Total PAH concentrations in liquid smoke flavorings and seasonings ranged from 6.3 to 43.7 µg/kg. Smoked meat products processed with natural wood smoke had higher total PAH and total carcinogenic PAH concentrations than those processed with liquid smoke flavorings. Contamination of vegetable oils with PAHs usually occurs during technological processes like direct fire drying, where combustion products may come into contact with the oil seeds or oil (Speer *et al.*, 1990; EC, 2002). It is clear that PAH concentrations in food range considerably depending on the preparation. Likewise, exposure to individuals within the population likely also varies considerably, perhaps over an order of magnitude, depending on an individual's diet and food preferences.

The European Commission (2002) compiled comparative intake data for individual PAHs. Intake data was gathered from five total diet studies conducted in the United Kingdom (two studies: Dennis *et al.*, 1983; COT, 2002), Italy (Turrio-Baldassarri *et al.*, 1996), the Netherlands (De Vos *et al.*, 1990), and Austria (Pfannhauser, 1991). Benzo[*a*]pyrene intakes were also available for Sweden (Beckman Sundh *et al.*, 1998), Germany (IPCS, 1998) and the U.S. (Butler *et al.*, 1993; Kazerouni *et al.*, 2001). EC (2002) provided mean daily intake of individual PAHs via food consumption (**Table 50**). The estimates presented in **Table 50** are based on European rather than U.S. or Floridian populations. However, EC (2002) provides a comparison between U.S. benzo[*a*]pyrene food intake rates to European countries. Mean benzo[*a*]pyrene intake in the U.S. (mean=0.14 µg/day) was estimated to be similar yet slightly lower than the European Union (0.05-0.29 µg/day), suggesting that European intake rates could be used as representative estimates for the U.S. population and may in fact be slightly conservative. Santodonato *et al.*, (1981) estimated that total PAH (including carcinogenic PAHs) concentrations in food typically range from 0.1 to 10 ppb (ng/g). The upper end of this range, 10 ppb, was used to represent the concentration of acenaphthene and fluorene. The total PAH exposure estimates are an order of magnitude greater than individual PAHs, and can be used as conservative estimates of food-related exposures for PAHs lacking individual estimates (*i.e.*, acenaphthene and fluorene). FDEP used the values reported in **Table 50** as the basis of PAH exposures via diet for purposes of RSC calculations.

Table 50. Estimated daily exposure intake of individual non-carcinogenic PAHs via dietary (food) intake. Daily intake was estimated using the upper end of the exposure range.

PAH	Daily per Capita Exposure (ng/person-day)	Daily Intake (mg/kg-day)
Acenaphthene	N/A	0.00029[1]
Anthracene	<30-640	0.000008[2]
Fluoranthene	600-1660	0.000021[2]
Fluorene	N/A	0.00029[1]
Pyrene	600-1090	0.000014[2]
Total PAH[1]	2030-20,300	0.00029[1]

[1] Estimated from Santodonato *et al.*, (1981) based on a food-based concentration of 10 ppb (ng/g), and total daily food consumption of 29 g/kg-day.

[2] Estimated daily average adult intakes from EC (2002) using an average 80 kg body weight.

Soil

PAHs are ubiquitous in soil. Because anthropogenic combustion processes are a major source of PAHs in soils, soil concentrations have tended to increase over the last 100-150 years, especially in urban areas (Jones *et al.*, 1989A, 1989B). Background concentrations for rural, agricultural, and urban soils (from the U.S. and other countries) are given in **Table 51**. In general, concentrations ranked as follows: urban > agricultural > rural. Evidence of the global distribution of PAHs was given by Thomas (1986) who detected benzo[g,h,i]perylene and fluoranthene at concentrations above 150 µg/kg in arctic soils. Soil samples collected from remote wooded areas of Wyoming contained total PAH concentrations of up to 210 µg/kg.

Table 51. Background soil concentrations of polycyclic aromatic hydrocarbons (PAHs). Table recreated after ATSDR (1995).

Compound	Rural Soil (µg/kg)	Agricultural Soil (µg/kg)	Urban Soil (µg/kg)
Acenaphthene	1.7	6	
Anthracene		11-13	
Fluoranthene	0.3-40	120-210	200-166,000
Fluorene	9.7		
Pyrene	1-19.7	99-150	145-147,000

Several researchers have observed a greater amount of PAHs in urban soils as these areas are more exposed than rural areas to the PAHs produced by both stationary (power plants, industries, and residential heating) and diffused sources (traffic emissions, and road byproducts such as wearing of tires and asphalt constituents). For instance, Maisto *et al*., (2006) reported that total PAHs were 2-20 times greater in the urban areas of Naples, Italy, than park soils that were 12 km away. Similarly, Baek *et al.* (1991) reported that the urban soils near the highways were highly contaminated. In New Orleans, Wang *et al.* (2008) observed the higher amounts of PAHs in soils close to the roads (7,189 µg/kg) than in open spaces that were 10 m away from the roads (2,404 µg/kg). Similar results were shown by Wilcke (2000), who reported that PAH levels declined exponentially with increase in distance from the roads due to the reduced vehicular emissions. In Northern Germany, Krauss and Wilcke (2003) found that the PAHs in gardens and industrial soils (> 10 µg/kg) were eightfold greater than the park soils (1.9 µg/kg) while the lowest amounts were observed in agricultural soils (0.64 µg/kg).

Chahal *et al*., (2010) determined PAH contamination levels in urban residential soils in Pinellas County, FL. They reported mean soil levels for all non-carcinogenic PAHs under consideration, except acenaphthene (**Table 52**). Wang *et al*., (2008) reported PAHs from two major U.S. cities, New Orleans and Detroit. Sampling sites included house foundations, open spaces, and soils bordering residential (light to moderate traffic) and busy (heavy traffic) streets. Results from soils in the vicinity of busy streets are not reproduced here under the reasoning that, although the contamination level may be higher than other areas, the general population exposure to soils from these areas is negligible given that few people will spend much time, particularly engaging in activities that might lead to soil ingestion, in these areas due to safety concerns. The soil concentrations from New Orleans and Detroit tend to be higher than Pinellas County, FL; however, the estimated daily doses are within an order of magnitude for all parameters. Both studies represent conservative estimates of general population exposure to PAHs through incidental soil consumption. Both studies are conservative in that they represent urban areas with extensive and long-term motor vehicle traffic as well as industrial development. Less developed and less highly traveled areas of the state are likely to have lower contamination levels. Use of the daily intake values listed in **Tables 52** and **53** are therefore conservative for the general population, while also being protective and representative of potential exposures for urban and suburban populations. The Florida-specific exposures from Chahal *et al*., (2010) were used to calculate RSC values for anthracene, fluoranthene, flourene and pyrene, while Wang et al., (2008) was used for acenaphthene.

Table 52. Mean soil concentrations for individual PAHs in Pinellas County, FL as reported by Chahal *et al*., (2010). Daily intakes were calculated from the mean soil concentrations and exposure inputs of 50 mg/day soil ingestion and 80 kg body weight.

PAH	Mean Soil (µg/kg)	Daily Intake (mg/kg-day)
Acenaphthene	N/A	
Anthracene	110	$6.88 \cdot 10^{-8}$
Fluoranthene	133	$0.31 \cdot 10^{-8}$
Fluorene	33	$2.06 \cdot 10^{-8}$

PAH	**Mean Soil (µg/kg)**	**Daily Intake (mg/kg-day)**
Pyrene	297	$1.86 \cdot 10^{-7}$

Table 53. Mean soil concentrations for individual PAHs in New Orleans and Detroit as reported by Wang *et al*., (2008). Daily intakes were calculated from the overall mean soil concentrations.

Soil Location	**Units**	**Acenaphthene**	**Anthracene**	**Fluoranthene**	**Fluorene**	**Pyrene**
Open Space: New Orleans	(µg/kg)	11.5	36.5	365	13.7	378
Open Space: Detroit	(µg/kg)	15.6	24.1	447	3.4	408
Foundation: New Orleans	(µg/kg)	23.6	76.5	949	27.9	751
Foundation: Detroit:	(µg/kg)	7.2	29.8	451	5.5	366
Street Side: New Orleans	(µg/kg)	26.5	63.1	936	20.6	793
Street Side: Detroit	(µg/kg)	14.5	49.3	926	5.4	740
Range	(µg/kg)	7.2-26.5	365-949	3.4-27.9	24.1-76.5	366-793
Mean	(µg/kg)	16.5	679	12.8	46.6	573
Daily Intake	(mg/kg-day)	$1.03 \cdot 10^{-8}$	$4.24 \cdot 10^{-7}$	$8 \cdot 10^{-9}$	$2.91 \cdot 10^{-8}$	$3.58 \cdot 10^{-7}$

Kay *et al.* (2008) assessed the ambient concentrations of PAHs detected in surface soils at 57 locations in Chicago, Illinois using stratified random sampling techniques. **Table 54** below summarizes the concentrations of acenaphthene, anthracene, fluoranthene, fluorene, and pyrene detected during the sampling, which was conducted in June 2001 and January 2002. Sample data from one location (CE-19) were excluded from the assessment and deemed to be statistical outliers.

Table 54. Ambient Concentrations of Acenaphthene, Anthracene, Fluoranthene, Fluorene, and Pyrene Detected in Chicago Soils Kay *et al.* (2008)

Parameter	**Number of detections out of 57 samples collected***	**Range of detected concentrations excluding site CE-19 (µg/kg)**	**Mean excluding site CE-19 (µg/kg)**	**Standard Deviation excluding site CE-19 (µg/kg)**	**Median excluding site CE-19 (µg/kg)**
Acenaphthene	51	< 5-1500	NC	NC	85
Anthracene	54	< 7-4600	NC	NC	205
Fluoranthene	57	52-35,000	4,983	6,897	2,050

Parameter	Number of detections out of 57 samples collected*	Range of detected concentrations excluding site CE-19 (µg/kg)	Mean excluding site CE-19 (µg/kg)	Standard Deviation excluding site CE-19 (µg/kg)	Median excluding site CE-19 (µg/kg)
Fluorene	51	< 6-2000	NC	NC	84
Pyrene	57	51-30000	3,483	5,187	1,650

NC= could not be calculated, * including site CE-19

RSC Derivation

EPA (2015E, F, I, J, L) recommended an RSC of 20 percent (0.20) for each of the non-carcinogenic PAHs based on the agency's review of the parameters' physical properties and available exposure information. EPA determined that air, drinking water, and fish and shellfish were potentially significant sources. EPA followed the Exposure Decision Tree in EPA's 2000 Methodology (USEPA, 2000), and determined that there were significant potential sources other than fish and shellfish from inland and nearshore waters and water ingestion exist (Box 8A in the Decision Tree); however, the agency further determined that information is not available to quantitatively characterize exposure from those different sources (Box 8B in the Decision Tree).

FDEP reviewed the available literature and assembled estimates of ambient and non-ambient exposures to the non-carcinogenic PAHs for purposes of calculating an RSC for Florida. The exposure estimates described above were used to estimate a total non-surface water exposure dose for each of the five PAHs as summarized in **Table 55**. The department determined that there was substantial uncertainty in the exposures and therefore chose to express them as a range. These estimated exposures were used to calculate the percentage method based RSC (**Table 56**). For all five PAHs, the lower end RSC was estimated at less than 1% for Class I and III waters. The upper end RSC estimates ranged from 8.7 to 20% and 10 to 21% for Class III and I waters, respectively. The department determined that these results supported the use of the RSC floor and therefore a value of 0.2 was used for all non-carcinogenic PAHs.

Table 55. Tabulation of non-surface water exposures (mg/kg-day) to non-carcinogenic PAHs for the general population.

Source Type (Ambient/Non-Ambient)	Exposure Route	Acenaphthene (mg/kg-day)	Anthracene (mg/kg-day)	Fluoranthene (mg/kg-day)	Fluorene (mg/kg-day)	Pyrene (mg/kg-day)
Ambient	Fresh and Estuarine Fish	$6.46\cdot10^{-7}$ to $2.80\cdot10^{-5}$	$4.07\cdot10^{-7}$ to $5.55\cdot10^{-5}$	$1.22\cdot10^{-4}$ to $4.44\cdot10^{-3}$	$1.27\cdot10^{-6}$ to $5.55\cdot10^{-5}$	$9.15\cdot10^{-7}$ to $7.44\cdot10^{-5}$
Ambient	Drinking Water	$1.02\cdot10^{-6}$ to $5.1\cdot10^{-6}$	$1.95\cdot10^{-6}$ to $3.90\cdot10^{-6}$	$4.8\cdot10^{-5}$ to $4.08\cdot10^{-4}$	$4.5\cdot10^{-6}$ to $4.8\cdot10^{-6}$	$6.00\cdot10^{-7}$ to $5.10\cdot10^{-6}$
Non-Ambient	Diet	$2.91\cdot10^{-4}$	$2.91\cdot10^{-4}$	$2.91\cdot10^{-4}$	$2.91\cdot10^{-4}$	$2.91\cdot10^{-4}$
Non-Ambient	Outdoor Air	$1.55\cdot10^{-8}$ to $1.95\cdot10^{-8}$	$1.67\cdot10^{-7}$ to $1.95\cdot10^{-7}$	$9.13\cdot10^{-8}$ to $2.30\cdot10^{-7}$	$2.01\cdot10^{-7}$ to $2.50\cdot10^{-7}$	$5.07\cdot10^{-8}$ to $9.17\cdot10^{-8}$

Source Type (Ambient/Non-Ambient)	**Exposure Route**	**Acenaphthene (mg/kg-day)**	**Anthracene (mg/kg-day)**	**Fluoranthene (mg/kg-day)**	**Fluorene (mg/kg-day)**	**Pyrene (mg/kg-day)**
Non-Ambient	Indoor Air	$6.12 \cdot 10^{-7}$	$1.56 \cdot 10^{-6}$	$3.54 \cdot 10^{-7}$	$7.40 \cdot 10^{-7}$	$1.93 \cdot 10^{-7}$
Non-Ambient	Soil Ingestion	$1.70 \cdot 10^{-7}$	$2.75 \cdot 10^{-8}$	$3.32 \cdot 10\text{-}^{8}$	$8.25 \cdot 10^{-9}$	$7.43 \cdot 10^{-8}$

Table 56. Summary of lower and upper range total non-surface water source exposure to five PAHs and selected RSC values. The lower range exposures were tabulated in **Table 55** above. The upper range estimates were calculated by increasing dietary (food) exposures by a factor 10. The selected RSCs were calculated from the upper end exposure estimate.

Parameter	Class III Lower RSC Estimate	Class III Upper RSC Estimate	Class I Lower RSC Estimate	Class I Upper RSC Estimate
Acenaphthene	0.22%	8.7%	0.57%	10%
Anthracene	0.14%	16%	0.80%	17%
Fluoranthene	0.51%	16%	0.72%	17%
Fluorene	0.43%	16%	0.43%	16%
Pyrene	0.31%	20%	0.52%	21%

Dimethyl phthalate (DMP)

Background

Dimethyl phthalate (DMP) (CASRN 131-11-3) is a phthalate ester used in manufacturing solid rocket propellant and consumer products such as insect repellants, lacquers, safety glasses, rubber coating agents, molding powders, pesticides, and plastics (Lewis, 2007). Acute exposure via inhalation in humans results in irritation of the eyes, nose, and throat (HSDB, No. 1641; New Jersey DOH, 1986). Data suggests that the general population may be exposed to dimethyl phthalate through inhalation of ambient air, ingestion of drinking water, and dermal contact with products containing DMP (HSDB, No. 1641). Its former use as an insect repellent resulted in its direct release to the environment (Lewis, 2007). DMP occurs in nature as a metabolite of *Gibberella fujikuroi* (O'Neil, 2006), which is a fungus that causes 'cotton boll rot' and is found in Florida.

DMP is a colorless oily liquid with a slightly sweet odor (New Jersey DOH, 1986). Its vapor pressure is $3.09 \cdot 10^{-3}$ mm Hg at 25°C (Daubert, 1989), which indicates it can be found in both vapor and particulate phases in the atmosphere (Bidleman, 1988). Vapor phase DMP is degraded in the air by reaction with photochemically-produced hydroxyl radicals. It's half-life in the air is expected to be 28 days (HSDB, No. 1641). While the particulate phase of DMP is removed by wet or dry deposition, it is also subject to direct photolysis by sunlight since it contains chromophores that absorb at wavelengths greater than 290 nm (HSDB, No. 1641).

In soil, DMP is expected to have high to moderate mobility based on its log K_{oc} of 55-360 (Osipoff, 1981). It has a Henry's Law Constant of $2.0 \cdot 10^{-7}$ atm-m^3/mole, which makes volatilization from moist soil surfaces unexpected (HSDB, No. 1641). Biodegradation half-lives in contaminated soil ranging from 15 to 123 days (Kincannon and Lin, 1985) suggest that biodegradation is dependent on prior exposure and subsequent acclimation (HSDB, No. 1641).

If released into water, dimethyl phthatlate is expected to adsorb to suspended solids and sediment based upon its mean K_{oc} value of greater than 5.2 (Ritsema, 1989). A 50 percent biodegradation in 1 to 5 days with complete disappearance obtained in 2 to 13 days in sediment-water estuarine and freshwater sites suggest that biodegradation may be an important environmental fate process in water (Walker, 1984; HSDB, No. 1641). Volatilization from water surfaces is not expected to be an important fate process (Lyman, 1990) based upon this compound's estimated Henry's Law constant (HSDB, No. 1641).

Aerobic degradation studies indicated primary degradation for the lower molecular weight phthalate esters (which include DMP) occurred rapidly, typically exceeding 90% degradation within a week (Staples *et al.*, 1997). Microorganisms isolated from soil are capable of utilizing dimethyl phthalate (Williams, 1983). Microorganisms from natural waters are also able to use DMP (Taylor, 1981). Ritsema (1989) showed that DMP was completely degraded in 2 to 13 days in sediment-water systems obtained from 6 different estuarine and freshwater sites bordering the Gulf of Mexico.

Exposure Source Determinations

Manufacturing and Release

The US EPA Toxic Release Inventory (TRI) Explorer reported a total on-site release of dimethyl phthalate in Florida in 2014 of 639.46 pounds, with the majority of the release/ disposal originating from fugitive and point source air emissions. Review of the release data for the period from 2005 through 2014 for Florida, Alabama, Georgia, and the entire U.S., confirm that the vast majority of environmental releases of chloroform is via air emissions (USEPA, 2015D; **Table 57**).

Table 57. Summary of average annual percent total releases of dimethyl phthalate to the environment from 2005 through 2014. Air releases includes both stack and fugitive air. Surface water discharge includes direct (on-site) releases to water, transfers to POTW for release, and transfers to POTW for treatment (metals only). There were no reported releases of dimethyl phthalate for the states of Alabama, Florida, and Georgia.

Geographic Area	Air Releases	Class I Well Disposal	Land Treatment	Landfill	Other Disposal	Surface Impoundment	Surface Water Discharge
Florida	100.0%	0.0%	-	-	-	-	-
Alabama	97.2%	-	-	-	2.8%	-	-
Georgia	100.0%	-	-	-	-	-	-
US Total	90.7%	0.9%	0.0%	0.6%	0.1%	0.0%	0.1%

Ambient Exposure Sources

Surface Water

DMP was detected in the Mississippi River at 0.002 and 0.005 µg/L (DeLeon, 1986). Using data in STORET, DMP was detected in 6% of samples at concentrations below 10 µg/L (Staples *et al.*, 1985).

The IWR Run 50 database was queried for DMP data to determine typical ambient surface water concentrations in Florida. There were 167 measurements in the database for the period from 2005 to 2014; however, there were no DMP values reported above the method detection limits, which ranged from 0.18 to 11 µg/L. The average DMP concentration was estimated be < 1.3 µg/L. This values represents one half the average MDL.

Ingestion of Freshwater and Estuarine Fish

DMP has been detected in oysters and clams from Lake Pontchartrain, LA at concentrations of 8.4 ng/g and 44 ng/g wet weight (McFall, 1985). DMP concentrations ranging from 0.58- 2.28 ng/g lipid were measured in a variety of marine organisms (invertebrates and fish) in 1999 from British Columbia (MacKintosh, 2004). This chemical was not included in NOAA's Mussel Watch Survey, and it was not on the list of analytes in EPA's National Lake Fish Tissue Study.

Because neither Florida specific nor surrogate fish tissue data could be located, the mean surface water DMP concentration of <1.3 µg/L calculated from IWR Run 50 data was used in conjunction with the Florida BCF of 2,500 L/kg to estimate an average Florida fish tissue concentrations for fresh and estuarine fish. FDEP developed an estimated average Florida fish tissue concentrations by multiplying the BCF by the mean surface water concentration and applying a conversion factor (0.001) to convert the units to mg/kg-fish tissue. The estimated average Florida fish concentration was calculated to be 0.193 mg/day and was used as an upper end estimate of intake via the consumption of fresh and estuarine fish. A mean concentration in fish of 0.21 ng/g from Schecter *et al.* (2013) was used as the lower end estimate ($2.72 \cdot 10^{-6}$ mg/day) for daily intake via the consumption of fresh and estuarine fish.

Non-ambient Exposure Sources

Treated Drinking Water

DMP is not regulated under the safe drinking water act and does not have a FDA bottled water standard. DMP was detected in drinking water at 3 New Orleans plants, with values ranging from 0.13 to 0.27 µg/L (Keith *et al.*, 1976). DMP has been detected in other sources in Philadelphia (Suffet, 1980), England (Fielding *et al.*, 1981), Japan (Akiyama, 1980), and Cincinnati, OH (Lucas, 1984). Note that many of the concentrations mentioned above were determined over 20 years ago. Clark *et al.*, (2011) provided an estimated mean concentration of 0.027 µg/L for drinking water.

Drinking water facility data for the period between 2004 and 2014 were queried from the State's Drinking Water Data Base (http://www.dep.state.fl.us/water/drinkingwater/download.htm). DMP results were reported for only 5 facilities (Florida City, North Miami Beach, Manatee County Utilities, Dunedin Water System, and Tarpon Springs Water System). All values were reported as non-detect (0 µg/L). The mean value of <1.3 µg/L from the IWR Run 50 database and the mean value from Clark *et al.* of 0.027 ug/L, (2011), respectively were used to estimate upper and lower exposures levels via drinking water, and to calculate an RSC for DMP. The drinking water exposure estimate ranged from $6.48 \cdot 10^{-5}$ to $3.12 \cdot 10^{-3}$ mg/day.

Groundwater

Little information could be located regarding dimethyl phthalate concentrations in groundwater. However, a DMP concentration was reported as detected in groundwater in Massachusetts at 0.10 µg/L (Bedient, 1983).

Air

The USEPA considers DMP to be a hazardous air pollutant (USEPA, 2013C). DMP was not detected in 70 samples collected outside of office buildings in U.S. cities in Kansas, Texas, New Jersey, Wisconsin, or Montana (Shields, 1996). In indoor air, DMP was detected in Wisconsin (0.43 to 0.60 µg/m^3) and New Jersey (1.54 to 1.74 µg/m^3) in 1987 (Shields and Weschler, 1987). In 1988, it was detected in an office building also in Wisconsin, at concentrations ranging from 0.7 to 1.2 µg/m^3. Clark *et al.* (2011) reported a mean DMP indoor air concentration of 0.923 µg/m^3 and a mean DMP outdoor air concentration of 0.0033 µg/m^3. According to the U.S. EPA's 2011 National Air Toxics Assessment data, the total modeled ambient air concentration of dimethyl phthalate in Florida was 0.000186 µg/m^3. The total ambient dimethyl phthalate concentrations estimated for Florida counties ranged from a minimum of 0 µg/m^3 reported in a number of counties to a maximum of 0.153 µg/m^3 in Polk County (USEPA, 2015C). The total value for Florida from the U.S. EPA's 2011 National Air Toxics Assessment data was used for the purposes of calculating an RSC for DMP.

Soil and Dust

Due to the ubiquitous nature of phthalates in consumer products, these chemicals can become incorporated into soils and household dusts. Various DMP soil concentrations were located within literature. DMP was detected in 6 out of 10 soils in Canada. Results were not quantified, but the detection limit was 0.03 mg/kg dry weight (Webber, 1995). Clark *et al.* (2011) reported a mean ingested soil concentration of 0.0002 µg/g, Mcfall (1985) reported DMP soil concentrations of 0.002 and 0.0002 (µg/g), and Lopes and Furlong (2001) reported a DMP soil concentration of 0.12 (µg/g). The mean ingested soil concentration from Clark *et al.* (2011) was used to estimate daily DMP exposure ($4.0 \cdot 10^{-9}$ mg/day) from the ingestion of soil. This value was used in the RSC calculation.

Diet (other than fresh or estuarine fish)

Dimethyl phthalate concentrations were measured for but not detected in 57 vodka and spirit bottles (Leibowitz, 1995). DMP was also measured for but not detected in corn grain, carrot, and cabbage samples collected at a coal refuse reclamation site in Illinois (Webber, 1994). In a study that tested coffee filters, DMP was detected in 1 of 10 filters at a concentration of 2.0 µg/g (Fricker, 1990). Clark *et al.* (2011) analyzed, but did not detect DMP in a variety of foods, including water, cereals, dairy, eggs, fats and oils, fruit, grains, meats, nuts and beans, poultry, processed meats, vegetable products, and others. DMP was detected in fish and milk at 0.0012 µg/g and 0.7 µg/L, respectively. Schecter *et al.* (2013) conducted an analysis of 72 different foods collected from Albany, New York to determine phthalate concentrations detected in different food groups. **Table 58** below displays the mean dimethyl phthalate concentrations detected in the food groups assessed

Table 58. Estimated Mean Concentrations of Dimethyl Phthalate in Foods assessed by Schecter *et al* (2013).

Food Group	**Detection Frequency** LOD=0.2	**Mean Detected Concentration (ng/g whole weight)**[2]
Beverages (n=8)	2	0.13
Milk (n=2)	0	0.1
Other Dairy (n=9)	4	0.48
Fish (n=5)	2	0.21
Fruit/Vegetables (n=5)	0	0.1
Grain (n=7)	5	0.3
Beef (n=2)	1	0.18
Pork (n=4)	2	0.33
Poultry (n=6)	3	0.15
Meat and Meat Products (n=13)[1]	7	0.22
Vegetable Oils (n=3)	1	1.2
Condiments (n=6)	3	0.33
Infant Food (n=7)	0	0.1

[1] 12 of 13 samples included in the "meat and meat products" group are included in other groups as well; [2] The food concentrations listed above are means with one half the LOD conservatively used for measures below detect.

Casajuana and Lacorte (2004) analyzed whole milk sample packaged in Tetra Brik and High Density Polyethylene (HDPE) bottles for concentrations of different phthalates. The average DMP concentrations detected and reported in **Table 59** were relatively low in comparison to other phthalate concentrations detected in the analyzed whole milk samples.

Table 59. Average concentrations (μg/kg) of DMP Detected in Analyzed Milk Samples

Parameter	**Tetra Brik Brand 1 (n=2)**	**Tetra Brik Brand 2 (n=2)**	**HDPE Brand 3 (n=2)**	**HDPE Brand 4 (n=2)**	**Infant Formula (n=2)**
DMP	1.75± 0.1	1.30±0.2	0.97±0.1	1.19±0.2	1.38±0.01

FDEP used the estimated mean concentrations of dimethyl phthalate in foods from Schecter *et al* (2013) as the basis of its estimate for exposures via diet (**Table 60**).

Table 60. Estimates of mean daily exposure to DMP via dietary consumption for Florida adults. Mean concentrations are from Schecter *et al* (2013). Total meat was taken as the average of beef, pork, and meat and meat products. Dairy was calculated as the average of milk and other dairy.

Food Category	**Mean Concentration (µg/g)**	**Consumption (g/kg-day)**	**mg/kg-day**
Fruits	0.0001	1.6	$1.6 \cdot 10^{-7}$
Vegetables	0.0001	2.9	$2.9 \cdot 10^{-7}$
Total Meat	0.00022	2	$4.4 \cdot 10^{-7}$
Dairy	0.00029	6.6	$1.9 \cdot 10^{-6}$
Grain	0.0003	2.6	$7.8 \cdot 10^{-7}$
Marine Fish	0.00021	0.16	$3.4 \cdot 10^{-8}$
Fats	0.0012	1.2	$1.4 \cdot 10^{-6}$
		Total	$5.06 \cdot 10^{-6}$

Personal care and consumer products

Several million tons of phthalates are used each year in the production of soft polyvinyl chloride and other plastics that are used in many consumer and personal care products (e.g., makeup, deodorant, perfume, nail polish). Phthalates are not chemically bound to the products they are constituents of and are released continuously into the air. Although DMP is not among the most commonly used phthalate plasticizers, it still may be used in many products, thus creating a pathway for potential exposure especially for women who often utilize personal care products, more so than men, and children who possess a lower threshold of exposure.

Wormuth *et al.* (2006) conducted an extensive analysis of exposure to eight phthalate esters, including DBP, for European populations. The analysis included exposures from inhalation of indoor air, outdoor air, and while using spray paints; dermal exposure from personal care products, gloves, and textiles; and, oral exposure from food, dust, mouthing (young children) and ingestion of personal care products. They estimated daily exposures for seven age and gender groups (consumer groups): infants (0-12 months, 5.5 kg bw); toddlers (1-3 years, 13 kg bw); children (4-10 years, 27 kg bw); female adolescents (11-18 years, 57.5 kg bw); male adolescents (11-18 years, 57.5 kg bw); female adults (18-80 years, 60 kg bw); and, male adults (18-80 years, 70 kg bw). Mean daily dimethyl phthalate exposures for these groups reported by Wormuth *et al.* (2006) are provided in **Table 61**. The mean total daily exposure of $2.30 \cdot 10^{-4}$ µg/kg-day for adults from Wormuth *et al.* (2006) was used by FDEP to estimate dimethyl phthalate exposure for purposes of calculating an RSC for the parameter.

Table 61. Total Mean Daily Exposure to Dimethyl Phthalate in Seven Consumer Groups taken from Wormuth *et al.* (2006).

Consumer Group	Mean Total Daily Exposure (µg/kg-day)
Infant	$1.99 \cdot 10^{-3}$
Toddlers	$7.40 \cdot 10^{-4}$
Children	$5.10 \cdot 10^{-4}$
Female Teen	$2.20 \cdot 10^{-4}$
Male Teens	$2.50 \cdot 10^{-4}$
Female adults	$2.30 \cdot 10^{-4}$
Male Adults	$2.30 \cdot 10^{-4}$

RSC Derivation

EPA (2015H) recommended an RSC of 20 percent (0.20) for dimethyl phthalate based on the agencies review of the parameter's physical properties and available exposure information. EPA determined that air, drinking water, and fish and shellfish were potentially significant sources. EPA followed the Exposure Decision Tree in EPA's 2000 Methodology (USEPA 2000), and determined that there were significant potential sources other than fish and shellfish from inland and nearshore waters and water ingestion exist (Box 8A in the Decision Tree); however, the agency further determined that information is not available to quantitatively characterize exposure from those different sources (Box 8B in the Decision Tree).

FDEP reviewed the available literature and assembled estimates of ambient and non-ambient exposures to dimethyl phthalate for purposes of calculating an RSC for Florida. However, the department concurs with EPA's determination that the data are not sufficient to quantify exposures from these sources. For Class III waters, the percentage based RSC ranged from 0.014 to 91%. The percentage based RSC for Class I waters ranged from 0.35 to 91%. The wide range of the RSC values is partially a reflection of the high uncertainty in the exposure estimates; that is, there is insufficient information to adequately characterize the exposure. Therefore, following the Decision Tree would lead to an RSC of 0.2. There is information to suggest that non-ambient exposures are significant, but the information is not sufficient to quantitatively characterize exposures from ambient and non-ambient sources.

Table 62. Summary of major ambient and non-ambient dimethyl phthalate exposures to the general adult Florida populations. Exposures were used in the RSC calculations.

Source Type (Ambient/Non-Ambient)	Exposure Route	Lower Exposure Estimate (mg/kg-day)	Upper Exposure Estimate (mg/kg-day)
Ambient	Fresh and Estuarine Fish	$3.40 \cdot 10^{-8}$	$2.41 \cdot 10^{-3}$
Ambient	Treated Drinking Water	$8.10 \cdot 10^{-7}$	$3.90 \cdot 10^{-5}$

Source Type (Ambient/Non-Ambient)	Exposure Route	Lower Exposure Estimate (mg/kg-day)	Upper Exposure Estimate (mg/kg-day)
Non-Ambient	Diet	$5.06 \cdot 10^{-6}$	$5.06 \cdot 10^{-6}$
Non-Ambient	Outdoor Air	$3.72 \cdot 10^{-8}$	$3.72 \cdot 10^{-8}$
Non-Ambient	Soil Ingestion	$5.00 \cdot 10^{-11}$	$5.00 \cdot 10^{-11}$
Non-Ambient	Personal Care Products	$2.30 \cdot 10^{-4}$	$2.30 \cdot 10^{-4}$

References

Akiyama, T., Koga, M., Shinohara, R., Kido, A., and Etoh, S. (1980). Detection and Identification of Trace Organic Substances in the Aquatic Environment. *Journal of University of Occupational and Environmental Health*. 2: 285-300.

ASTER. (1996). ASTER (Assessment Tools for the Evaluation of Risk) ecotoxicity profile. Duluth, MN: Environmental Research Laboratory, U.S. Environmental Protection Agency.

ATSDR. (Agency for Toxic Substances and Disease Registry). (1990). Toxicological profile for nitrobenzene. US Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry.

ATSDR. (Agency for Toxic Substances and Disease Registry). (1993). Toluene Toxicity Clinical Evaluation. U.S. Department of Health and Human Services. Public Health Service. Agency for Toxic Substances and Disease Registry.

ATSDR. (Agency for Toxic Substances and Disease Registry). (1995). Toxicological Profile for Polycyclic Aromatic Hydrocarbons. U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry.

ATSDR. (Agency for Toxic Substances and Disease Registry). (1997). Toxicological Profile for Chloroform. U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry.

ATSDR. (Agency for Toxic Substances and Disease Registry). (2000). Toxicological Profile for Toluene. U.S. Department of Health and Human Services. Public Health Service. Agency for Toxic Substances and Disease Registry.

ATSDR. (Agency for Toxic Substances and Disease Registry). (2003). Toxicological Profile for Selenium. U.S. Department of Health and Human Services. Public Health Service. Agency for Toxic Substances and Disease Registry.

Baek, S., R.A. Field, and M.E. Goldstone. (1991). A Review of Atmospheric Polycyclic Aromatic Hydrocarbons: Sources, Fate and Behavior. *Water Air Soil Pollution*, 60: 279-300.

Banerjee S, Yalkowsky SH, Valvani SC. (1980). Water solubility and octanol/water partitioncoefficients of organics. Limitations of the solubility-partition coefficient correlation. *Environ Sci Technol* 14:1227-1229.

Barceloux, DG. (1999). Selenium. *Journal of Toxicology: Clinical Toxicology*, 37(2):145-172.

Basu, D. K., and J. Saxena. (1978). Polynuclear Aromatic Hydrocarbons in Selected U.S. Drinking Waters and their Raw Water Sources. *Environmental Science & Technology, 12*(7): 795.

Beckman Sundh, U., A. Thuvander, and C. Andersson. (1998). Review of PAH in Food – Potential Health Effects and Contents in Food. *Report 8/98*. Livsmedelsverket, National Food Administration, Uppsala, Sweden.

Bedient, Philip B., N. Springer, E. Baca, T. Bouvette, S.R. Hutchins, and M. Tomson. (1983). Ground-Water Transport from Wastewater Infiltration. *Journal of Environmental Engineering.* 109: 485-501.

Bialostosky K, Wright, JD, Kennedy-Stephenson, J, McDowell, M and Johnson, CL. (2002). Dietary Intake of Macronutrients, Micronutrients, and Other Dietary Constituents: United States 1988–94. National Center for Health Statistics. Vital Health Stat 11(245).

Bidleman, T.F. (1988). Atmospheric Processes. *Environmental Science and Technology*. 22: 361-367.

Bizzari SN, Kishi A. (2007). Nitrobenzene. In *Chemical Economics Handbook.* Menlo Park, CA: SRI Consulting. Online edition.

Boublik T, Fried V, Hala E. (1984). The vapor pressures of pure substances: Selected values of the temperature dependence of the vapor pressures of some pure substances in the normal and low-pressure region. Volume 17. Amsterdam, Netherlands: Elsevier Scientific Publications.

Bozzelli J.W., B.B. Kebbekus, and A. Greenberg. (1980). Analysis of Selected Toxic and Carcinogenic Substances in Ambient Air at New Jersey. Trenton, New Jersey, New Jersey Department of Environmental Protection, Office of Cancer and Toxic Substances Research.

Bozzelli, J.W., and B.B. Kebbekus. (1982). A Study of Some Aromatic and Halocarbon Vapors in the Ambient Atmosphere of New Jersey. *J Environ Sci Health*, 5: 693–711.

Breckenridge, RP and Crockett, AB. (1995). Engineering Forum Issue: Determination of Background Concentrations of Inorganics in Soils and Sediments at Hazardous Waste Sites. United States Environmental Protection Agency: Office of Research and Development and Office of Solid Waste and Emergency Response. EPA/540/S-96/500.

Butler, J.P., Post, G.B., Lioy, P.J., J.M. Waldman, and A. Greenberg. (1993). Assessment of Carcinogenic Risk from Personal Exposure to Benzo[a]pyrene in the Total Human Environmental Exposure Study (THEES). *J. Air Waste Manage. Assoc.*, 43: 970-977.

Casajuana, N. and Lacorte, S. (2004). New Methodology for the Determination of Phthalate Esters, Bisphenol A, Bisphenol A Diglycidyl Ether, and Nonylphenol in Commercial Whole Milk Samples. *Journal of Agricultural and Food Chemistry*, 52: 3702-3707.

Chahal, M. K., Toor, G. S., Brown, P. (2010). Trace Metals and Polycyclic Aromatic Carbons in an Urbanized Area of Florida. *Soil and Sediment Contamination,* 19:1-16.

Chan, C-C., Spengler, J.D., Ozkaynak, H., and Lefkopoulou, M. (1991). Commuter Exposures to VOCs in Boston, Massachusetts. *Journal of the Air and Waste Management Association*, 41(12): 1594-1600.

Chen, M., Ma, L.Q., and Harris, W.G. (1999). Baseline Concentrations of 15 Trace Elements in Florida Surface Solis. *Journal of Environmental Quality*, 28 (4): 1173-1181.

Clark, K., David, R., Guinn, R., Kramarz, K., Lampi, M., and Staples, C. (2011). Modeling Human Exposure to Phthalate Esters: A Comparison of Indirect and Biomonitoring Estimation Methods. *Human and Ecological Risk Assessment: An International Journal*, 17: 923-965.

CLPSD. (1989). Contract Laboratory Program Statistical Database. Viar and Company, Management Services Division, Alexandria, VA. October. Cited in ATSDR, 1992.

COT (Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment), (2002). Polycyclic Aromatic Hydrocarbons in the 2000 Total Diet Study. Reports TOX/2002/26, TOX/2002/26 Annex A (Draft) and TOX/2002/26 Annex B. United Kingdom.

Daubert T.E. and R.P. Danner. (1989). Physical and Thermodynamic Properties of Pure Chemicals: Data Compilation. Washington D.C. Taylor and Francis Group.

DeLeon I.R., C.J. Byrne, E.A. Peuler, S.R. Antoine, J. Schefer, and R.C. Murphy. (1986). Trace Organic and Heavy Metal Pollutants in the Mississippi River. *Chemosphere*. 15: 795-805.

Dennis, M.J., R.C. Massey, D.J. McWeeny, M.E. Knowles, and D. Watson. (1983). Analysis of Polycyclic Aromatic Hydrocarbons in UK Total Diets. *Food Chem. Toxicol*., 21: 569-574.

Dennis R.M., W.J. Wujeik, W.L. Lowe, and P.J. Marks. (1990). Task Order 7. Use of activated carbon for treatment of explosive-contaminated groundwater at the Milan army ammunition plant. Aberdeen Proving Ground, Maryland, US Army Toxic and Hazardous Materials Agency (Report CETHA-TE-CR-90041).

Deshon, HD. (1979). Carbon tetrachloride. In: Grayson M, Eckroth D, eds. Kirk-Othmer Encyclopedia of Chemical Technology, 3rd ed, vol 5. New York, NY: John Wiley and Sons, pp. 693-703.

De Vos, R.H., W. Van Dokkum, Schouten, and P. De Jong-Berkhout. (1990). Polycyclic Aromatic Hydrocarbons in Dutch Total Diet Samples (1984-1986). *Food Chem. Toxicol*., 28: 263-268.

EC (European Commission). (2002). Polycyclic Aromatic Hydrocarbons – Occurrence in Foods, Dietary Exposure and Health Effects. Scientific Committee on Food, Brussels, Belgium. Available from: http://ec.europa.eu/food/fs/sc/scf/out154_en.pdf.

Environment Agency Japan. (1992). Chemicals in the Environment: Report on Environmental Survey and Wildlife Monitoring of Chemicals in Fiscal Year 1991. Tokyo, Environment Agency Japan, Department of Environmental Health.

Fielding M., T.M. Gibson, H.A. James, K. McLoughlin, and C.P. Steel. (1981). Organic Micropollutants in Drinking Water. Medmenham, Water Research Centre (Technical Report TR159).

Finley, JW. (2006). Bioavailability of Selenium from Foods. *Nutritional Reviews* 64(3): 146-151.

Fishbein, L. (1988). Toluene: Uses, Occurrence and Exposure. *IARC Scientific Publications* 85: 97-108

FDEP. (Florida Department of Environmental Protection). Drinking Water Database. Available from: http://www.dep.state.fl.us/water/drinkingwater/download.htm.

FDEP. (Florida Department of Environmental Protection). (2012). 2012 Survey of Trihalomethanes in Finfish Collected Near the Outfalls of Domestic Wastewater Treatment Facilities. Bureau of Laboratories Division of Environmental Assessment and Restoration.

Fontenot, B E, Hunt, L R, Hildenbrand Z L, Carlton, D D jr., Oka, H. (2013). An Evaluation of Water Quality in Private Drinking Water Wells Near Natural Gas Extraction Sites in the Barnett Shale Formation. *Environmental Science and Technology* 47 (17).

Fricker C and Hardy J.K. (1990). Characterization of Commercially Available Coffee Filter Papers. *Journal of Environmental Science and Health, Part A*, 25: 927-36.

Glauser, James, and Funada, Chiyo (November, 2011). Marketing Research Report: Chlorinated Methanes. *Chemical Economics Handbook*, SRI Consulting: pages 14 and 20–21.

Gomaa, E. A., J.I., Gray, S. Rabie, C. Lopez-Bote, and A.M. Booren. (1993). Polycyclic Aromatic Hydrocarbons in Smoked Food Products and Commercial Liquid Smoke Flavorings. *Food Addit. & Contam.* , 10: 503-521.

Gossett JM. (1987). Measurement of Henry's Law constant for Cl and C2 chlorinated hydrocarbons. *Environ Sci Technol* 21:202-206.

Guillen, M.D., P. Sopelana, and M.A. Partearroyo. (1997). Food as a Source of Polycyclic Aromatic Carcinogens. Rev. *Environ. Health*, 12: 133-146.

Hansch C, Leo AJ. (1985). Medchem Project Issue 26. Claremont, CA: Pomona College

Harkov R., B. Kebbekus, J.W. Bozzelli, and P.J. Lioy. (1983). Measurement of Selected Volatile Organic Compounds at Three Locations in New Jersey during the Summer Season. *J Air Pollut Control Assoc*, 33: 1177–1183.

Harkov R., B. Kebbekus, J.W. Bozzelli, P.J. Lioy, and J. Daisey. (1984). Comparison of Selected Volatile Organic Compounds during the Summer and Winter at Urban Sites in New Jersey. *Sci Total Environ*, 38: 259–274.

Heroux, M-E., Clark, N., Ryswyk, K. V., Mallick, R., Gilbert, N. L., Harrison, I., Rispler, K., Wang, D., Anastassopoulos, A., Guay, M., MacNeill, M., and Wheeler, A.J. (2010). Predictors of Indoor Air Concentrations in Smoking and Non-Smoking Residences. *Int. J. Environ. Res. Public Health*, 7:3080-3099.

Howard PH. (1990). Handbook of environmental fate and exposure data for organic chemicals. Vol. II. Solvents. Chelsea, MI: Lewis Publishers, Inc.

HSDB. (Hazardous Substances Data Bank). [Internet]. Bethesda, MD: National Library of Medicine (US) Division of Specialized Services. 1986-. HSDB No. 1641, Dimethyl Phthalate [Cited 2016 March 25]. Available from: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB

HSDB. (Hazardous Substances Data Bank). [Internet]. Bethesda, MD: National Library of Medicine (US) Division of Specialized Services. 1986-. HSDB No. 104, Nitrobenzene. [Cited 2016 March 25]. Available from: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB

HSDB. (Hazardous Substances Data Bank). [Internet]. Bethesda, MD: National Library of Medicine (US) Division of Specialized Services. Toluene, HSDB No. 131. [Cited 2016 March 25]. Toluene, HSDB No. 131. Available from: http://toxnet.nlm.nih.gov/cgi-in/sis/search2/r?dbs+hsdb:@term+@DOCNO+131

Hunt GT, Kindya RJ, Hall RR, and Pangaro N. (1982). The Polycyclic Aromatic Environment of the Fluidized-bed Coal Combustion Process - An Investigation of Chemical and Biological Activity. *Proc 6th Int Phys Biol Chem Symp, PolynuclAromat Hydrocarbons. Battelle Press*: 583-608.

Hunt, W.F. Jr, R.B. Faoro, and W. Freas. (1986). Report on the Interim Database for State and Local Air Toxic Volatile Organic Chemical Measurements. Washington, DC, US Environmental Protection Agency (EPA-450/4-86-012).

IARC. (International Agency for Research on Cancer). (1973). Certain polycyclic aromatic hydrocarbons and heterocyclic compounds. Monographs on the evaluation of carcinogenic risk of the chemical to man. Vol. 3. Lyon, France: World Health Organization, International Agency for Research on Cancer.

IARC. (International Agency for Research on Cancer). (1983). IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans. Vol. 32: Polynuclear aromatic compounds: Part 1. Chemical, environmental and experimental data. Lyons, France: World Health Organization, International Agency for Research on Cancer, 155-161, 225-231.

IARC. (International Agency for Research on Cancer). (1996). Nitrobenzene. In: Printing Processes and Printing Inks, Carbon Black and Some Nitro Compounds. Lyon, International Agency for Research on Cancer, IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Vol. 65.

IPCS. (International Programme on Chemical Safety). (1985). Concise International Chemical Assessment Document 52: Toluene. World Health Organization, Geneva. Available from: http://www.inchem.org/documents/ehc/ehc/ehc52.htm

IPCS. (International Programme on Chemical Safety). (1987). Environmental Health Criteria 58: Selenium. World Health Organization, Geneva. Available from: http://www.inchem.org/documents/ehc/ehc/ehc58.htm

IPCS. (International Programme on Chemical Safety). (1998). Selected Non-heterocyclic Polycyclic Aromatic Hydrocarbons. Environmental Health Criteria 202.World Health Organization, Geneva. Available from: http://www.inchem.org/documents/ehc/ehc/ehc202.htm.

Ivahnenko, T. and Zogorski, J.S. (2006) Sources and Occurrence of Chloroform and other Trihalomethanes in Drinking-Water Supply Wells in the United States, 1986-2001. Scientific Investigations Report 2006-5015, U.S. Department of the Interior, U.S. Geological Survey.

Jefferson County Department of Health. (2009). Birmingham Air Toxic Study. Environmental Health Services Air and Radiation Protection Division. Available from: http://www.jcdh.org/misc/ViewBLOB.aspx?BLOBId=182

Jia, C., Batterman, S., and Godwin, C. (2008). VOCs in Industrial, Urban, and Suburban Neighborhoods, Part 1: Indoor and Outdoor Concentrations, Variations and Risk Drivers. *Atmospheric Environment*, 42: 2083-2100.

Jones, K.C., G. Grimmer, and J. Jacob. (1989A). Changes in the Polynuclear Aromatic Hydrocarbon Content of Wheat Grain and Pasture Grassland over the Last Century from One Site in the UK. *Sci. Total Environ.,* 78:117-130.

Jones, K.C., J.A. Stratford, and K.S. Waterhouse. (1989B). Increase in the Polynuclear Aromatic Hydrocarbon Content of an Agricultural Soil over the Last Century. *Environ. Sci. Technol.,* 23: 95-101.

Kabziński, A.K.M., J. Cyran, and R. Juszczak. (2002). Determination of Polycyclic Aromatic Hydrocarbons in Water (including Drinking Water) of Łódź. *Polish Journal of Environmental Studies*, 11(6): 695-706.

Kay, R. T., Arnold, T. L., Cannon, W. F., Graham, D. (2008). Concentrations of Polycyclic Aromatic Hydrocarbons and Inorganic Constituents in Ambient Surface Soils, Chicago, Illinois: 2001-2002. *Soil & Sediment Contamination* 17: 221-236.

Kazerouni, N., R. Sinha, C.H. Hsu, A. Greenberg, and N. Rothman. (2001). Analysis of 200 Food Items for Benzo[a]pyrene and Estimation of its Intake in an Epidemiologic Study. *Food Chem. Toxicol*., 39: 423-436.

Keeler, G.J. and Pirrone, N. (1996). Atmospheric Transport and Deposition of Trace Elements to Lake Erie from Urban Areas. *Wat. Sci. Tech.* 33(4-5):259-265.

Keith L.H., A.W. Garrison, F.R. Allen, M.H. Carter, T.L. Floyd, J.D. Pope, and A.D. Thurston. (1976). Identification of organic compounds in drinking water from thirteen U.S. cities. In: Keith L.H. (editor). (1976). Southeast Environmental Research Lab. *Identification and Analysis of Organic Pollutants in Water.* Athens, GA. Ann Arbor Science Publishers, Ann Arbor Michigan.

Kincannon D.F. and Y.S. Lin. (1985). Microbial Degradation of Hazardous Wastes by Land Treatment. *Proceedings of the Industrial Waste Conference*, 40: 607-619.

Kirschner, E.M. (1996). Growth of Top 50 Chemicals Slowed in 1995 from Very High 1994 rate. *Chem Eng News* 74(15): 16-22. Available from: http://pubs.acs.org/cen/hotarticles/cenear/960408/growth.html.

Kopfler F.C., R.G. Melton, J.L. Mullaney, and R.G. Tardiff. (1977). Human exposure to water pollutants. *Adv Environ Sci Technol*, 8: 419–433.

Krauss, M., and W. Wilcke. (2003). Polychlorinated Naphthalenes in Urban Soils: Analysis, Concentrations, and Relation to other Persistent Organic Pollutants. *Environ. Pollution*, 122: 75-89.

Larsson, B., and G. Sahlberg. (1982). Polycyclic Aromatic Hydrocarbons in Lettuce: Influence of a Highway and an Aluminum Smelter. In: Polynuclear Aromatic Hydrocarbons: Physical and Biological Chemistry (Cooke, M., Denis, A.J., and Fisher, G.L., Eds.). Battelle Press, Columbus, Ohio, pp 417-426.

Leibowitz J.N., R. Sarmiento, S.M. Dugar, and M.W. Ethridge. (1995). Determination of Six Common Phthalate Plasticizers in Grain Neutral Spirits and Vodka. *Journal of AOAC International*, 78: 730-735.

Lewis R.J. Sr. (2007). *Hawley's Condensed Chemical Dictionary*, 15th ed. John Wiley and Sons, Inc. NY, NY pp. 453.

Li, A., T.M. Schoonover, Q. Zou, F. Norlock, L.M. Conroy, P.A. Scheff, and R.A. Wadden. (2005). Polycyclic Aromatic Hydrocarbons in Residential Air of Ten Chicago Area Homes: Concentrations and Influencing Factors. *Atmospheric Environment*, 39 (19): 3491-3501.

Lijinsky, W. and Shubik, P. (1965A). Polynuclear Hydrocarban Carcinogens in Cooked Meat and Smoked Food. *Industrial Medicine & Surgery* 34:152-154.

Lijinsky, W. and Shubik, P. (1965B). The Detection of Polycyclic Aromatic Hydrocarbons in Liquid Smoke and Some Foods. *Toxicology and applied Pharmacology* 7:337-343.

Lin, L., Fan, Z., Zhu, X., and Huang, L. (2011). Characterization of Atmospheric Polycyclic Aromatic Hydrocarbons in a Mixed-Use Urban Community in Patterson, NJ: Concentrations and Sources. *J. Air & Waste Manage. Assoc.* 61:631-639.

Lioy P.J., J.M. Daisey, T. Atherholt, J. Bozzelli, R. Darack, R. Fisher , A. Greenberg, R. Harkov, B. Kebbekus, T.J. Kneip, J. Lewis, G. McGarrity, L. McGeorge, and N.M. Reiss. (1983). The New Jersey Project on Airborne Toxic Elements and Organic Substances (ATEOS): A Summary of the 1981 Summer and 1982 Winter Studies. *J Air Pollut Control Fed*, 33: 649–657.

Lopes TJ and Furlong ET (2001). Occurrence and Potential Adverse effects of Semivolatile Organic Compounds in Streambed Sediment, United States, 1992-1995. Environ Toxicol Chem: 20:727–737.

Lucas S.V. (1984).*GC/MS Analysis of Organics in Drinking Water Concentrates and Advanced Waste Treatment Concentrates: Volume 1 Analysis Results for 17 Drinking Water, 16 Advanced Waste Treatment and 3 Process Blank Concentrates.* USEPA-600/1-84-020A. (NTIS PB85-128221) Columbus, OH: Columbus Labs Health Effects Research Lab.

Lyman W.J., D.H. Rosenblatt, and W.J. Reehl. (1990). *Handbook of Chemical Property Estimation Methods*. Washington, DC: American Chemical Society. pp. 15-1 to 15-29.

Mabey WR, Smith JH, Podoll RT, Johnson HL, Mill T, Chou TW, Gates J, Partridge IW, Jaber H, and Vandenberg D.(1982). Aquatic Fate Processes Data for Organic Priority Pollutants. USEPA-440/4-81-014. U.S. Environmental Protection Agency, Washington, DC. December 1982.

MacKintosh C.E., J. Maldonado, J. Hongwu, N. Hoover, A. Chong, M. Ikonomou, and F.A.P.C. Gobas. (2004). Distribution of Phthalate Esters in a Marine Aquatic Food Web: Comparison to Polychlorinated Biphenyls. *Environmental Science and Technology*. 38: 2011-20.

Maisto, G., F. De Nicola, V.P. Maria, and A. Alfani. (2006). PAHs and Trace Elements in Volcanic Urban and Natural Soils. *Geoderma*, 136: 20-27.

McFall J.A., S. Antoine, and I. DeLeon. (1985). Base-neutral Extractable Organic Pollutants in Biota and Sediments from Lake Pontchartrain. *Chemosphere*. 14:1561-9.

McFarlane J.C., C. Nolt, and C.Wickliff. (1987A). The Uptake, Distribution and Metabolism of Four Organic Chemicals by Soybean Plants and Barley Roots. *Environ Toxico1 Chem*, 6: 847-856.

McFarlane J.C., T. Pfleeger, and J. Fletcher. (1987B). Transpiration Effect on the Uptake and Distribution of Bromacil, Nitrobenzene, and Phenol in Soybean Plants. *J Environ Qual*, 16: 372-376.

McLean, JE and Bledsoe, BE. (1992). Ground Water Issue: Behavior of Metals in Soils. United States Environmental Protection Agency: Office of Research and Development and Office of Solid Waste and Emergency Response. EPA/540/S-92/018

Menzie. C. A., B.B. Potocki, and J. Santodonato. (1992). Ambient Concentrations and Exposure to Carcinogenic PAHs in the Environment. *Environ. Sci. Technol*., 26(7): 1278-1284.

Merck Index. (1989). Merck index: An encyclopedia of chemicals, drugs, and biologicals. 1lth ed. Budavari S, ed. Rahway NJ: Merck & Co., Inc.

Nelson CR & Hites RA (1980) Aromatic Amines in and near the Buffalo River. *Environ. Sci. Technol.*, 14: 1147.1149.

New Jersey Department of Health. (1986). Hazardous Substance Fact Sheet on Dimethyl Phthalate. New Jersey Department of Health, Trenton, NJ. Available from: http://nj.gov/health/eoh/rtkweb/documents/fs/0765.pdf

NFPA. (1994). Fire Protection Guide to Hazardous Materials, 1 lth edition, National Fire Protection Association, Quincy, MA.

Nicholson BC, Maguire BP, Bursill DB. (1984). Henry's law constants for the trihalomethanes: Effects of water composition and temperature. *Environ Sci Technol* 28:5 18-521.

Nirmalakhandan NN, Speece RE. (1988). QSAR model for predicting Henry's constant. *Environ Sci Technol* 22:1349-1357.

NOAA. (2014). *National Centers for Ocean and Coastal Science, National Status and Trends Data Portal (NCCOS NS&T Data Portal)*. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Centers for Ocean and Coastal Science, Silver Spring, MD. http://egisws02.nos.noaa.gov/nsandt/index.html#.

OEHHA. (Office of Environmental Health Hazard Assessment). (1999). Public Health Goal for Toluene in Drinking Water. California Environmental Protection Agency. Available from: http://oehha.ca.gov/water/public-health-goals-phgs.

OEHHA. (Office of Environmental Health Hazard Assessment). (2010). Public Health Goals for Chemicals in Drinking Water: Selenium. Government of California. Available from: http://oehha.ca.gov/water/public-health-goals-phgs.

O'Neil, M.J. (editor). 2006. The Merck Index. 14th ed. Whitehouse Station, NJ: Merck and Co. Inc. pp. 551.

Osipoff R.J., N.J. Hutzler, J.C. Crittenden. (1981). Interaction of Specific Toxic Organic Chemicals Percolating Through a Soil. *Proceedings of the Industrial Waste Conference.* 35: 17-23.

Otson R, Williams DT, & Bothwell PD (1982) Volatile Organic Compounds in Water at Thirty Canadian Potable Water Treatment Facilities. *J Assoc Off Anal Chem*, 65: 1370–1374.

Pellizzari E.D. (1978). Quantification of Chlorinated Hydrocarbons in Previously Collected Air Samples. Research Triangle Park, North Carolina, US Environmental Protection Agency (EPA-450/3-78-112)

Pfannhauser, W., (1991). Polyzyklische aromatische Kohlenwasserstoffe (PAK) in der Nahrung und auf ausgewählten Gemüseproben in Österreich [Polycyclic Aromatic Hydrocarbons (PAH) in Food and on Selected Samples of Vegetables in Austria]. *Mitt. Gebiete Lebensm. Hyg*., 82: 66-79.

Phillips, D.H. (1999). Polycyclic Aromatic Hydrocarbons in the *Diet. Mutat. Res.*, 443: 139-147.

Poor, N. (2002). Atmospheric Deposition of Nitrogen and Air Toxins to the Tampa Bay Estuary. Final Report, prepared for the Tampa Bay Estuary Program, St. Petersburg, FL.

Poor, N.D., R. Tremblay, H. Kay, V. Bhethanabotla, E. Swartz, M. Luther, and S. Campbell. (2004). Atmospheric Concentrations and Dry Deposition Rates of Polycyclic Aromatic Hydrocarbons (PAHs) for Tampa Bay, Florida, USA. *Atmos. Environ*.38: 6005-6015.

Presser, TS and Luoma, SN. (2010). A Methodology for Ecosystem-Scale Modeling of Selenium. *Integrated Environmental assessment and management* 6(4): 685-710.

Ritsema R., W.P. Cofino, P.C.M Frintrop, and U.A.T. Brinkman. (1989). Trace-level Analysis of Phthalate Esters in Surface Water and Suspended Particulate Matter by Means of Capillary Gas Chromatography with Electron-Capture and Mass-Selective Detection. *Chemosphere*, 18: 2161-75.

Rosen M.E., J.F. Pankow, J. Gibs, and T.T. Imbrigiotta. (1992). Comparison of Downhole and Surface Sampling for the Determination of Volatile Organic Compounds (VOCs) in ground water. *Ground Water Monit Rev*, 12: 126–133.

Sabljic A. (1984). Predictions of the nature and strength of soil sorption of organic pollutants by molecular topology. *J Agric Food Chem* 32:243-246.

Santodonato, J., Howard, P., and Basu, D. (1981). Health and Ecological Assessment of Polynuclear Aromatic Hydrocarbans. Center for Chemical Hazard Assessment, Syracuse Research Corporation, Syracuse, New York.

Schecter, A., M. Lorber, Y. Guo, Q. Wu, S.H. Yun, K. Kannan, M. Hommel, N. Imran, L. Hynan, D. Cheng, J. Colacino, and L.S. Birnbaum. (2013). Phthalate Concentrations and Dietary Exposure from Food Purchased in New York State. *Environmental Health Perspectives.* 121: 473-479.

Sheldon L, Clayton A, Keever J, Perritt R, Whitaker D. (1993). Indoor concentrations of polycyclic aromatic hydrocarbons in California residences. Final report. Air Resources Board, Sacramento.

Shields HC, Weschler CJ. (1987). Analysis of Ambient Concentrations of Organic Vapors with a Passive Sampler. *J Air Pollut Control Assoc* 37(9):1039-1045.

Shields H.C., D.M. Fleischer, and C.J. Weschler. (1996). Comparisons among VOCs Measured in Three Types of U.S. Commercial Buildings with Difference Occupational Densities. *Indoor Air*, 6: 2-17.

Skupinska, K. I. Misiewicz, and T. Kasprzycak-Guttman. (2004). Polycyclic Aromatic Hydrocarbons: Physiochemical Properties, Environmental Appearance and Impact on Living Organisms. *Acta Poloniae Pharmaceutica-Drug Research*, 61(3): 233-240.

Speer, K., E. Steeg, P. Horstmann, T.H. Kühn, and A, Montag. (1990). Determination and Distribution of Polycyclic Aromatic Hydrocarbons in Native Vegetable Oils, Smoked Fish Products, Mussels and Oysters, and Bream from the River Elbe. *J. High Res. Chrom*., 13, 104-111.

SRC. (1994). Syracuse Research Center. Henry’s Law Constant Program (HENRYWIN), version 2.50, Serial H0142). Chemcial Hazard Assessment Division, Environmental Chemistry Center, Syracuse, NY.

SRI 2009. (2009). Directory of Chemical Producers. Menlo Park, CA: SRI Consulting. Database edition.

Staples, C.A., A. F. Werner, and T.J. Hoogheem. (1985). Assessment of Priority Pollutant Concentrations in the United States Using STORET Database. *Environ. Toxic. and Chem*, 4: 131-142.

Staples C.A., D.R. Peterson, T.F. Parkerton, and W.J. Adams. (1997). The Environmental Fate of Phthalate Esters. *Chemosphere,* 35: 667-749.

Su, C., Ford, RG, Wilkin, RT. (2007). Monitored Natural Attenuation of Inorganic Contaminants in Ground Water: Volume 2 Assessment for Non-Radionuclides Including Arsenic, Cadmium, Chromium, Copper, Lead, Nickel, Nitrate, Perchlorate, and Selenium. National Risk Management Research Laboratory Office of Research and Development U.S. Environmental Protection Agency Cincinnati, Ohio 45268EPA/600/R-07/140.

Suffet, I.H., L. Brenner, and P. Cairo. (1980). GC/MS Identification of Trace Organics in Philadelphia Drinking Waters during a 2-year Period. *Water Research*, 14: 853-67.

Taylor B.F., R.W. Curry, and E.F. Corcoran. (1981). Potential for Biodegradation of Phthalic Acid Esters in Marine Regions. *Applied and Environmental Micorbiology*, 42: 590-5.

Thomas, W. (1986). Accumulation of Airborne Trace Pollutants by Arctic Plants and Soil. *Water Sci Technol.*, 18:47-57.

Turpin, B.J., Weisel, C.P., Morandi, M., Colome, S., Stock, T., Eisenreich,S., Buckley, B. and others. (2007). Relationships of Indoor, Outdoor, and Personal Air (RIOPA): Part II. Analyses of Concentrations of Particulate Matter Species. Health Effects Institute.

Turrio-Baldassarri, L., A. di Domenico, C. La Rocca, N. Iacovella, and F. Rodriguez. (1996). Polycyclic Aromatic Hydrocarbons in Italian National and Regional Diets. *Polycyclic Aromatic Compounds*, 10: 343-349.

USEPA. (United States Environmental Protection Agency). (N.D.). Technical Fact Sheet on Selenium. Available from: http://water.epa.gov/drink/contaminants/basicinformation/historical/upload/Archived-Technical-Fact-Sheet-on-Selenium.pdf.

USEPA. (United States Environmental Protection Agency). (1983). Nitrobenzene. In: Treatability manual. Vol I. Treatability data. Washington, DC, US Environmental Protection Agency, Office of Research and Development (EPA-600/2-82-001a).

USEPA. (United States Environmental Protection). (1987). U.S. Environmental Protection Agency. Code of Federal Regulations. 40 CFR 246, Appendix XI.

USEPA. (United States Environmental Protection Agency). (2000). Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health. Office of Water. EPA-822-B-00-004. October.

USEPA. (United States Environmental Protection Agency). (2001). Relative Source Contribution for Chloroform. US Environmental Protection Agency, Office of Water. Washington, DC. EPA-822-R-01-006.

USEPA. (United States Environmental Protection Agency). (2003). Ambient Water Quality Criterion for the Protection of Human Health: Chloroform - Revised Draft. Office of Water. EPA-822-R-04-002. December.

USEPA. (United States Environmental Protection Agency). (2005). 2011 National-Scale Air Toxics Assessment; State Summaries. Available from: https://www.epa.gov/national-air-toxics-assessment/2011-nata-assessment-results

USEPA. (United States Environmental Protection Agency). (2009A). Contaminant Occurrence Support Document for Category 1 Contaminants for the Second Six- Year Review of National Primary Drinking Water Regulations. Office of Water. EPA-815-B-09-010.

USEPA. (United States Environmental Protection Agency). (2009B). Contaminant Occurrence Support Document for Category 2 Contaminants for the Second Six- Year Review of National Primary Drinking Water Regulations. Office of Water. EPA-815-B-09-011.

USEPA. (United States Environmental Protection Agency). (2011). Exposure Factors Handbook: 2011 Edition. EPA/600/R-090/052F. Office of Research and Development, Washington, DC.

USEPA. (United States Environmental Protection Agency). (2012A). Basic Information about Selenium in Drinking Water. Available from: http://water.epa.gov/drink/contaminants/basicinformation/selenium.cfm

USEPA. (United States Environmental Protection Agency). (2012B). Toluene. Technology Transfer Network - Air Toxics Web Site. Available from: http://www.epa.gov/ttn/atw/hlthef/toluene.html

USEPA. (United States Environmental Protection Agency). (2013A). Evaluation of the Ocean Discharge Criteria. Region 4 Water Protection Division Wetlands, Coastal and Oceans Branch. Available from: http://www.epa.gov/region4/water/permits/documents/ocean_discharge_criteria_evaluation_al0067237.pdf

USEPA. (United States Environmental Protection Agency). (2013B). 2011 National Emissions Inventory Data. Available from: https://www.epa.gov/air-emissions-inventories/2011-national-emissions-inventory-nei-data

USEPA. (United States Environmental Protection Agency). (2013C). *The Clean Air Act Amendments of 1990 List of Hazardous Air Pollutants*. Air toxics web site. U.S. Environmental Protection Agency, Office of Air and Radiation, Office of Air Quality Planning and Standards, Washington, DC. http://www.epa.gov/airtoxics/orig189.html

USEPA. (United States Environmental Protection Agency). Integrated Risk Information System (IRIS). Available from: http://www.epa.gov/iris/subst/0012.htm

USEPA. (United States Environmental Protection Agency). (2013E). Selenium Compounds. Available from: http://www.epa.gov/ttn/atw/hlthef/selenium.html

USEPA. (United States Environmental Protection Agency). (2014A). Estimated Fish Consumption Rates for the U.S. Population and Selected Subpopulations (NHANES 2003 2010). U.S. Environmental Protection Agency, Office of Water, Washington, DC. http://www.epa.gov/sites/production/files/2015-01/documents/fish-consumption-rates-2014.pdf

USEPA. (United States Environmental Protection Agency). (2014B). *Drinking Water Contaminants. National Primary Drinking Water Regulations*. U.S. Environmental Protection Agency, Office of Water, Office of Ground Water and Drinking Water, Washington, DC. Accessed January 2015. http://water.epa.gov/drink/contaminants/index.cfm

USEPA. (United States Environmental Protection Agency). (2014C). 2012 National Monitoring Programs Annual Report (UATMP, NATTS, CSATAM). Prepared by: Eastern Research Group, Inc. for Margaret Dougherty and David Shelow, Office of Air Quality Planning and Standards, USEPA.

USEPA. (United States Environmental Protection Agency). (2015A). Ambient Monitoring Technology Information Center. Accessed from: http://www3.epa.gov/ttnamti1/toxdat.html

USEPA. (United States Environmental Protection Agency). (2015B). 2011 National Emissions Inventory, Version 2 Technical Support Document. Office of Air Quality Planning and Standards, Air Quality Assessment Division, Emissions Inventory and Analysis Group, Research Triangle Park, North Carolina. Available from: https://www.epa.gov/sites/production/files/2015-10/documents/nei2011v2_tsd_14aug2015.pdf

USEPA. (United States Environmental Protection Agency). (2015C). 2011 National Air Toxics Assessment. Available from: https://www.epa.gov/national-air-toxics-assessment/2011-nata-assessment-results

USEPA. (United States Environmental Protection Agency). (2015D). TRI Explorer. (2014 Dataset [released October 2015]) (Internet database) Retrieved from https://iaspub.epa.gov/triexplorer/tri_release.chemical

USEPA. (United States Environmental Protection Agency). (2015E). Update of Human Health Ambient Water Quality Criteria: Acenaphthene. Office of Water Office of Science and Technology. Washington, DC.

USEPA. (United States Environmental Protection Agency). (2015F). Update of Human Health Ambient Water Quality Criteria: Anthracene. Office of Water Office of Science and Technology. Washington, DC.

USEPA. (United States Environmental Protection Agency). (2015G). Update of Human Health Ambient Water Quality Criteria: Chloroform. Office of Water Office of Science and Technology. Washington, DC.

USEPA. (United States Environmental Protection Agency). (2015H). Update of Human Health Ambient Water Quality Criteria: Dimethyl Phthalate. Office of Water Office of Science and Technology. Washington, DC.

USEPA. (United States Environmental Protection Agency). (2015I). Update of Human Health Ambient Water Quality Criteria: Fluoranthene. Office of Water Office of Science and Technology. Washington, DC.

USEPA. (United States Environmental Protection Agency). (2015J). Update of Human Health Ambient Water Quality Criteria: Fluorene. Office of Water Office of Science and Technology. Washington, DC.

USEPA. (United States Environmental Protection Agency). (2015K). Update of Human Health Ambient Water Quality Criteria: Nitrobenzene. Office of Water Office of Science and Technology. Washington, DC.

USEPA. (United States Environmental Protection Agency). (2015L). Update of Human Health Ambient Water Quality Criteria: Pyrene. Office of Water Office of Science and Technology. Washington, DC. USEPA. (United States Environmental Protection Agency). (2015M). Update of Human Health Ambient Water Quality Criteria: Toluene.

Office of Water Office of Science and Technology. Washington, DC. USFDA. (United States Food and Drug Administration). (2006). Total Diet Study Market Baskets 1991-3 through 2003-4. Center for Food Safety and Applied Nutrition Office of Food Safety. http://www.fda.gov/downloads/Food/FoodScienceResearch/TotalDietStudy/UCM184303.pdf.

USFDA. (United States Food and Drug Administration). (2014). Total Diet Study Elements Results Summary Statistics Market Baskets 2006 through 2011. Center for Food Safety and Applied Nutrition, Office of Analytics and Outreach/Chemical Hazard Assessment Team. http://www.fda.gov/downloads/Food/FoodScienceResearch/TotalDietStudy/UCM184301.pdf

USGS. (United States Geologic Survey). (1997). Methods to Identify Areas Susceptible to Irrigation-Induced Selenium Contamination in the Western United States. United States Department of the Interior. Fact Sheet FS–038–97. Available from: http://www.usbr.gov/niwqp/bibliography/pdf/fs-038-97.pdf

Verschueren K, ed. (1983). Handbook of Environmental Data on Organic Chemicals. 2nd ed. York, NY: Van Nostrand Reinhold Company, 606-611.

Walker W.W., C.R. Cripe, P.H. Pritchard, and A.W. Bourquin. (1984). Dibutylphthalate Degradation in Estuarine and Freshwater Sites. *Chemosphere*, 13: 1283-94.

Wang, G., Q. Zhang, P. Ma, J. Rowden, H.W. Mielke, C. Gonzales, and E. Powell. (2008). Sources and Distribution of Polycyclic aromatic Hydrocarbons in Urban Soils: Case Studies of Detroit and New Orleans. *Soil Sed. Contam.,* 17: 547-563.

Weast RC, ed. (1985). CRC handbook of chemistry and physics: A ready-reference book of chemical and physical data. 66th ed. Boca Raton, FL: CRC Press, Inc., C-115.

Weast RC, ed. (1989). CRC handbook of chemistry and physics. 66th ed. Boca Raton, FL: CRC Press, C-518.

Webber M.D., R.I. Pietz, T.C. Granato, and M.L. Svoboda. (1994). Plant Uptake of PCBs and other Contaminants from Sludge-treated Coal Refuse. *Journal of Environmental Quality*, 23: 1019-26.

Webber M.D. and C. Wang. (1995). Industrial Organic Compounds in Selected Canadian Soils. *Canadian Journal of Soil Science*, 75: 513-24.

Weigal, S., K. Bester, and H. Hüherfuss. (2005). Identification and Quantification of Pesticides, Industrial Chemicals, and Organobromine Compounds of Medium to High Polarity in the North Sea. *Mar. Poll. Bull*, 50: 252-263.

Wilcke, W. (2007). Global Patterns of Polycyclic Aromatic Hydrocarbons (PAHs) in Soil. *Geoderma*, 141: 157-166.

Wilcke, W. (2000). Polycyclic Aromatic Hydrocarbons (PAHs) in Soil-A Review. *J. Plant Nut. Soil Sci.*, 163: 229-243.

Wild, S.R., and K.C. Jones. (1995). Polynuclear Aromatic-Hydrocarbons in the United Kingdom Environment: A Preliminary Source Inventory and Budget. *Environ. Pollution*, 88: 91-108.

WHO. (World Health Organization). (2004). Toluene in Drinking-water: Background Document for Development of WHO Guidelines for Drinking-water Quality. Available from: http://www.who.int/water_sanitation_health/dwq/chemicals/toluene.pdf

WHO. (World Health Organization). (2011). Selenium in Drinking-water: Background document for development of WHO Guidelines for Drinking-water Quality. Available from: http://www.who.int/water_sanitation_health/dwq/chemicals/selenium.pdf

Wormuth, M., M. Scheringer, M. Vollenweider, and K. Hungerbühler. (2006). What Are the Sources of Exposure to Eight Frequently Used Phthalic Acid Esters in Europeans? *Society for Risk Analysis*, 26: 803-824.

Wujcik W.J., W.L. Lowe, P.J. Marks, and W.E. Sisk. (1992). Granular Activated Carbon Pilot Treatment Studies for Explosives Removal from Contaminated Groundwater. *Environ Prog*, 11: 178–189.

Zhang, Y.X., and S. Tao. (2009). Global Atmospheric Emission Inventory of Polycyclic Aromatic Hydrocarbons (PAHs) for 2004. *Atmos. Environ.*, 42: 812-819.

Appendix E. Sensitivity Analysis of Monte Carlo Model Inputs.

Table E-1. Model assumption sensitivity analysis for non-carcinogens and carcinogens, for all end points [cancer risk, non-carcinogen criteria, and hazard quotient (HQ)], and classes (I and III). Class III includes Class II and Class III-Limited waters]. Class I includes Class I-Treated. Total fish consumption (Total FCR) is included at the end of the table to show the influence of the nine fish consumption rates and geographic region on total fish consumption, which was used in calculations for parameters with only a single BCF.

Parameter: Endpoint (Class)	BW	DW	Atlantic TL2	Atlantic TL3	Atlantic TL4	Gulf TL2	Gulf TL3	Gulf TL4	Inland S. TL2	Inland S. TL3	Inland S. TL4	Geographic Region
1,1,2,2-Tetrachloroethane: Cancer Risk (Class I)	-0.25	0.96	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	-0.01
1,1,2,2-Tetrachloroethane: Cancer Risk (Class III)	-0.30	0.00	0.24	0.21	0.15	0.17	0.16	0.11	0.12	0.11	0.10	-0.18
1,1,2-Trichloroethane: Cancer Risk (Class I)	-0.25	0.96	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	-0.01
1,1,2-Trichloroethane: Cancer Risk (Class III)	-0.30	0.00	0.24	0.21	0.15	0.17	0.16	0.11	0.12	0.11	0.10	-0.18
1,2,4-Trichlorobenzene: Cancer Risk (Class I)	-0.31	0.10	0.34	0.16	0.04	0.24	0.12	0.03	0.18	0.08	0.03	-0.19
1,2,4-Trichlorobenzene: Cancer Risk (Class III)	-0.28	0.00	0.35	0.16	0.04	0.25	0.12	0.03	0.18	0.08	0.03	-0.20
1,2-Dichloroethane: Cancer Risk (Class I)	-0.23	0.96	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	-0.01
1,2-Dichloroethane: Cancer Risk (Class III)	-0.30	0.00	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.11	0.10	-0.18
1,2-Dichloropropane: Cancer Risk (Class I)	-0.24	0.96	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.00	-0.01
1,2-Dichloropropane: Cancer Risk (Class III)	-0.30	0.00	0.23	0.22	0.15	0.16	0.16	0.11	0.12	0.11	0.10	-0.18
1,2-Diphenylhydrazine: Cancer Risk (Class I)	-0.28	0.92	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.01	0.02	-0.03
1,2-Diphenylhydrazine: Cancer Risk (Class III)	-0.30	0.00	0.24	0.21	0.15	0.17	0.16	0.11	0.12	0.10	0.10	-0.18
1,3-Dichloropropene: Cancer Risk (Class I)	-0.24	0.96	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	-0.01
1,3-Dichloropropene: Cancer Risk (Class III)	-0.30	0.00	0.23	0.22	0.15	0.16	0.16	0.11	0.12	0.11	0.10	-0.18

Parameter: Endpoint (Class)	BW	DW	Atlantic TL2	Atlantic TL3	Atlantic TL4	Gulf TL2	Gulf TL3	Gulf TL4	Inland S. TL2	Inland S. TL3	Inland S. TL4	Geographic Region
2,4,6-Trichlorophenol: Cancer Risk (Class I)	-0.35	0.70	0.13	0.12	0.09	0.09	0.08	0.06	0.06	0.05	0.06	-0.09
2,4,6-Trichlorophenol: Cancer Risk (Class III)	-0.30	0.00	0.24	0.21	0.15	0.17	0.16	0.11	0.12	0.10	0.11	-0.17
2,4-Dinitrotoluene: Cancer Risk (Class I)	-0.24	0.96	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.00	-0.01
2,4-Dinitrotoluene: Cancer Risk (Class III)	-0.30	0.00	0.24	0.22	0.15	0.16	0.16	0.11	0.12	0.11	0.10	-0.18
3,3'-Dichlorobenzidine: Cancer Risk (Class I)	-0.32	0.84	0.09	0.07	0.06	0.06	0.05	0.04	0.04	0.03	0.04	-0.06
3,3'-Dichlorobenzidine: Cancer Risk (Class III)	-0.30	0.00	0.24	0.21	0.15	0.17	0.16	0.11	0.12	0.10	0.10	-0.18
Acrylonitrile: Cancer Risk (Class I)	-0.23	0.96	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	-0.01
Acrylonitrile: Cancer Risk (Class III)	-0.30	0.00	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.12	0.09	-0.18
Aldrin: Cancer Risk (Class I)	-0.26	0.00	0.04	0.26	0.26	0.03	0.19	0.19	0.02	0.12	0.17	-0.13
Aldrin: Cancer Risk (Class III)	-0.26	0.00	0.04	0.26	0.26	0.03	0.19	0.19	0.02	0.12	0.17	-0.13
alpha-Hexachlorocyclohexane (HCH): Cancer Risk (Class I)	-0.32	0.12	0.29	0.17	0.12	0.20	0.13	0.09	0.14	0.08	0.08	-0.18
alpha-Hexachlorocyclohexane (HCH): Cancer Risk (Class III)	-0.29	0.00	0.29	0.17	0.12	0.21	0.13	0.09	0.15	0.09	0.09	-0.18
Benzene Cancer: See Table E-2												
Benzidine: Cancer Risk (Class I)	-0.23	0.96	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	-0.01
Benzidine: Cancer Risk (Class III)	-0.30	0.00	0.23	0.22	0.14	0.16	0.17	0.10	0.12	0.11	0.10	-0.18
Benzo(a)anthracene: Cancer Risk (Class I)	-0.32	0.07	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.11	0.09	-0.18
Benzo(a)anthracene: Cancer Risk (Class III)	-0.30	0.00	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.12	0.09	-0.18
Benzo(a)pyrene: Cancer Risk (Class I)	-0.32	0.07	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.11	0.09	-0.18
Benzo(a)pyrene: Cancer Risk (Class III)	-0.30	0.00	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.12	0.09	-0.18

Parameter: Endpoint (Class)	BW	DW	Atlantic TL2	Atlantic TL3	Atlantic TL4	Gulf TL2	Gulf TL3	Gulf TL4	Inland S. TL2	Inland S. TL3	Inland S. TL4	Geographic Region
Benzo(b)fluoranthene: Cancer Risk (Class I)	-0.32	0.07	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.11	0.09	-0.18
Benzo(b)fluoranthene: Cancer Risk (Class III)	-0.30	0.00	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.12	0.09	-0.18
Benzo(k)fluoranthene: Cancer Risk (Class I)	-0.32	0.07	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.11	0.09	-0.18
Benzo(k)fluoranthene: Cancer Risk (Class III)	-0.30	0.00	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.12	0.09	-0.18
beta-Hexachlorocyclohexane (HCH): Cancer Risk (Class I)	-0.36	0.65	0.15	0.13	0.10	0.10	0.09	0.07	0.07	0.05	0.06	-0.10
beta-Hexachlorocyclohexane (HCH): Cancer Risk (Class III)	-0.30	0.00	0.24	0.21	0.15	0.17	0.16	0.11	0.12	0.10	0.10	-0.18
Bis(2-Chloroethyl) Ether: Cancer Risk (Class I)	-0.23	0.96	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	-0.01
Bis(2-Chloroethyl) Ether: Cancer Risk (Class III)	-0.30	0.00	0.23	0.22	0.14	0.16	0.17	0.10	0.12	0.11	0.10	-0.18
Bis(2-Ethylhexyl) Phthalate: Cancer Risk (Class I)	-0.36	0.29	0.21	0.21	0.13	0.14	0.15	0.09	0.10	0.10	0.08	-0.16
Bis(2-Ethylhexyl) Phthalate: Cancer Risk (Class III)	-0.30	0.00	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.12	0.09	-0.18
Bis(Chloromethyl) Ether: Cancer Risk (Class I)	-0.23	0.96	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	-0.01
Bis(Chloromethyl) Ether: Cancer Risk (Class III)	-0.30	0.00	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.12	0.09	-0.18
Bromoform: Cancer Risk (Class I)	-0.25	0.96	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	-0.01
Bromoform: Cancer Risk (Class III)	-0.30	0.00	0.24	0.21	0.15	0.17	0.16	0.11	0.12	0.11	0.10	-0.18
Butylbenzyl Phthalate: Cancer Risk (Class I)	-0.31	0.01	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.12	0.09	-0.18
Butylbenzyl Phthalate: Cancer Risk (Class III)	-0.30	0.00	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.12	0.09	-0.18
Carbon Tetrachloride: Cancer Risk (Class I)	-0.26	0.95	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	-0.02

Parameter: Endpoint (Class)	BW	DW	Atlantic TL2	Atlantic TL3	Atlantic TL4	Gulf TL2	Gulf TL3	Gulf TL4	Inland S. TL2	Inland S. TL3	Inland S. TL4	Geographic Region
Carbon Tetrachloride: Cancer Risk (Class III)	-0.30	0.00	0.24	0.21	0.15	0.17	0.16	0.11	0.12	0.10	0.10	-0.18
Chlordane: Cancer Risk (Class I)	-0.28	0.01	0.08	0.28	0.21	0.05	0.21	0.15	0.04	0.14	0.14	-0.15
Chlordane: Cancer Risk (Class III)	-0.28	0.00	0.08	0.28	0.22	0.05	0.21	0.15	0.04	0.14	0.14	-0.15
Chlorodibromomethane: Cancer Risk (Class I)	-0.24	0.96	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.01	-0.01
Chlorodibromomethane: Cancer Risk (Class III)	-0.30	0.00	0.23	0.22	0.15	0.16	0.16	0.11	0.12	0.11	0.10	-0.18
Chrysene: Cancer Risk (Class I)	-0.32	0.07	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.11	0.09	-0.18
Chrysene: Cancer Risk (Class III)	-0.30	0.00	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.12	0.09	-0.18
Dibenzo(a,h)anthracene: Cancer Risk (Class I)	-0.32	0.07	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.11	0.09	-0.18
Dibenzo(a,h)anthracene: Cancer Risk (Class III)	-0.30	0.00	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.12	0.09	-0.18
Dichlorobromomethane: Cancer Risk (Class I)	-0.24	0.96	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.01	-0.01
Dichlorobromomethane: Cancer Risk (Class III)	-0.30	0.00	0.24	0.22	0.15	0.17	0.16	0.11	0.12	0.11	0.10	-0.18
Dieldrin: Cancer Risk (Class I)	-0.27	0.00	0.04	0.26	0.26	0.03	0.19	0.18	0.02	0.13	0.16	-0.13
Dieldrin: Cancer Risk (Class III)	-0.27	0.00	0.04	0.26	0.26	0.03	0.19	0.18	0.02	0.13	0.16	-0.13
Heptachlor Epoxide: Cancer Risk (Class I)	-0.29	0.02	0.09	0.28	0.21	0.06	0.21	0.15	0.04	0.14	0.14	-0.15
Heptachlor Epoxide: Cancer Risk (Class III)	-0.28	0.00	0.09	0.28	0.21	0.06	0.21	0.15	0.04	0.14	0.14	-0.15
Heptachlor: Cancer Risk (Class I)	-0.27	0.01	0.04	0.27	0.25	0.03	0.20	0.18	0.02	0.13	0.16	-0.13
Heptachlor: Cancer Risk (Class III)	-0.27	0.00	0.04	0.27	0.25	0.03	0.20	0.18	0.02	0.13	0.16	-0.13
Hexachlorobenzene: Cancer Risk (Class I)	-0.29	0.01	0.16	0.22	0.23	0.11	0.16	0.16	0.07	0.10	0.15	-0.15
Hexachlorobenzene: Cancer Risk (Class III)	-0.29	0.00	0.16	0.22	0.23	0.11	0.16	0.16	0.07	0.10	0.15	-0.15
Hexachlorobutadiene: Cancer Risk (Class I)	-0.24	0.02	0.41	0.05	0.02	0.29	0.04	0.02	0.22	0.03	0.02	-0.19

Parameter: Endpoint (Class)	BW	DW	Atlantic TL2	Atlantic TL3	Atlantic TL4	Gulf TL2	Gulf TL3	Gulf TL4	Inland S. TL2	Inland S. TL3	Inland S. TL4	Geographic Region
Hexachlorobutadiene: Cancer Risk (Class III)	-0.24	0.00	0.41	0.05	0.02	0.29	0.04	0.02	0.22	0.03	0.02	-0.19
Hexachlorocyclohexane (HCH)-Technical: Cancer Risk (Class I)	-0.37	0.56	0.17	0.15	0.11	0.12	0.11	0.08	0.08	0.06	0.07	-0.12
Hexachlorocyclohexane (HCH)-Technical: Cancer Risk (Class III)	-0.30	0.00	0.23	0.21	0.15	0.16	0.16	0.11	0.12	0.10	0.11	-0.17
Hexachloroethane: Cancer Risk (Class I)	-0.32	0.23	0.34	0.07	0.10	0.24	0.05	0.08	0.17	0.03	0.07	-0.16
Hexachloroethane: Cancer Risk (Class III)	-0.27	0.00	0.36	0.08	0.11	0.26	0.06	0.08	0.19	0.04	0.08	-0.18
Indeno(1,2,3-cd)pyrene: Cancer Risk (Class I)	-0.32	0.07	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.11	0.09	-0.18
Indeno(1,2,3-cd)pyrene: Cancer Risk (Class III)	-0.30	0.00	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.12	0.09	-0.18
Isophorone: Cancer Risk (Class I)	-0.23	0.96	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	-0.01
Isophorone: Cancer Risk (Class III)	-0.30	0.00	0.23	0.22	0.14	0.16	0.17	0.11	0.12	0.11	0.10	-0.18
Methylene Chloride: Cancer Risk (Class I)	-0.23	0.96	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	-0.01
Methylene Chloride: Cancer Risk (Class III)	-0.30	0.00	0.23	0.22	0.14	0.16	0.17	0.10	0.12	0.11	0.10	-0.18
p,p'-Dichlorodiphenyldichloroethane (DDD): Cancer Risk (Class I)	-0.29	0.01	0.12	0.25	0.23	0.08	0.18	0.17	0.05	0.12	0.15	-0.15
p,p'-Dichlorodiphenyldichloroethane (DDD): Cancer Risk (Class III)	-0.29	0.00	0.12	0.25	0.23	0.08	0.18	0.17	0.05	0.12	0.15	-0.15
p,p'-Dichlorodiphenyldichloroethylene (DDE): Cancer Risk (Class I)	-0.28	0.00	0.10	0.22	0.27	0.07	0.16	0.20	0.05	0.10	0.17	-0.14
p,p'-Dichlorodiphenyldichloroethylene (DDE): Cancer Risk (Class III)	-0.28	0.00	0.10	0.22	0.27	0.07	0.16	0.20	0.05	0.10	0.17	-0.14

Parameter: Endpoint (Class)	BW	DW	Atlantic TL2	Atlantic TL3	Atlantic TL4	Gulf TL2	Gulf TL3	Gulf TL4	Inland S. TL2	Inland S. TL3	Inland S. TL4	Geographic Region
p,p'-Dichlorodiphenyltrichloroethane (DDT): Cancer Risk (Class I)	-0.25	0.00	0.06	0.18	0.32	0.04	0.13	0.24	0.03	0.08	0.20	-0.11
p,p'-Dichlorodiphenyltrichloroethane (DDT): Cancer Risk (Class III)	-0.25	0.00	0.06	0.18	0.32	0.04	0.13	0.24	0.03	0.08	0.20	-0.11
PCBs: Cancer Risk (Class I)	-0.30	0.01	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.12	0.09	-0.18
PCBs: Cancer Risk (Class III)	-0.30	0.00	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.12	0.09	-0.18
Pentachlorophenol: Cancer Risk (Class I)	-0.35	0.57	0.05	0.17	0.18	0.04	0.12	0.13	0.02	0.07	0.11	-0.09
Pentachlorophenol: Cancer Risk (Class III)	-0.28	0.00	0.08	0.25	0.24	0.06	0.19	0.18	0.04	0.12	0.16	-0.14
Tetrachloroethylene (Perchloroethylene): Cancer Risk (Class I)	-0.32	0.82	0.09	0.08	0.06	0.06	0.06	0.04	0.04	0.03	0.04	-0.06
Tetrachloroethylene (Perchloroethylene): Cancer Risk (Class III)	-0.30	0.00	0.24	0.21	0.15	0.17	0.16	0.11	0.12	0.10	0.10	-0.18
Toxaphene: Cancer Risk (Class I)	-0.31	0.05	0.14	0.27	0.17	0.10	0.20	0.12	0.07	0.13	0.12	-0.16
Toxaphene: Cancer Risk (Class III)	-0.30	0.00	0.14	0.27	0.17	0.10	0.20	0.12	0.07	0.14	0.12	-0.16
Trichloroethylene (TCE): Cancer Risk (Class I)	-0.26	0.95	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.00	0.01	-0.02
Trichloroethylene (TCE): Cancer Risk (Class III)	-0.30	0.00	0.24	0.21	0.15	0.17	0.16	0.11	0.12	0.10	0.10	-0.18
Vinyl Chloride: Cancer Risk (Class I)	-0.23	0.96	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	-0.01
Vinyl Chloride: Cancer Risk (Class III)	-0.30	0.00	0.23	0.22	0.15	0.16	0.16	0.11	0.12	0.11	0.10	-0.18
1,1,1-Trichloroethane: HQ (Class I)	-0.25	0.95	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.01	-0.01
1,1,1-Trichloroethane: HQ (Class III)	-0.30	0.00	0.24	0.21	0.15	0.17	0.16	0.11	0.12	0.10	0.10	-0.18
1,1,1-Trichloroethane: Non-Cancer Criterion (Class I)	0.25	-0.95	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	-0.01	0.01

Parameter: Endpoint (Class)	BW	DW	Atlantic TL2	Atlantic TL3	Atlantic TL4	Gulf TL2	Gulf TL3	Gulf TL4	Inland S. TL2	Inland S. TL3	Inland S. TL4	Geographic Region
1,1,1-Trichloroethane: Non-Cancer Criterion (Class III)	0.30	0.00	-0.24	-0.21	-0.15	-0.17	-0.16	-0.11	-0.12	-0.10	-0.10	0.18
1,1,2,2-Tetrachloroethane: Non-Cancer Criterion (Class I)	0.25	-0.96	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	-0.01	0.01
1,1,2,2-Tetrachloroethane: Non-Cancer Criterion (Class III)	0.30	0.00	-0.24	-0.21	-0.15	-0.17	-0.16	-0.11	-0.12	-0.11	-0.10	0.18
1,1,2-Trichloroethane: Non-Cancer Criterion (Class I)	0.25	-0.96	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	-0.01	0.01
1,1,2-Trichloroethane: Non-Cancer Criterion (Class III)	0.30	0.00	-0.24	-0.21	-0.15	-0.17	-0.16	-0.11	-0.12	-0.11	-0.10	0.18
1,1-Dichloroethylene: HQ (Class I)	-0.24	0.96	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	-0.01
1,1-Dichloroethylene: HQ (Class III)	-0.30	0.00	0.23	0.22	0.15	0.16	0.16	0.11	0.12	0.11	0.10	-0.18
1,1-Dichloroethylene: Non-Cancer Criterion (Class I)	0.24	-0.96	0.00	0.00	-0.01	0.00	-0.01	0.00	0.00	0.00	0.00	0.01
1,1-Dichloroethylene: Non-Cancer Criterion (Class III)	0.30	0.00	-0.23	-0.22	-0.15	-0.16	-0.16	-0.11	-0.12	-0.11	-0.10	0.18
1,2,4,5-Tetrachlorobenzene: HQ (Class I)	-0.26	0.02	0.39	0.07	0.04	0.28	0.05	0.03	0.21	0.04	0.03	-0.19
1,2,4,5-Tetrachlorobenzene: HQ (Class III)	-0.25	0.00	0.40	0.07	0.04	0.29	0.06	0.03	0.21	0.04	0.03	-0.19
1,2,4,5-Tetrachlorobenzene: Non-Cancer Criterion (Class I)	0.26	-0.02	-0.39	-0.07	-0.04	-0.28	-0.05	-0.03	-0.21	-0.04	-0.03	0.19
1,2,4,5-Tetrachlorobenzene: Non-Cancer Criterion (Class III)	0.25	0.00	-0.40	-0.07	-0.04	-0.29	-0.06	-0.03	-0.21	-0.04	-0.03	0.19
1,2,4-Trichlorobenzene: Non-Cancer Criterion (Class I)	0.31	-0.10	-0.34	-0.16	-0.04	-0.24	-0.12	-0.03	-0.18	-0.08	-0.03	0.19
1,2,4-Trichlorobenzene: Non-Cancer Criterion (Class III)	0.28	0.00	-0.35	-0.16	-0.04	-0.25	-0.12	-0.03	-0.18	-0.08	-0.03	0.20
1,2-Dichlorobenzene: HQ (Class I)	-0.33	0.81	0.10	0.08	0.07	0.07	0.06	0.05	0.04	0.03	0.04	-0.06
1,2-Dichlorobenzene: HQ (Class III)	-0.30	0.00	0.24	0.21	0.15	0.17	0.16	0.11	0.12	0.10	0.11	-0.17
1,2-Dichlorobenzene: Non-Cancer Criterion (Class I)	0.33	-0.81	-0.10	-0.08	-0.07	-0.07	-0.06	-0.05	-0.04	-0.03	-0.04	0.06

Parameter: Endpoint (Class)	BW	DW	Atlantic TL2	Atlantic TL3	Atlantic TL4	Gulf TL2	Gulf TL3	Gulf TL4	Inland S. TL2	Inland S. TL3	Inland S. TL4	Geographic Region
1,2-Dichlorobenzene: Non-Cancer Criterion (Class III)	0.30	0.00	-0.24	-0.21	-0.15	-0.17	-0.16	-0.11	-0.12	-0.10	-0.11	0.17
1,2-Dichloroethane: Non-Cancer Criterion (Class I)	0.23	-0.96	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.01
1,2-Dichloroethane: Non-Cancer Criterion (Class III)	0.30	0.00	-0.23	-0.23	-0.14	-0.16	-0.17	-0.10	-0.11	-0.11	-0.10	0.18
1,2-Dichloropropane: Non-Cancer Criterion (Class I)	0.24	-0.96	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	-0.01	0.00	0.00	0.01
1,2-Dichloropropane: Non-Cancer Criterion (Class III)	0.30	0.00	-0.23	-0.22	-0.15	-0.16	-0.16	-0.11	-0.12	-0.11	-0.10	0.18
1,3-Dichlorobenzene: HQ (Class I)	-0.34	0.74	0.05	0.12	0.12	0.04	0.09	0.08	0.03	0.05	0.07	-0.07
1,3-Dichlorobenzene: HQ (Class III)	-0.29	0.00	0.13	0.25	0.22	0.09	0.18	0.16	0.06	0.12	0.14	-0.15
1,3-Dichlorobenzene: Non-Cancer Criterion (Class I)	0.34	-0.74	-0.05	-0.12	-0.12	-0.04	-0.09	-0.08	-0.03	-0.05	-0.07	0.07
1,3-Dichlorobenzene: Non-Cancer Criterion (Class III)	0.29	0.00	-0.13	-0.25	-0.22	-0.09	-0.18	-0.16	-0.06	-0.12	-0.14	0.15
1,3-Dichloropropene: Non-Cancer Criterion (Class I)	0.24	-0.96	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.01
1,3-Dichloropropene: Non-Cancer Criterion (Class III)	0.30	0.00	-0.23	-0.22	-0.15	-0.16	-0.16	-0.11	-0.12	-0.11	-0.10	0.18
1,4-Dichlorobenzene: HQ (Class I)	-0.31	0.85	0.06	0.08	0.07	0.04	0.06	0.05	0.03	0.03	0.04	-0.05
1,4-Dichlorobenzene: HQ (Class III)	-0.30	0.00	0.18	0.24	0.18	0.12	0.18	0.13	0.09	0.12	0.12	-0.17
1,4-Dichlorobenzene: Non-Cancer Criterion (Class I)	0.31	-0.85	-0.06	-0.08	-0.07	-0.04	-0.06	-0.05	-0.03	-0.03	-0.04	0.05
1,4-Dichlorobenzene: Non-Cancer Criterion (Class III)	0.30	0.00	-0.18	-0.24	-0.18	-0.12	-0.18	-0.13	-0.09	-0.12	-0.12	0.17
2,4,5-Trichlorophenol: HQ (Class I)	-0.36	0.68	0.14	0.12	0.10	0.10	0.09	0.07	0.06	0.05	0.06	-0.09
2,4,5-Trichlorophenol: HQ (Class III)	-0.30	0.00	0.24	0.21	0.16	0.17	0.15	0.12	0.12	0.10	0.11	-0.17
2,4,5-Trichlorophenol: Non-Cancer Criterion (Class I)	0.36	-0.68	-0.14	-0.12	-0.10	-0.10	-0.09	-0.07	-0.06	-0.05	-0.06	0.09
2,4,5-Trichlorophenol: Non-Cancer Criterion (Class III)	0.30	0.00	-0.24	-0.21	-0.16	-0.17	-0.15	-0.12	-0.12	-0.10	-0.11	0.17

Parameter: Endpoint (Class)	BW	DW	Atlantic TL2	Atlantic TL3	Atlantic TL4	Gulf TL2	Gulf TL3	Gulf TL4	Inland S. TL2	Inland S. TL3	Inland S. TL4	Geographic Region
2,4,6-Trichlorophenol: Non-Cancer Criterion (Class I)	0.35	-0.70	-0.13	-0.12	-0.09	-0.09	-0.08	-0.06	-0.06	-0.05	-0.06	0.09
2,4,6-Trichlorophenol: Non-Cancer Criterion (Class III)	0.30	0.00	-0.24	-0.21	-0.15	-0.17	-0.16	-0.11	-0.12	-0.10	-0.11	0.17
2,4-Dichlorophenol: HQ (Class I)	-0.30	0.88	0.07	0.06	0.05	0.05	0.04	0.03	0.03	0.02	0.03	-0.04
2,4-Dichlorophenol: HQ (Class III)	-0.30	0.00	0.24	0.21	0.15	0.16	0.16	0.11	0.12	0.10	0.11	-0.17
2,4-Dichlorophenol: Non-Cancer Criterion (Class I)	0.30	-0.88	-0.07	-0.06	-0.05	-0.05	-0.04	-0.03	-0.03	-0.02	-0.03	0.04
2,4-Dichlorophenol: Non-Cancer Criterion (Class III)	0.30	0.00	-0.24	-0.21	-0.15	-0.16	-0.16	-0.11	-0.12	-0.10	-0.11	0.17
2,4-Dimethylphenol: HQ (Class I)	-0.24	0.96	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	-0.01
2,4-Dimethylphenol: HQ (Class III)	-0.30	0.00	0.24	0.21	0.15	0.17	0.16	0.11	0.12	0.11	0.10	-0.18
2,4-Dimethylphenol: Non-Cancer Criterion (Class I)	0.24	-0.96	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	-0.01	0.01
2,4-Dimethylphenol: Non-Cancer Criterion (Class III)	0.30	0.00	-0.24	-0.21	-0.15	-0.17	-0.16	-0.11	-0.12	-0.11	-0.10	0.18
2,4-Dinitrophenol: HQ (Class I)	-0.24	0.96	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.01	-0.01
2,4-Dinitrophenol: HQ (Class III)	-0.30	0.00	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.12	0.09	-0.18
2,4-Dinitrophenol: Non-Cancer Criterion (Class I)	0.24	-0.96	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	-0.01	0.00	-0.01	0.01
2,4-Dinitrophenol: Non-Cancer Criterion (Class III)	0.30	0.00	-0.23	-0.23	-0.14	-0.16	-0.17	-0.10	-0.11	-0.12	-0.09	0.18
2,4-Dinitrotoluene: Non-Cancer Criterion (Class I)	0.24	-0.96	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	-0.01	0.00	0.00	0.01
2,4-Dinitrotoluene: Non-Cancer Criterion (Class III)	0.30	0.00	-0.24	-0.22	-0.15	-0.16	-0.16	-0.11	-0.12	-0.11	-0.10	0.18
2-Chloronaphthalene: HQ (Class I)	-0.37	0.58	0.16	0.15	0.11	0.11	0.10	0.08	0.07	0.06	0.07	-0.11
2-Chloronaphthalene: HQ (Class III)	-0.30	0.00	0.24	0.21	0.15	0.17	0.16	0.11	0.12	0.10	0.11	-0.17
2-Chloronaphthalene: Non-Cancer Criterion (Class I)	0.37	-0.58	-0.16	-0.15	-0.11	-0.11	-0.10	-0.08	-0.07	-0.06	-0.07	0.11
2-Chloronaphthalene: Non-Cancer Criterion (Class III)	0.30	0.00	-0.24	-0.21	-0.15	-0.17	-0.16	-0.11	-0.12	-0.10	-0.11	0.17

Parameter: Endpoint (Class)	BW	DW	Atlantic TL2	Atlantic TL3	Atlantic TL4	Gulf TL2	Gulf TL3	Gulf TL4	Inland S. TL2	Inland S. TL3	Inland S. TL4	Geographic Region
2-Chlorophenol: HQ (Class I)	-0.24	0.96	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.01	-0.01
2-Chlorophenol: HQ (Class III)	-0.30	0.00	0.24	0.21	0.15	0.17	0.16	0.11	0.12	0.11	0.10	-0.18
2-Chlorophenol: Non-Cancer Criterion (Class I)	0.24	-0.96	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	-0.01	0.00	-0.01	0.01
2-Chlorophenol: Non-Cancer Criterion (Class III)	0.30	0.00	-0.24	-0.21	-0.15	-0.17	-0.16	-0.11	-0.12	-0.11	-0.10	0.18
2-Methyl-4,6-Dinitrophenol: HQ (Class I)	-0.25	0.95	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.01	-0.01
2-Methyl-4,6-Dinitrophenol: HQ (Class III)	-0.30	0.00	0.24	0.21	0.15	0.17	0.16	0.11	0.12	0.11	0.10	-0.18
2-Methyl-4,6-Dinitrophenol: Non-Cancer Criterion (Class I)	0.25	-0.95	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	-0.01	0.01
2-Methyl-4,6-Dinitrophenol: Non-Cancer Criterion (Class III)	0.30	0.00	-0.24	-0.21	-0.15	-0.17	-0.16	-0.11	-0.12	-0.11	-0.10	0.18
3-Methyl-4-Chlorophenol: HQ (Class I)	-0.29	0.90	0.06	0.05	0.04	0.04	0.04	0.03	0.03	0.02	0.02	-0.04
3-Methyl-4-Chlorophenol: HQ (Class III)	-0.30	0.00	0.24	0.21	0.15	0.17	0.16	0.11	0.12	0.10	0.10	-0.18
3-Methyl-4-Chlorophenol: Non-Cancer Criterion (Class I)	0.29	-0.90	-0.06	-0.05	-0.04	-0.04	-0.04	-0.03	-0.03	-0.02	-0.02	0.04
3-Methyl-4-Chlorophenol: Non-Cancer Criterion (Class III)	0.30	0.00	-0.24	-0.21	-0.15	-0.17	-0.16	-0.11	-0.12	-0.10	-0.10	0.18
Acenaphthene: HQ (Class I)	-0.37	0.37	0.20	0.20	0.12	0.14	0.14	0.08	0.09	0.09	0.08	-0.15
Acenaphthene: HQ (Class III)	-0.30	0.00	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.12	0.09	-0.18
Acenaphthene: Non-Cancer Criterion (Class I)	0.37	-0.37	-0.20	-0.20	-0.12	-0.14	-0.14	-0.08	-0.09	-0.09	-0.08	0.15
Acenaphthene: Non-Cancer Criterion (Class III)	0.30	0.00	-0.23	-0.23	-0.14	-0.16	-0.17	-0.10	-0.11	-0.12	-0.09	0.18
Acrolein: HQ (Class I)	-0.23	0.96	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	-0.01
Acrolein: HQ (Class III)	-0.30	0.00	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.12	0.09	-0.18
Acrolein: Non-Cancer Criterion (Class I)	0.23	-0.96	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.01

Parameter: Endpoint (Class)	BW	DW	Atlantic TL2	Atlantic TL3	Atlantic TL4	Gulf TL2	Gulf TL3	Gulf TL4	Inland S. TL2	Inland S. TL3	Inland S. TL4	Geographic Region
Acrolein: Non-Cancer Criterion (Class III)	0.30	0.00	-0.23	-0.23	-0.14	-0.16	-0.17	-0.10	-0.11	-0.12	-0.09	0.18
Aldrin: Non-Cancer Criterion (Class I)	0.26	0.00	-0.04	-0.26	-0.26	-0.03	-0.19	-0.19	-0.02	-0.12	-0.17	0.13
Aldrin: Non-Cancer Criterion (Class III)	0.26	0.00	-0.04	-0.26	-0.26	-0.03	-0.19	-0.19	-0.02	-0.12	-0.17	0.13
alpha-Endosulfan: HQ (Class I)	-0.36	0.62	0.16	0.13	0.10	0.11	0.10	0.07	0.07	0.05	0.06	-0.10
alpha-Endosulfan: HQ (Class III)	-0.30	0.00	0.24	0.21	0.15	0.17	0.16	0.11	0.12	0.10	0.10	-0.18
alpha-Endosulfan: Non-Cancer Criterion (Class I)	0.36	-0.62	-0.16	-0.13	-0.10	-0.11	-0.10	-0.07	-0.07	-0.05	-0.06	0.10
alpha-Endosulfan: Non-Cancer Criterion (Class III)	0.30	0.00	-0.24	-0.21	-0.15	-0.17	-0.16	-0.11	-0.12	-0.10	-0.10	0.18
alpha-Hexachlorocyclohexane (HCH): Non-Cancer Criterion (Class I)	0.32	-0.12	-0.29	-0.17	-0.12	-0.20	-0.13	-0.09	-0.14	-0.08	-0.08	0.18
alpha-Hexachlorocyclohexane (HCH): Non-Cancer Criterion (Class III)	0.29	0.00	-0.29	-0.17	-0.12	-0.21	-0.13	-0.09	-0.15	-0.09	-0.09	0.18
Anthracene: HQ (Class I)	-0.36	0.27	0.21	0.21	0.13	0.15	0.16	0.09	0.10	0.10	0.08	-0.16
Anthracene: HQ (Class III)	-0.30	0.00	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.12	0.09	-0.18
Anthracene: Non-Cancer Criterion (Class I)	0.36	-0.27	-0.21	-0.21	-0.13	-0.15	-0.16	-0.09	-0.10	-0.10	-0.08	0.16
Anthracene: Non-Cancer Criterion (Class III)	0.30	0.00	-0.23	-0.23	-0.14	-0.16	-0.17	-0.10	-0.11	-0.12	-0.09	0.18
Antimony: HQ (Class I)	-0.23	0.96	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	-0.01
Antimony: HQ (Class III)	-0.30	0.00	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.12	0.09	-0.18
Antimony: Non-Cancer Criterion (Class I)	0.23	-0.96	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.01
Antimony: Non-Cancer Criterion (Class III)	0.30	0.00	-0.23	-0.23	-0.14	-0.16	-0.17	-0.10	-0.11	-0.12	-0.09	0.18
Benzene: Non-Cancer Criterion (Class I)	0.24	-0.96	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	-0.01	0.00	-0.01	0.01

Parameter: Endpoint (Class)	BW	DW	Atlantic TL2	Atlantic TL3	Atlantic TL4	Gulf TL2	Gulf TL3	Gulf TL4	Inland S. TL2	Inland S. TL3	Inland S. TL4	Geographic Region
Benzene: Non-Cancer Criterion (Class III)	0.30	0.00	-0.24	-0.22	-0.15	-0.16	-0.16	-0.11	-0.12	-0.11	-0.10	0.18
Benzidine: Non-Cancer Criterion (Class I)	0.23	-0.96	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.01
Benzidine: Non-Cancer Criterion (Class III)	0.30	0.00	-0.23	-0.22	-0.14	-0.16	-0.17	-0.10	-0.12	-0.11	-0.10	0.18
Beryllium: HQ (Class I)	-0.28	0.92	0.05	0.05	0.03	0.03	0.04	0.02	0.02	0.02	0.02	-0.03
Beryllium: HQ (Class III)	-0.30	0.00	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.12	0.09	-0.18
Beryllium: Non-Cancer Criterion (Class I)	0.28	-0.92	-0.05	-0.05	-0.03	-0.03	-0.04	-0.02	-0.02	-0.02	-0.02	0.03
Beryllium: Non-Cancer Criterion (Class III)	0.30	0.00	-0.23	-0.23	-0.14	-0.16	-0.17	-0.10	-0.11	-0.12	-0.09	0.18
beta-Endosulfan: HQ (Class I)	-0.35	0.73	0.12	0.11	0.08	0.09	0.08	0.06	0.06	0.04	0.05	-0.08
beta-Endosulfan: HQ (Class III)	-0.30	0.00	0.24	0.21	0.15	0.17	0.16	0.11	0.12	0.10	0.11	-0.17
beta-Endosulfan: Non-Cancer Criterion (Class I)	0.35	-0.73	-0.12	-0.11	-0.08	-0.09	-0.08	-0.06	-0.06	-0.04	-0.05	0.08
beta-Endosulfan: Non-Cancer Criterion (Class III)	0.30	0.00	-0.24	-0.21	-0.15	-0.17	-0.16	-0.11	-0.12	-0.10	-0.11	0.17
Bis(2-Chloro-1-Methylethyl) Ether: HQ (Class I)	-0.25	0.95	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.01	-0.01
Bis(2-Chloro-1-Methylethyl) Ether: HQ (Class III)	-0.30	0.00	0.24	0.21	0.15	0.17	0.16	0.11	0.12	0.11	0.10	-0.18
Bis(2-Chloro-1-Methylethyl) Ether: Non-Cancer Criterion (Class I)	0.25	-0.95	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	-0.01	0.01
Bis(2-Chloro-1-Methylethyl) Ether: Non-Cancer Criterion (Class III)	0.30	0.00	-0.24	-0.21	-0.15	-0.17	-0.16	-0.11	-0.12	-0.11	-0.10	0.18
Bromoform: Non-Cancer Criterion (Class I)	0.25	-0.96	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	-0.01	0.01
Bromoform: Non-Cancer Criterion (Class III)	0.30	0.00	-0.24	-0.21	-0.15	-0.17	-0.16	-0.11	-0.12	-0.11	-0.10	0.18
Butylbenzyl Phthalate: Non-Cancer Criterion (Class I)	0.31	-0.01	-0.23	-0.23	-0.14	-0.16	-0.17	-0.10	-0.11	-0.12	-0.09	0.18

Parameter: Endpoint (Class)	BW	DW	Atlantic TL2	Atlantic TL3	Atlantic TL4	Gulf TL2	Gulf TL3	Gulf TL4	Inland S. TL2	Inland S. TL3	Inland S. TL4	Geographic Region
Butylbenzyl Phthalate: Non-Cancer Criterion (Class III)	0.30	0.00	-0.23	-0.23	-0.14	-0.16	-0.17	-0.10	-0.11	-0.12	-0.09	0.18
Carbon Tetrachloride: Non-Cancer Criterion (Class I)	0.26	-0.95	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	0.02
Carbon Tetrachloride: Non-Cancer Criterion (Class III)	0.30	0.00	-0.24	-0.21	-0.15	-0.17	-0.16	-0.11	-0.12	-0.10	-0.10	0.18
Chlordane: Non-Cancer Criterion (Class I)	0.28	-0.01	-0.08	-0.28	-0.21	-0.05	-0.21	-0.15	-0.04	-0.14	-0.14	0.15
Chlordane: Non-Cancer Criterion (Class III)	0.28	0.00	-0.08	-0.28	-0.22	-0.05	-0.21	-0.15	-0.04	-0.14	-0.14	0.15
Chlorobenzene: HQ (Class I)	-0.27	0.94	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.02	-0.02
Chlorobenzene: HQ (Class III)	-0.30	0.00	0.24	0.21	0.16	0.17	0.16	0.11	0.12	0.10	0.11	-0.17
Chlorobenzene: Non-Cancer Criterion (Class I)	0.27	-0.94	-0.03	-0.03	-0.03	-0.02	-0.02	-0.02	-0.02	-0.01	-0.02	0.02
Chlorobenzene: Non-Cancer Criterion (Class III)	0.30	0.00	-0.24	-0.21	-0.16	-0.17	-0.16	-0.11	-0.12	-0.10	-0.11	0.17
Chlorodibromomethane: Non-Cancer Criterion (Class I)	0.24	-0.96	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	-0.01	0.00	-0.01	0.01
Chlorodibromomethane: Non-Cancer Criterion (Class III)	0.30	0.00	-0.23	-0.22	-0.15	-0.16	-0.16	-0.11	-0.12	-0.11	-0.10	0.18
Chloroform: HQ (Class I)	-0.24	0.96	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.00	-0.01
Chloroform: HQ (Class III)	-0.30	0.00	0.24	0.22	0.15	0.16	0.16	0.11	0.12	0.11	0.10	-0.18
Chloroform: Non-Cancer Criterion (Class I)	0.24	-0.96	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	-0.01	0.00	0.00	0.01
Chloroform: Non-Cancer Criterion (Class III)	0.30	0.00	-0.24	-0.22	-0.15	-0.16	-0.16	-0.11	-0.12	-0.11	-0.10	0.18
Chlorophenoxy Herbicide (2,4,5-TP) [Silvex]: HQ (Class I)	-0.31	0.86	0.07	0.07	0.05	0.05	0.05	0.03	0.03	0.03	0.03	-0.05
Chlorophenoxy Herbicide (2,4,5-TP) [Silvex]: HQ (Class III)	-0.30	0.00	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.12	0.09	-0.18
Chlorophenoxy Herbicide (2,4,5-TP) [Silvex]: Non-Cancer Criterion (Class I)	0.31	-0.86	-0.07	-0.07	-0.05	-0.05	-0.05	-0.03	-0.03	-0.03	-0.03	0.05

Parameter: Endpoint (Class)	BW	DW	Atlantic TL2	Atlantic TL3	Atlantic TL4	Gulf TL2	Gulf TL3	Gulf TL4	Inland S. TL2	Inland S. TL3	Inland S. TL4	Geographic Region
Chlorophenoxy Herbicide (2,4,5-TP) [Silvex]: Non-Cancer Criterion (Class III)	0.30	0.00	-0.23	-0.23	-0.14	-0.16	-0.17	-0.10	-0.11	-0.12	-0.09	0.18
Chlorophenoxy Herbicide (2,4-D): HQ (Class I)	-0.26	0.94	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	-0.02
Chlorophenoxy Herbicide (2,4-D): HQ (Class III)	-0.30	0.00	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.12	0.09	-0.18
Chlorophenoxy Herbicide (2,4-D): Non-Cancer Criterion (Class I)	0.26	-0.94	-0.03	-0.03	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	0.02
Chlorophenoxy Herbicide (2,4-D): Non-Cancer Criterion (Class III)	0.30	0.00	-0.23	-0.23	-0.14	-0.16	-0.17	-0.10	-0.11	-0.12	-0.09	0.18
Cyanide: HQ (Class I)	-0.23	0.96	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	-0.01
Cyanide: HQ (Class III)	-0.30	0.00	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.12	0.09	-0.18
Cyanide: Non-Cancer Criterion (Class I)	0.23	-0.96	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.01
Cyanide: Non-Cancer Criterion (Class III)	0.30	0.00	-0.23	-0.23	-0.14	-0.16	-0.17	-0.10	-0.11	-0.12	-0.09	0.18
Dichlorobromomethane: Non-Cancer Criterion (Class I)	0.24	-0.96	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	-0.01	0.00	-0.01	0.01
Dichlorobromomethane: Non-Cancer Criterion (Class III)	0.30	0.00	-0.24	-0.22	-0.15	-0.17	-0.16	-0.11	-0.12	-0.11	-0.10	0.18
Dieldrin: Non-Cancer Criterion (Class I)	0.27	0.00	-0.04	-0.26	-0.26	-0.03	-0.19	-0.18	-0.02	-0.13	-0.16	0.13
Dieldrin: Non-Cancer Criterion (Class III)	0.27	0.00	-0.04	-0.26	-0.26	-0.03	-0.19	-0.18	-0.02	-0.13	-0.16	0.13
Diethyl Phthalate: HQ (Class I)	-0.35	0.22	0.22	0.22	0.13	0.15	0.16	0.09	0.10	0.10	0.09	-0.17
Diethyl Phthalate: HQ (Class III)	-0.30	0.00	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.12	0.09	-0.18
Diethyl Phthalate: Non-Cancer Criterion (Class I)	0.35	-0.22	-0.22	-0.22	-0.13	-0.15	-0.16	-0.09	-0.10	-0.10	-0.09	0.17
Diethyl Phthalate: Non-Cancer Criterion (Class III)	0.30	0.00	-0.23	-0.23	-0.14	-0.16	-0.17	-0.10	-0.11	-0.12	-0.09	0.18
Dimethyl Phthalate: HQ (Class I)	-0.32	0.06	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.11	0.09	-0.18

Parameter: Endpoint (Class)	BW	DW	Atlantic TL2	Atlantic TL3	Atlantic TL4	Gulf TL2	Gulf TL3	Gulf TL4	Inland S. TL2	Inland S. TL3	Inland S. TL4	Geographic Region
Dimethyl Phthalate: HQ (Class III)	-0.30	0.00	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.12	0.09	-0.18
Dimethyl Phthalate: Non-Cancer Criterion (Class I)	0.32	-0.06	-0.23	-0.23	-0.14	-0.16	-0.17	-0.10	-0.11	-0.11	-0.09	0.18
Dimethyl Phthalate: Non-Cancer Criterion (Class III)	0.30	0.00	-0.23	-0.23	-0.14	-0.16	-0.17	-0.10	-0.11	-0.12	-0.09	0.18
Di-n-Butyl Phthalate: HQ (Class I)	-0.32	0.08	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.11	0.09	-0.18
Di-n-Butyl Phthalate: HQ (Class III)	-0.30	0.00	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.12	0.09	-0.18
Di-n-Butyl Phthalate: Non-Cancer Criterion (Class I)	0.32	-0.08	-0.23	-0.23	-0.14	-0.16	-0.17	-0.10	-0.11	-0.11	-0.09	0.18
Di-n-Butyl Phthalate: Non-Cancer Criterion (Class III)	0.30	0.00	-0.23	-0.23	-0.14	-0.16	-0.17	-0.10	-0.11	-0.12	-0.09	0.18
Endosulfan Sulfate: HQ (Class I)	-0.35	0.71	0.13	0.11	0.09	0.09	0.08	0.06	0.06	0.04	0.05	-0.09
Endosulfan Sulfate: HQ (Class III)	-0.30	0.00	0.24	0.21	0.15	0.17	0.16	0.11	0.12	0.10	0.11	-0.17
Endosulfan Sulfate: Non-Cancer Criterion (Class I)	0.35	-0.71	-0.13	-0.11	-0.09	-0.09	-0.08	-0.06	-0.06	-0.04	-0.05	0.09
Endosulfan Sulfate: Non-Cancer Criterion (Class III)	0.30	0.00	-0.24	-0.21	-0.15	-0.17	-0.16	-0.11	-0.12	-0.10	-0.11	0.17
Endrin Aldehyde: HQ (Class I)	-0.35	0.25	0.19	0.23	0.14	0.13	0.17	0.10	0.09	0.11	0.09	-0.16
Endrin Aldehyde: HQ (Class III)	-0.30	0.00	0.20	0.24	0.15	0.14	0.18	0.11	0.10	0.12	0.10	-0.17
Endrin Aldehyde: Non-Cancer Criterion (Class I)	0.35	-0.25	-0.19	-0.23	-0.14	-0.13	-0.17	-0.10	-0.09	-0.11	-0.09	0.16
Endrin Aldehyde: Non-Cancer Criterion (Class III)	0.30	0.00	-0.20	-0.24	-0.15	-0.14	-0.18	-0.11	-0.10	-0.12	-0.10	0.17
Endrin: HQ (Class I)	-0.29	0.01	0.08	0.28	0.21	0.06	0.21	0.15	0.04	0.14	0.14	-0.15
Endrin: HQ (Class III)	-0.28	0.00	0.08	0.28	0.21	0.06	0.21	0.15	0.04	0.14	0.14	-0.15
Endrin: Non-Cancer Criterion (Class I)	0.29	-0.01	-0.08	-0.28	-0.21	-0.06	-0.21	-0.15	-0.04	-0.14	-0.14	0.15
Endrin: Non-Cancer Criterion (Class III)	0.28	0.00	-0.08	-0.28	-0.21	-0.06	-0.21	-0.15	-0.04	-0.14	-0.14	0.15
Ethylbenzene: HQ (Class I)	-0.36	0.67	0.14	0.12	0.10	0.10	0.09	0.07	0.06	0.05	0.06	-0.10
Ethylbenzene: HQ (Class III)	-0.30	0.00	0.24	0.21	0.15	0.17	0.16	0.11	0.12	0.10	0.11	-0.17

Parameter: Endpoint (Class)	BW	DW	Atlantic TL2	Atlantic TL3	Atlantic TL4	Gulf TL2	Gulf TL3	Gulf TL4	Inland S. TL2	Inland S. TL3	Inland S. TL4	Geographic Region
Ethylbenzene: Non-Cancer Criterion (Class I)	0.36	-0.67	-0.14	-0.12	-0.10	-0.10	-0.09	-0.07	-0.06	-0.05	-0.06	0.10
Ethylbenzene: Non-Cancer Criterion (Class III)	0.30	0.00	-0.24	-0.21	-0.15	-0.17	-0.16	-0.11	-0.12	-0.10	-0.11	0.17
Fluoranthene: HQ (Class I)	-0.33	0.11	0.22	0.23	0.13	0.16	0.17	0.10	0.11	0.11	0.09	-0.17
Fluoranthene: HQ (Class III)	-0.30	0.00	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.12	0.09	-0.18
Fluoranthene: Non-Cancer Criterion (Class I)	0.33	-0.11	-0.22	-0.23	-0.13	-0.16	-0.17	-0.10	-0.11	-0.11	-0.09	0.17
Fluoranthene: Non-Cancer Criterion (Class III)	0.30	0.00	-0.23	-0.23	-0.14	-0.16	-0.17	-0.10	-0.11	-0.12	-0.09	0.18
Fluorene: HQ (Class I)	-0.36	0.38	0.16	0.19	0.17	0.11	0.14	0.12	0.07	0.08	0.11	-0.13
Fluorene: HQ (Class III)	-0.30	0.00	0.19	0.22	0.20	0.13	0.16	0.14	0.09	0.11	0.13	-0.16
Fluorene: Non-Cancer Criterion (Class I)	0.36	-0.38	-0.16	-0.19	-0.17	-0.11	-0.14	-0.12	-0.07	-0.08	-0.11	0.13
Fluorene: Non-Cancer Criterion (Class III)	0.30	0.00	-0.19	-0.22	-0.20	-0.13	-0.16	-0.14	-0.09	-0.11	-0.13	0.16
gamma- Hexachlorocyclohexane (HCH): HQ (Class I)	-0.33	0.10	0.20	0.23	0.16	0.14	0.17	0.11	0.10	0.11	0.11	-0.17
gamma- Hexachlorocyclohexane (HCH): HQ (Class III)	-0.30	0.00	0.21	0.23	0.16	0.14	0.17	0.12	0.10	0.12	0.11	-0.17
gamma- Hexachlorocyclohexane (HCH): Non-Cancer Criterion (Class I)	0.33	-0.10	-0.20	-0.23	-0.16	-0.14	-0.17	-0.11	-0.10	-0.11	-0.11	0.17
gamma- Hexachlorocyclohexane (HCH): Non-Cancer Criterion (Class III)	0.30	0.00	-0.21	-0.23	-0.16	-0.14	-0.17	-0.12	-0.10	-0.12	-0.11	0.17
Heptachlor Epoxide: Non-Cancer Criterion (Class I)	0.29	-0.02	-0.09	-0.28	-0.21	-0.06	-0.21	-0.15	-0.04	-0.14	-0.14	0.15
Heptachlor Epoxide: Non-Cancer Criterion (Class III)	0.28	0.00	-0.09	-0.28	-0.21	-0.06	-0.21	-0.15	-0.04	-0.14	-0.14	0.15
Heptachlor: Non-Cancer Criterion (Class I)	0.27	-0.01	-0.04	-0.27	-0.25	-0.03	-0.20	-0.18	-0.02	-0.13	-0.16	0.13
Heptachlor: Non-Cancer Criterion (Class III)	0.27	0.00	-0.04	-0.27	-0.25	-0.03	-0.20	-0.18	-0.02	-0.13	-0.16	0.13

Parameter: Endpoint (Class)	BW	DW	Atlantic TL2	Atlantic TL3	Atlantic TL4	Gulf TL2	Gulf TL3	Gulf TL4	Inland S. TL2	Inland S. TL3	Inland S. TL4	Geographic Region
Hexachlorobenzene: Non-Cancer Criterion (Class I)	0.29	-0.01	-0.16	-0.22	-0.23	-0.11	-0.16	-0.16	-0.07	-0.10	-0.15	0.15
Hexachlorobenzene: Non-Cancer Criterion (Class III)	0.29	0.00	-0.16	-0.22	-0.23	-0.11	-0.16	-0.16	-0.07	-0.10	-0.15	0.15
Hexachlorobutadiene: Non-Cancer Criterion (Class I)	0.24	-0.02	-0.41	-0.05	-0.02	-0.29	-0.04	-0.02	-0.22	-0.03	-0.02	0.19
Hexachlorobutadiene: Non-Cancer Criterion (Class III)	0.24	0.00	-0.41	-0.05	-0.02	-0.29	-0.04	-0.02	-0.22	-0.03	-0.02	0.19
Hexachlorocyclopentadiene: HQ (Class I)	-0.34	0.18	0.18	0.24	0.15	0.13	0.18	0.11	0.09	0.12	0.10	-0.16
Hexachlorocyclopentadiene: HQ (Class III)	-0.30	0.00	0.19	0.25	0.15	0.13	0.19	0.11	0.09	0.13	0.10	-0.17
Hexachlorocyclopentadiene: Non-Cancer Criterion (Class I)	0.34	-0.18	-0.18	-0.24	-0.15	-0.13	-0.18	-0.11	-0.09	-0.12	-0.10	0.16
Hexachlorocyclopentadiene: Non-Cancer Criterion (Class III)	0.30	0.00	-0.19	-0.25	-0.15	-0.13	-0.19	-0.11	-0.09	-0.13	-0.10	0.17
Hexachloroethane: Non-Cancer Criterion (Class I)	0.32	-0.23	-0.34	-0.07	-0.10	-0.24	-0.05	-0.08	-0.17	-0.03	-0.07	0.16
Hexachloroethane: Non-Cancer Criterion (Class III)	0.27	0.00	-0.36	-0.08	-0.11	-0.26	-0.06	-0.08	-0.19	-0.04	-0.08	0.18
Isophorone: Non-Cancer Criterion (Class I)	0.23	-0.96	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.01
Isophorone: Non-Cancer Criterion (Class III)	0.30	0.00	-0.23	-0.22	-0.14	-0.16	-0.17	-0.11	-0.12	-0.11	-0.10	0.18
Methoxychlor: HQ (Class I)	-0.32	0.07	0.15	0.27	0.17	0.10	0.20	0.12	0.07	0.13	0.11	-0.16
Methoxychlor: HQ (Class III)	-0.30	0.00	0.15	0.27	0.17	0.10	0.20	0.12	0.07	0.14	0.11	-0.17
Methoxychlor: Non-Cancer Criterion (Class I)	0.32	-0.07	-0.15	-0.27	-0.17	-0.10	-0.20	-0.12	-0.07	-0.13	-0.11	0.16
Methoxychlor: Non-Cancer Criterion (Class III)	0.30	0.00	-0.15	-0.27	-0.17	-0.10	-0.20	-0.12	-0.07	-0.14	-0.11	0.17
Methyl Bromide: HQ (Class I)	-0.23	0.96	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	-0.01
Methyl Bromide: HQ (Class III)	-0.30	0.00	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.11	0.10	-0.18

Parameter: Endpoint (Class)	BW	DW	Atlantic TL2	Atlantic TL3	Atlantic TL4	Gulf TL2	Gulf TL3	Gulf TL4	Inland S. TL2	Inland S. TL3	Inland S. TL4	Geographic Region
Methyl Bromide: Non-Cancer Criterion (Class I)	0.23	-0.96	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.01
Methyl Bromide: Non-Cancer Criterion (Class III)	0.30	0.00	-0.23	-0.23	-0.14	-0.16	-0.17	-0.10	-0.11	-0.11	-0.10	0.18
Methylene Chloride: Non-Cancer Criterion (Class I)	0.23	-0.96	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.01
Methylene Chloride: Non-Cancer Criterion (Class III)	0.30	0.00	-0.23	-0.22	-0.14	-0.16	-0.17	-0.10	-0.12	-0.11	-0.10	0.18
Nitrobenzene: HQ (Class I)	-0.24	0.96	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	-0.01
Nitrobenzene: HQ (Class III)	-0.30	0.00	0.23	0.22	0.15	0.16	0.16	0.11	0.12	0.11	0.10	-0.18
Nitrobenzene: Non-Cancer Criterion (Class I)	0.24	-0.96	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.01
Nitrobenzene: Non-Cancer Criterion (Class III)	0.30	0.00	-0.23	-0.22	-0.15	-0.16	-0.16	-0.11	-0.12	-0.11	-0.10	0.18
p,p'-Dichlorodiphenyldichloroethane (DDD): Non-Cancer Criterion (Class I)	0.29	-0.01	-0.12	-0.25	-0.23	-0.08	-0.18	-0.17	-0.05	-0.12	-0.15	0.15
p,p'-Dichlorodiphenyldichloroethane (DDD): Non-Cancer Criterion (Class III)	0.29	0.00	-0.12	-0.25	-0.23	-0.08	-0.18	-0.17	-0.05	-0.12	-0.15	0.15
p,p'-Dichlorodiphenyldichloroethylene (DDE): Non-Cancer Criterion (Class I)	0.28	0.00	-0.10	-0.22	-0.27	-0.07	-0.16	-0.20	-0.05	-0.10	-0.17	0.14
p,p'-Dichlorodiphenyldichloroethylene (DDE): Non-Cancer Criterion (Class III)	0.28	0.00	-0.10	-0.22	-0.27	-0.07	-0.16	-0.20	-0.05	-0.10	-0.17	0.14
p,p'-Dichlorodiphenyltrichloroethane (DDT): Non-Cancer Criterion (Class I)	0.25	0.00	-0.06	-0.18	-0.32	-0.04	-0.13	-0.24	-0.03	-0.08	-0.20	0.11

Parameter: Endpoint (Class)	BW	DW	Atlantic TL2	Atlantic TL3	Atlantic TL4	Gulf TL2	Gulf TL3	Gulf TL4	Inland S. TL2	Inland S. TL3	Inland S. TL4	Geographic Region
p,p'-Dichlorodiphenyltrichloroethane (DDT): Non-Cancer Criterion (Class III)	0.25	0.00	-0.06	-0.18	-0.32	-0.04	-0.13	-0.24	-0.03	-0.08	-0.20	0.11
Pentachlorobenzene: HQ (Class I)	-0.30	0.05	0.22	0.18	0.21	0.15	0.13	0.15	0.11	0.08	0.14	-0.16
Pentachlorobenzene: HQ (Class III)	-0.29	0.00	0.22	0.18	0.21	0.15	0.13	0.15	0.11	0.08	0.14	-0.16
Pentachlorobenzene: Non-Cancer Criterion (Class I)	0.30	-0.05	-0.22	-0.18	-0.21	-0.15	-0.13	-0.15	-0.11	-0.08	-0.14	0.16
Pentachlorobenzene: Non-Cancer Criterion (Class III)	0.29	0.00	-0.22	-0.18	-0.21	-0.15	-0.13	-0.15	-0.11	-0.08	-0.14	0.16
Pentachlorophenol: Non-Cancer Criterion (Class I)	0.35	-0.57	-0.05	-0.17	-0.18	-0.04	-0.12	-0.13	-0.02	-0.07	-0.11	0.09
Pentachlorophenol: Non-Cancer Criterion (Class III)	0.28	0.00	-0.08	-0.25	-0.24	-0.06	-0.19	-0.18	-0.04	-0.12	-0.16	0.14
Phenol: HQ (Class I)	-0.23	0.96	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	-0.01
Phenol: HQ (Class III)	-0.30	0.00	0.23	0.22	0.15	0.16	0.17	0.11	0.12	0.11	0.10	-0.18
Phenol: Non-Cancer Criterion (Class I)	0.23	-0.96	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.01
Phenol: Non-Cancer Criterion (Class III)	0.30	0.00	-0.23	-0.22	-0.15	-0.16	-0.17	-0.11	-0.12	-0.11	-0.10	0.18
Pyrene: HQ (Class I)	-0.35	0.21	0.22	0.22	0.13	0.15	0.16	0.09	0.11	0.10	0.09	-0.17
Pyrene: HQ (Class III)	-0.30	0.00	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.12	0.09	-0.18
Pyrene: Non-Cancer Criterion (Class I)	0.35	-0.21	-0.22	-0.22	-0.13	-0.15	-0.16	-0.09	-0.11	-0.10	-0.09	0.17
Pyrene: Non-Cancer Criterion (Class III)	0.30	0.00	-0.23	-0.23	-0.14	-0.16	-0.17	-0.10	-0.11	-0.12	-0.09	0.18
Selenium: HQ (Class I)	-0.25	0.96	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	-0.01
Selenium: HQ (Class III)	-0.30	0.00	0.23	0.23	0.14	0.16	0.17	0.10	0.11	0.12	0.09	-0.18
Selenium: Non-Cancer Criterion (Class I)	0.25	-0.96	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	-0.01	0.01
Selenium: Non-Cancer Criterion (Class III)	0.30	0.00	-0.23	-0.23	-0.14	-0.16	-0.17	-0.10	-0.11	-0.12	-0.09	0.18

Parameter: Endpoint (Class)	BW	DW	Atlantic TL2	Atlantic TL3	Atlantic TL4	Gulf TL2	Gulf TL3	Gulf TL4	Inland S. TL2	Inland S. TL3	Inland S. TL4	Geographic Region
Tetrachloroethylene (Perchloroethylene): Non-Cancer Criterion (Class I)	0.32	-0.82	-0.09	-0.08	-0.06	-0.06	-0.06	-0.04	-0.04	-0.03	-0.04	0.06
Tetrachloroethylene (Perchloroethylene): Non-Cancer Criterion (Class III)	0.30	0.00	-0.24	-0.21	-0.15	-0.17	-0.16	-0.11	-0.12	-0.10	-0.10	0.18
Toluene: HQ (Class I)	-0.26	0.94	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	-0.02
Toluene: HQ (Class III)	-0.30	0.00	0.23	0.22	0.15	0.16	0.16	0.11	0.12	0.11	0.10	-0.18
Toluene: Non-Cancer Criterion (Class I)	0.26	-0.94	-0.03	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	-0.01	-0.01	0.02
Toluene: Non-Cancer Criterion (Class III)	0.30	0.00	-0.23	-0.22	-0.15	-0.16	-0.16	-0.11	-0.12	-0.11	-0.10	0.18
Toxaphene: Non-Cancer Criterion (Class I)	0.31	-0.05	-0.14	-0.27	-0.17	-0.10	-0.20	-0.12	-0.07	-0.13	-0.12	0.16
Toxaphene: Non-Cancer Criterion (Class III)	0.30	0.00	-0.14	-0.27	-0.17	-0.10	-0.20	-0.12	-0.07	-0.14	-0.12	0.16
trans-1,2-Dichloroethylene (DCE): HQ (Class I)	-0.24	0.96	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.01	-0.01
trans-1,2-Dichloroethylene (DCE): HQ (Class III)	-0.30	0.00	0.24	0.22	0.15	0.16	0.16	0.11	0.12	0.11	0.10	-0.18
trans-1,2-Dichloroethylene (DCE): Non-Cancer Criterion (Class I)	0.24	-0.96	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	-0.01	0.00	-0.01	0.01
trans-1,2-Dichloroethylene (DCE): Non-Cancer Criterion (Class III)	0.30	0.00	-0.24	-0.22	-0.15	-0.16	-0.16	-0.11	-0.12	-0.11	-0.10	0.18
Trichloroethylene (TCE): Non-Cancer Criterion (Class I)	0.26	-0.95	-0.02	-0.02	-0.02	-0.02	-0.02	-0.01	-0.01	0.00	-0.01	0.02
Trichloroethylene (TCE): Non-Cancer Criterion (Class III)	0.30	0.00	-0.24	-0.21	-0.15	-0.17	-0.16	-0.11	-0.12	-0.10	-0.10	0.18
Vinyl Chloride: Non-Cancer Criterion (Class I)	0.23	-0.96	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.01
Vinyl Chloride: Non-Cancer Criterion (Class III)	0.30	0.00	-0.23	-0.22	-0.15	-0.16	-0.16	-0.11	-0.12	-0.11	-0.10	0.18
Total Fish Consumption Rate	0.00	0.00	0.24	0.24	0.15	0.17	0.18	0.11	0.12	0.12	0.10	-0.19

Table E-2. Model assumption sensitivity analysis for benzene cancer risk. Class III includes Class II and Class III-Limited waters]. Class I includes Class I-Treated.

Assumptions	Benzene CSF	Atlantic TL2	Atlantic TL3	Atlantic TL4	BW	DW	Gulf TL2	Gulf TL3	Gulf TL4	Inland South TL2	Inland South TL3	Inland South TL4	Region Select
Benzene: Cancer Risk (Class I)	0.27	0.01	0.01	0.01	-0.19	0.92	0.00	0.01	0.01	0.01	0.01	0.00	-0.01
Benzene: : Cancer Risk (Class II)	0.39	0.21	0.20	0.13	-0.27	0.00	0.15	0.15	0.10	0.11	0.10	0.09	-0.16

Appendix F. Summary of Probabilistic Risk Analyses of Proposed Criteria.

Table F-1. Parameter specific percentiles of non-cancer risk (HQ) for adult consumers of freshwater and estuarine fish and Florida drinking water. Criteria inputs used in the risk assessment were rounded to two significant figures, consistent with the proposed final values. Risk is expressed as the HQ relative to the proposed human health criteria. Class III risks include Class II and Class III-Limited waters. Risks for Class I include Class I-Treated. Risks were calculated based on the most sensitive human health-based criteria listed in Table 6-1. There are 31 parameters with both a CSF and RFD. HQ for 30 of these parameters (denoted by an *) were run based on the cancer risk based criteria to demonstrate that proposed criteria will be fully protective of all endpoints. Benzene has both a CSF and RfD; however, the non-cancer endpoint was used to assess the HQ, because the non-cancer effect was the most sensitive endpoint.

Parameter	Mean	5 %tile	10 %tile	20 %tile	30 %tile	40 %tile	50 %tile	60 %tile	70 %tile	80 %tile	90 %tile	95 %tile	99 %tile
1,1,1-Trichloroethane Class I	0.44	0.02	0.04	0.09	0.15	0.23	0.32	0.43	0.57	0.74	1.02	1.26	1.77
1,1,1-Trichloroethane Class III	0.49	0.09	0.12	0.17	0.22	0.28	0.34	0.42	0.52	0.68	0.99	1.36	2.54
1,1,2,2-Tetrachloroethane Class I*	1.27E-03	4.52E-05	8.88E-05	2.38E-04	4.31E-04	6.61E-04	9.25E-04	1.25E-03	1.64E-03	2.15E-03	2.95E-03	3.66E-03	5.13E-03
1,1,2,2-Tetrachloroethane Class III*	1.25E-03	2.29E-04	3.07E-04	4.40E-04	5.71E-04	7.09E-04	8.71E-04	1.07E-03	1.34E-03	1.74E-03	2.53E-03	3.49E-03	6.52E-03
1,1,2-Trichloroethane Class I*	2.18E-02	8.10E-04	1.58E-03	4.14E-03	7.45E-03	1.14E-02	1.59E-02	2.14E-02	2.82E-02	3.70E-02	5.06E-02	6.28E-02	8.80E-02
1,1,2-Trichloroethane Class III*	2.24E-02	4.08E-03	5.48E-03	7.85E-03	1.02E-02	1.26E-02	1.56E-02	1.91E-02	2.39E-02	3.10E-02	4.52E-02	6.24E-02	1.16E-01
1,1-Dichloroethylene Class I	0.42	0.01	0.01	0.07	0.13	0.21	0.30	0.41	0.54	0.72	0.99	1.24	1.73
1,1-Dichloroethylene Class III	0.51	0.09	0.12	0.18	0.23	0.29	0.35	0.43	0.54	0.70	1.02	1.40	2.62
1,2,4-Trichlorobenzene Class I*	1.69E-02	3.22E-03	4.19E-03	5.86E-03	7.46E-03	9.22E-03	1.13E-02	1.38E-02	1.73E-02	2.28E-02	3.38E-02	4.80E-02	9.50E-02
1,2,4-Trichlorobenzene Class III*	1.70E-02	2.71E-03	3.67E-03	5.34E-03	7.01E-03	8.84E-03	1.10E-02	1.37E-02	1.74E-02	2.32E-02	3.51E-02	5.03E-02	1.01E-01
1,2-Dichlorobenzene Class I	0.50	0.08	0.12	0.18	0.25	0.32	0.40	0.50	0.61	0.76	1.00	1.22	1.74
1,2-Dichlorobenzene Class III	0.50	0.09	0.12	0.17	0.23	0.28	0.34	0.42	0.53	0.69	1.00	1.39	2.60
1,2-Dichloroethane Class I*	1.96E-02	2.31E-04	5.79E-04	2.98E-03	6.13E-03	9.79E-03	1.40E-02	1.92E-02	2.55E-02	3.38E-02	4.66E-02	5.80E-02	8.12E-02
1,2-Dichloroethane Class III*	1.91E-02	3.52E-03	4.72E-03	6.76E-03	8.75E-03	1.09E-02	1.33E-02	1.64E-02	2.05E-02	2.66E-02	3.85E-02	5.30E-02	9.78E-02
1,2-Dichloropropane Class I*	1.58E-03	3.17E-05	7.05E-05	2.59E-04	5.07E-04	7.99E-04	1.14E-03	1.55E-03	2.05E-03	2.71E-03	3.72E-03	4.63E-03	6.49E-03
1,2-Dichloropropane Class III*	1.56E-03	2.87E-04	3.84E-04	5.50E-04	7.13E-04	8.86E-04	1.09E-03	1.34E-03	1.67E-03	2.17E-03	3.16E-03	4.35E-03	8.09E-03
1,3-Dichlorobenzene Class I	0.52	0.09	0.13	0.20	0.27	0.34	0.42	0.51	0.62	0.76	1.00	1.25	1.90
1,3-Dichlorobenzene Class III	0.50	0.08	0.11	0.16	0.21	0.27	0.33	0.41	0.51	0.68	1.01	1.43	2.91
1,3-Dichloropropene Class I*	1.65E-03	2.67E-05	6.24E-05	2.62E-04	5.23E-04	8.31E-04	1.19E-03	1.62E-03	2.15E-03	2.84E-03	3.91E-03	4.86E-03	6.82E-03
1,3-Dichloropropene Class III*	1.67E-03	3.08E-04	4.13E-04	5.90E-04	7.65E-04	9.50E-04	1.17E-03	1.43E-03	1.79E-03	2.32E-03	3.38E-03	4.64E-03	8.65E-03
1,4-Dichlorobenzene Class I	0.49	0.07	0.10	0.17	0.24	0.31	0.39	0.49	0.61	0.77	1.02	1.24	1.75

Parameter	Mean	5 %tile	10 %tile	20 %tile	30 %tile	40 %tile	50 %tile	60 %tile	70 %tile	80 %tile	90 %tile	95 %tile	99 %tile
1,4-Dichlorobenzene Class III	0.52	0.09	0.13	0.18	0.23	0.29	0.36	0.44	0.55	0.72	1.05	1.45	2.80
2,4,6-Trichlorophenol Class I*	0.45	0.09	0.12	0.19	0.25	0.31	0.37	0.45	0.54	0.66	0.87	1.07	1.61
2,4,6-Trichlorophenol Class III*	0.45	0.08	0.11	0.16	0.21	0.26	0.31	0.39	0.48	0.63	0.91	1.27	2.36
2,4-Dichlorophenol Class I	0.49	0.06	0.09	0.15	0.22	0.30	0.38	0.48	0.61	0.77	1.03	1.26	1.76
2,4-Dichlorophenol Class III	0.50	0.09	0.12	0.17	0.23	0.28	0.35	0.42	0.53	0.69	1.00	1.39	2.60
2,4-Dimethylphenol Class I	0.43	0.01	0.03	0.08	0.14	0.22	0.31	0.42	0.56	0.73	1.01	1.25	1.75
2,4-Dimethylphenol Class III	0.51	0.09	0.12	0.18	0.23	0.29	0.35	0.43	0.54	0.70	1.02	1.41	2.63
2,4-Dinitrophenol Class I	0.43	0.01	0.02	0.07	0.14	0.22	0.31	0.42	0.55	0.73	1.00	1.25	1.75
2,4-Dinitrophenol Class III	0.50	0.09	0.12	0.18	0.23	0.28	0.35	0.43	0.54	0.69	1.01	1.38	2.54
2,4-Dinitrotoluene Class I*	3.87E-03	7.52E-05	1.69E-04	6.31E-04	1.24E-03	1.96E-03	2.79E-03	3.80E-03	5.03E-03	6.65E-03	9.13E-03	1.14E-02	1.59E-02
2,4-Dinitrotoluene Class III*	3.74E-03	6.85E-04	9.18E-04	1.31E-03	1.70E-03	2.12E-03	2.60E-03	3.19E-03	3.99E-03	5.18E-03	7.54E-03	1.04E-02	1.93E-02
2-Chloronaphthalene Class I	0.54	0.12	0.16	0.23	0.30	0.37	0.44	0.52	0.62	0.76	1.00	1.26	2.04
2-Chloronaphthalene Class III	0.48	0.09	0.12	0.17	0.22	0.27	0.34	0.41	0.52	0.67	0.98	1.35	2.53
2-Chlorophenol Class I	0.43	0.01	0.02	0.07	0.14	0.22	0.31	0.42	0.55	0.73	1.00	1.24	1.75
2-Chlorophenol Class III	0.50	0.09	0.12	0.17	0.23	0.28	0.35	0.43	0.53	0.69	1.01	1.39	2.59
2-Methyl-4,6-Dinitrophenol Class I	0.44	0.02	0.03	0.09	0.15	0.23	0.32	0.43	0.57	0.74	1.02	1.26	1.77
2-Methyl-4,6-Dinitrophenol Class III	0.49	0.09	0.12	0.17	0.22	0.28	0.34	0.42	0.53	0.68	0.99	1.37	2.56
3-Methyl-4-Chlorophenol Class I	0.47	0.05	0.08	0.14	0.21	0.28	0.36	0.46	0.59	0.75	1.01	1.24	1.73
3-Methyl-4-Chlorophenol Class III	0.50	0.09	0.12	0.18	0.23	0.28	0.35	0.43	0.53	0.69	1.01	1.40	2.60
Acenaphthene Class I	0.56	0.13	0.18	0.24	0.31	0.37	0.44	0.52	0.62	0.77	1.04	1.37	2.37
Acenaphthene Class III	0.51	0.09	0.13	0.18	0.24	0.29	0.36	0.44	0.55	0.71	1.03	1.42	2.62
Acrolein Class I	4.28E-01	3.39E-03	9.25E-03	6.27E-02	1.32E-01	2.13E-01	3.06E-01	4.19E-01	5.58E-01	7.41E-01	1.02E+00	1.27E+00	1.78E+00
Acrolein Class III	0.51	0.09	0.13	0.18	0.23	0.29	0.35	0.44	0.54	0.70	1.02	1.40	2.58
alpha-Endosulfan Class I	0.54	0.11	0.16	0.23	0.30	0.37	0.44	0.53	0.63	0.77	1.01	1.26	1.98
alpha-Endosulfan Class III	0.50	0.09	0.12	0.17	0.22	0.28	0.34	0.42	0.53	0.69	1.00	1.38	2.57
Anthracene Class I	0.53	0.13	0.17	0.23	0.29	0.35	0.41	0.49	0.58	0.73	0.99	1.32	2.30
Anthracene Class III	0.50	0.09	0.12	0.18	0.23	0.28	0.35	0.43	0.54	0.70	1.01	1.38	2.55
Antimony Class I	4.14E-01	3.28E-03	8.95E-03	6.06E-02	1.28E-01	2.06E-01	2.96E-01	4.06E-01	5.40E-01	7.17E-01	9.87E-01	1.23E+00	1.73E+00

Parameter	Mean	5 %tile	10 %tile	20 %tile	30 %tile	40 %tile	50 %tile	60 %tile	70 %tile	80 %tile	90 %tile	95 %tile	99 %tile
Antimony Class III	0.49	0.09	0.12	0.17	0.22	0.28	0.34	0.42	0.53	0.68	0.99	1.36	2.50
Benzene Class I*	0.28	0.01	0.01	0.05	0.09	0.15	0.21	0.28	0.37	0.48	0.66	0.82	1.15
Benzene Class III*	0.29	0.05	0.07	0.10	0.13	0.16	0.20	0.24	0.30	0.40	0.57	0.80	1.52
Benzidine Class I*	7.40E-06	7.84E-08	2.01E-07	1.11E-06	2.30E-06	3.69E-06	5.30E-06	7.25E-06	9.64E-06	1.28E-05	1.76E-05	2.19E-05	3.07E-05
Benzidine Class III*	7.39E-06	1.36E-06	1.82E-06	2.61E-06	3.39E-06	4.20E-06	5.16E-06	6.34E-06	7.93E-06	1.03E-05	1.49E-05	2.05E-05	3.79E-05
Beryllium Class I	0.46	0.04	0.07	0.13	0.19	0.27	0.35	0.45	0.58	0.75	1.00	1.23	1.72
Beryllium Class III	0.50	0.09	0.12	0.18	0.23	0.29	0.35	0.43	0.54	0.70	1.01	1.39	2.56
beta-Endosulfan Class I	0.51	0.10	0.14	0.21	0.27	0.34	0.42	0.51	0.61	0.75	0.99	1.21	1.80
beta-Endosulfan Class III	0.50	0.09	0.12	0.18	0.23	0.28	0.35	0.43	0.53	0.69	1.01	1.40	2.61
Bis(2-Chloro-1-Methylethyl) Ether Class I	0.44	0.02	0.03	0.09	0.15	0.23	0.32	0.43	0.57	0.74	1.02	1.26	1.77
Bis(2-Chloro-1-Methylethyl) Ether Class III	0.50	0.09	0.12	0.18	0.23	0.28	0.35	0.43	0.54	0.70	1.01	1.40	2.60
Bis(2-Ethylhexyl) Phthalate Class I*	5.99E-03	1.40E-03	1.87E-03	2.66E-03	3.34E-03	4.05E-03	4.80E-03	5.67E-03	6.77E-03	8.29E-03	1.11E-02	1.43E-02	2.42E-02
Bis(2-Ethylhexyl) Phthalate Class III*	6.00E-03	1.11E-03	1.49E-03	2.13E-03	2.75E-03	3.42E-03	4.20E-03	5.17E-03	6.46E-03	8.35E-03	1.21E-02	1.66E-02	3.06E-02
Bromoform Class I*	3.63E-02	1.31E-03	2.57E-03	6.83E-03	1.23E-02	1.89E-02	2.65E-02	3.57E-02	4.69E-02	6.16E-02	8.42E-02	1.05E-01	1.47E-01
Bromoform Class III*	0.04	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.08	0.10	0.20
Butylbenzyl Phthalate Class I*	2.02E-03	3.84E-04	5.10E-04	7.24E-04	9.34E-04	1.16E-03	1.42E-03	1.74E-03	2.17E-03	2.80E-03	4.06E-03	5.57E-03	1.02E-02
Butylbenzyl Phthalate Class III*	2.00E-03	3.70E-04	4.97E-04	7.10E-04	9.19E-04	1.14E-03	1.40E-03	1.73E-03	2.16E-03	2.79E-03	4.04E-03	5.55E-03	1.02E-02
Carbon Tetrachloride Class I*	1.79E-02	9.49E-04	1.73E-03	3.83E-03	6.46E-03	9.63E-03	1.32E-02	1.76E-02	2.29E-02	2.99E-02	4.08E-02	5.05E-02	7.06E-02
Carbon Tetrachloride Class III*	1.73E-02	3.15E-03	4.23E-03	6.06E-03	7.86E-03	9.76E-03	1.20E-02	1.48E-02	1.84E-02	2.40E-02	3.49E-02	4.81E-02	8.98E-02
Chlordane Class I*	2.79E-02	4.54E-03	6.09E-03	8.80E-03	1.14E-02	1.44E-02	1.79E-02	2.23E-02	2.83E-02	3.77E-02	5.67E-02	8.04E-02	1.65E-01
Chlordane Class III*	2.77E-02	4.43E-03	5.97E-03	8.66E-03	1.13E-02	1.43E-02	1.78E-02	2.21E-02	2.82E-02	3.75E-02	5.66E-02	8.02E-02	1.64E-01
Chlorobenzene Class I	0.43	0.03	0.05	0.11	0.17	0.24	0.32	0.43	0.55	0.71	0.97	1.19	1.67
Chlorobenzene Class III	0.50	0.09	0.12	0.17	0.23	0.28	0.34	0.42	0.53	0.69	1.00	1.39	2.60
Chlorodibromomethane Class I*	6.40E-03	1.61E-04	3.41E-04	1.10E-03	2.09E-03	3.27E-03	4.63E-03	6.28E-03	8.29E-03	1.09E-02	1.50E-02	1.87E-02	2.62E-02
Chlorodibromomethane Class III*	6.28E-03	1.15E-03	1.54E-03	2.20E-03	2.86E-03	3.55E-03	4.36E-03	5.36E-03	6.70E-03	8.70E-03	1.27E-02	1.74E-02	3.24E-02
Chloroform Class I	0.43	0.01	0.02	0.07	0.14	0.22	0.31	0.42	0.56	0.74	1.01	1.26	1.77
Chloroform Class III	0.49	0.09	0.12	0.17	0.22	0.28	0.34	0.42	0.52	0.68	0.99	1.36	2.54

Parameter	Mean	5 %tile	10 %tile	20 %tile	30 %tile	40 %tile	50 %tile	60 %tile	70 %tile	80 %tile	90 %tile	95 %tile	99 %tile
Chlorophenoxy Herbicide (2,4,5-TP) [Silvex] Class I	0.48	0.07	0.10	0.16	0.23	0.30	0.38	0.48	0.59	0.75	1.00	1.22	1.70
Chlorophenoxy Herbicide (2,4,5-TP) [Silvex] Class III	0.49	0.09	0.12	0.18	0.23	0.28	0.35	0.43	0.53	0.69	1.00	1.37	2.52
Chlorophenoxy Herbicide (2,4-D) Class I	0.44	0.03	0.05	0.10	0.16	0.24	0.32	0.43	0.56	0.73	0.99	1.22	1.71
Chlorophenoxy Herbicide (2,4-D) Class III	0.51	0.09	0.13	0.18	0.23	0.29	0.35	0.44	0.54	0.70	1.02	1.40	2.58
Cyanide Class I	4.26E-01	3.38E-03	9.20E-03	6.23E-02	1.32E-01	2.11E-01	3.05E-01	4.17E-01	5.55E-01	7.37E-01	1.01E+00	1.27E+00	1.77E+00
Cyanide Class III	0.50	0.09	0.12	0.18	0.23	0.29	0.35	0.43	0.54	0.70	1.02	1.39	2.57
Dichlorobromomethane Class I*	4.96E-02	1.15E-03	2.47E-03	8.36E-03	1.61E-02	2.52E-02	3.58E-02	4.86E-02	6.43E-02	8.49E-02	1.17E-01	1.45E-01	2.03E-01
Dichlorobromomethane Class III*	0.05	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.07	0.10	0.14	0.25
Dieldrin Class I*	6.24E-03	8.79E-04	1.20E-03	1.76E-03	2.32E-03	2.96E-03	3.72E-03	4.71E-03	6.05E-03	8.20E-03	1.27E-02	1.88E-02	4.13E-02
Dieldrin Class III*	6.24E-03	8.73E-04	1.19E-03	1.75E-03	2.31E-03	2.95E-03	3.71E-03	4.70E-03	6.04E-03	8.19E-03	1.27E-02	1.88E-02	4.13E-02
Diethyl Phthalate Class I	0.53	0.12	0.16	0.22	0.27	0.33	0.39	0.47	0.57	0.72	1.01	1.36	2.43
Diethyl Phthalate Class III	0.50	0.09	0.12	0.18	0.23	0.28	0.35	0.43	0.53	0.69	1.00	1.38	2.54
Dimethyl Phthalate Class I	0.51	0.10	0.14	0.19	0.24	0.30	0.36	0.44	0.54	0.70	1.01	1.38	2.52
Dimethyl Phthalate Class III	0.49	0.09	0.12	0.17	0.22	0.28	0.34	0.42	0.53	0.68	0.99	1.36	2.50
Di-n-Butyl Phthalate Class I	0.51	0.11	0.14	0.19	0.25	0.30	0.36	0.44	0.55	0.70	1.01	1.37	2.50
Di-n-Butyl Phthalate Class III	0.50	0.09	0.12	0.18	0.23	0.28	0.35	0.43	0.54	0.70	1.01	1.38	2.55
Endosulfan Sulfate Class I	0.53	0.10	0.14	0.22	0.29	0.36	0.44	0.53	0.64	0.78	1.02	1.26	1.89
Endosulfan Sulfate Class III	0.49	0.09	0.12	0.17	0.22	0.28	0.34	0.42	0.53	0.68	1.00	1.38	2.57
Endrin Class I	0.50	0.08	0.11	0.16	0.21	0.26	0.32	0.40	0.51	0.67	1.01	1.42	2.88
Endrin Class III	0.49	0.08	0.11	0.16	0.20	0.26	0.32	0.40	0.50	0.67	1.00	1.42	2.88
Ethylbenzene Class I	0.53	0.11	0.15	0.22	0.29	0.36	0.43	0.52	0.62	0.76	1.00	1.24	1.90
Ethylbenzene Class III	0.49	0.09	0.12	0.17	0.22	0.27	0.34	0.41	0.52	0.67	0.98	1.36	2.54
Fluoranthene Class I	0.51	0.11	0.14	0.20	0.25	0.30	0.37	0.44	0.55	0.70	1.00	1.36	2.47
Fluoranthene Class III	0.50	0.09	0.13	0.18	0.23	0.29	0.35	0.43	0.54	0.70	1.02	1.40	2.57
Fluorene Class I	0.52	0.12	0.16	0.22	0.28	0.33	0.40	0.47	0.57	0.70	0.96	1.27	2.34
Fluorene Class III	0.47	0.08	0.11	0.16	0.20	0.26	0.31	0.39	0.49	0.64	0.94	1.32	2.65

Parameter	Mean	5 %tile	10 %tile	20 %tile	30 %tile	40 %tile	50 %tile	60 %tile	70 %tile	80 %tile	90 %tile	95 %tile	99 %tile
gamma- Hexachlorocyclohexane (HCH) Class I	0.51	0.11	0.14	0.20	0.25	0.30	0.36	0.44	0.55	0.70	1.00	1.37	2.54
gamma- Hexachlorocyclohexane (HCH) Class III	0.50	0.09	0.12	0.18	0.23	0.28	0.35	0.43	0.53	0.69	1.01	1.39	2.60
Heptachlor Class I*	1.23E-02	1.76E-03	2.40E-03	3.51E-03	4.62E-03	5.89E-03	7.39E-03	9.34E-03	1.20E-02	1.62E-02	2.50E-02	3.68E-02	7.95E-02
Heptachlor Class III*	1.23E-02	1.75E-03	2.38E-03	3.50E-03	4.60E-03	5.87E-03	7.37E-03	9.32E-03	1.20E-02	1.62E-02	2.50E-02	3.67E-02	7.95E-02
Heptachlor Epoxide Class I*	0.07	0.01	0.02	0.02	0.03	0.04	0.05	0.06	0.07	0.09	0.14	0.20	0.40
Heptachlor Epoxide Class III*	0.07	0.01	0.02	0.02	0.03	0.04	0.05	0.06	0.07	0.09	0.14	0.20	0.41
Hexachlorobutadiene Class I*	0.43	0.05	0.07	0.10	0.14	0.18	0.23	0.30	0.40	0.56	0.93	1.40	3.03
Hexachlorobutadiene Class III*	0.42	0.05	0.07	0.10	0.14	0.18	0.23	0.30	0.40	0.56	0.92	1.40	3.03
Hexachlorocyclopentadiene Class I	0.52	0.12	0.15	0.21	0.26	0.32	0.38	0.46	0.56	0.71	1.01	1.36	2.48
Hexachlorocyclopentadiene Class III	0.50	0.09	0.12	0.18	0.23	0.28	0.35	0.43	0.53	0.69	1.01	1.38	2.57
Hexachloroethane Class I*	0.18	0.04	0.05	0.07	0.08	0.10	0.12	0.15	0.18	0.24	0.36	0.51	1.02
Hexachloroethane Class III*	0.18	0.03	0.04	0.05	0.07	0.09	0.11	0.14	0.18	0.24	0.37	0.54	1.12
Isophorone Class I*	2.65E-02	3.61E-04	8.77E-04	4.10E-03	8.33E-03	1.33E-02	1.90E-02	2.60E-02	3.45E-02	4.56E-02	6.28E-02	7.82E-02	1.10E-01
Isophorone Class III*	2.61E-02	4.81E-03	6.45E-03	9.22E-03	1.19E-02	1.49E-02	1.82E-02	2.24E-02	2.80E-02	3.63E-02	5.27E-02	7.25E-02	1.35E-01
Methoxychlor Class I	0.52	0.10	0.14	0.19	0.24	0.30	0.36	0.44	0.55	0.71	1.03	1.41	2.64
Methoxychlor Class III	0.50	0.09	0.12	0.17	0.22	0.28	0.34	0.42	0.53	0.69	1.01	1.39	2.62
Methyl Bromide Class I	4.16E-01	3.98E-03	1.05E-02	6.19E-02	1.29E-01	2.07E-01	2.97E-01	4.07E-01	5.41E-01	7.18E-01	9.89E-01	1.23E+00	1.73E+00
Methyl Bromide Class III	0.50	0.09	0.12	0.18	0.23	0.28	0.35	0.43	0.53	0.69	1.00	1.38	2.56
Methylene Chloride Class I*	4.16E-01	4.41E-03	1.13E-02	6.26E-02	1.30E-01	2.08E-01	2.98E-01	4.08E-01	5.42E-01	7.19E-01	9.89E-01	1.23E+00	1.73E+00
Methylene Chloride Class III*	0.42	0.08	0.10	0.15	0.19	0.24	0.30	0.36	0.46	0.59	0.86	1.18	2.18
Nitrobenzene Class I	0.42	0.01	0.02	0.07	0.13	0.21	0.30	0.41	0.55	0.72	0.99	1.24	1.73
Nitrobenzene Class III	0.50	0.09	0.12	0.18	0.23	0.28	0.35	0.43	0.54	0.70	1.01	1.39	2.60
p,p'- Dichlorodiphenyltrichloroethane (DDT) Class I*	2.86E-02	3.37E-03	4.60E-03	6.77E-03	9.02E-03	1.16E-02	1.47E-02	1.88E-02	2.48E-02	3.45E-02	5.77E-02	9.09E-02	2.37E-01
p,p'- Dichlorodiphenyltrichloroethane (DDT) Class III*	2.86E-02	3.36E-03	4.58E-03	6.75E-03	9.00E-03	1.16E-02	1.47E-02	1.88E-02	2.47E-02	3.45E-02	5.76E-02	9.09E-02	2.37E-01
Pentachlorobenzene Class I	0.49	0.09	0.12	0.17	0.22	0.27	0.33	0.40	0.50	0.66	0.97	1.37	2.79
Pentachlorobenzene Class III	0.51	0.09	0.12	0.17	0.22	0.27	0.34	0.42	0.52	0.69	1.03	1.45	2.98

Parameter	Mean	5 %tile	10 %tile	20 %tile	30 %tile	40 %tile	50 %tile	60 %tile	70 %tile	80 %tile	90 %tile	95 %tile	99 %tile
Pentachlorophenol Class I*	2.49E-03	4.92E-04	6.81E-04	9.93E-04	1.29E-03	1.59E-03	1.92E-03	2.31E-03	2.78E-03	3.43E-03	4.60E-03	6.02E-03	1.11E-02
Pentachlorophenol Class III*	2.58E-03	3.98E-04	5.38E-04	7.83E-04	1.02E-03	1.29E-03	1.60E-03	2.01E-03	2.55E-03	3.41E-03	5.21E-03	7.53E-03	1.61E-02
Phenol Class I	4.28E-01	4.92E-03	1.24E-02	6.50E-02	1.34E-01	2.14E-01	3.07E-01	4.20E-01	5.58E-01	7.39E-01	1.02E+00	1.27E+00	1.78E+00
Phenol Class III	0.50	0.09	0.12	0.18	0.23	0.29	0.35	0.43	0.54	0.70	1.01	1.39	2.60
Pyrene Class I	0.53	0.13	0.17	0.23	0.29	0.34	0.41	0.48	0.58	0.73	1.00	1.33	2.33
Pyrene Class III	0.49	0.09	0.12	0.17	0.23	0.28	0.35	0.42	0.53	0.69	1.00	1.37	2.52
Selenium Class I	0.43	0.01	0.03	0.08	0.15	0.22	0.32	0.43	0.56	0.74	1.01	1.25	1.75
Selenium Class III	0.50	0.09	0.12	0.18	0.23	0.29	0.35	0.43	0.54	0.70	1.01	1.39	2.56
Tetrachloroethylene (Perchloroethylene) Class I*	0.40	0.06	0.09	0.14	0.20	0.26	0.32	0.40	0.49	0.61	0.81	0.99	1.40
Tetrachloroethylene (Perchloroethylene) Class III*	0.40	0.07	0.10	0.14	0.18	0.22	0.27	0.34	0.42	0.55	0.80	1.10	2.06
Toluene Class I	0.44	0.03	0.05	0.10	0.16	0.24	0.33	0.43	0.56	0.73	1.00	1.23	1.72
Toluene Class III	0.50	0.09	0.12	0.18	0.23	0.28	0.35	0.43	0.53	0.69	1.01	1.39	2.60
Toxaphene Class I*	1.29E-02	2.54E-03	3.33E-03	4.67E-03	5.95E-03	7.37E-03	8.96E-03	1.10E-02	1.37E-02	1.78E-02	2.59E-02	3.56E-02	6.73E-02
Toxaphene Class III*	1.32E-02	2.36E-03	3.17E-03	4.56E-03	5.88E-03	7.37E-03	9.04E-03	1.12E-02	1.40E-02	1.83E-02	2.68E-02	3.70E-02	7.05E-02
trans-1,2-Dichloroethylene (DCE) Class I	0.42	0.01	0.02	0.07	0.14	0.22	0.31	0.42	0.55	0.73	1.00	1.24	1.74
trans-1,2-Dichloroethylene (DCE) Class III	0.49	0.09	0.12	0.17	0.22	0.28	0.34	0.42	0.53	0.68	0.99	1.37	2.56
Trichloroethylene (TCE) Class I*	0.19	0.01	0.02	0.04	0.07	0.10	0.14	0.19	0.25	0.33	0.44	0.55	0.77
Trichloroethylene (TCE) Class III*	0.20	0.04	0.05	0.07	0.09	0.11	0.14	0.17	0.21	0.27	0.39	0.54	1.01
Vinyl Chloride Class I*	1.11E-03	1.19E-05	3.06E-05	1.67E-04	3.46E-04	5.54E-04	7.95E-04	1.09E-03	1.45E-03	1.92E-03	2.64E-03	3.29E-03	4.61E-03
Vinyl Chloride Class III*	1.13E-03	2.07E-04	2.77E-04	3.97E-04	5.14E-04	6.39E-04	7.84E-04	9.64E-04	1.21E-03	1.56E-03	2.27E-03	3.12E-03	5.81E-03

Table F-2. Parameter specific percentiles of incremental cancer risk for adult consumers of freshwater and estuarine fish and Florida drinking water. Criteria inputs used in the risk assessment were rounded to two significant figures, consistent with the proposed final values. Class III risks include Class II and Class III-Limited waters. Risks for Class I include Class I-Treated.

Parameter	Mean	5 %tile	10 %tile	20 %tile	30 %tile	40 %tile	50 %tile	60 %tile	70 %tile	80 %tile	90 %tile	95 %tile	99 %tile
1,1,2,2-Tetrachloroethane Class I	1.02E-06	3.61E-08	7.10E-08	1.90E-07	3.44E-07	5.29E-07	7.40E-07	9.98E-07	1.31E-06	1.72E-06	2.36E-06	2.93E-06	4.11E-06

Parameter	Mean	5 %tile	10 %tile	20 %tile	30 %tile	40 %tile	50 %tile	60 %tile	70 %tile	80 %tile	90 %tile	95 %tile	99 %tile
1,1,2,2-Tetrachloroethane Class III	1.00E-06	1.83E-07	2.46E-07	3.52E-07	4.57E-07	5.67E-07	6.97E-07	8.56E-07	1.07E-06	1.39E-06	2.02E-06	2.79E-06	5.21E-06
1,1,2-Trichloroethane Class I	9.95E-07	3.69E-08	7.21E-08	1.89E-07	3.40E-07	5.20E-07	7.26E-07	9.78E-07	1.28E-06	1.69E-06	2.31E-06	2.87E-06	4.01E-06
1,1,2-Trichloroethane Class III	1.02E-06	1.86E-07	2.50E-07	3.58E-07	4.64E-07	5.76E-07	7.09E-07	8.71E-07	1.09E-06	1.42E-06	2.06E-06	2.84E-06	5.31E-06
1,2,4-Trichlorobenzene Class I	9.78E-07	1.87E-07	2.43E-07	3.40E-07	4.33E-07	5.35E-07	6.54E-07	8.01E-07	1.00E-06	1.32E-06	1.96E-06	2.79E-06	5.51E-06
1,2,4-Trichlorobenzene Class III	9.89E-07	1.57E-07	2.13E-07	3.10E-07	4.06E-07	5.13E-07	6.39E-07	7.94E-07	1.01E-06	1.35E-06	2.04E-06	2.92E-06	5.83E-06
1,2-Dichloroethane Class I	1.01E-06	1.19E-08	2.98E-08	1.54E-07	3.15E-07	5.04E-07	7.23E-07	9.89E-07	1.31E-06	1.74E-06	2.40E-06	2.99E-06	4.18E-06
1,2-Dichloroethane Class III	9.83E-07	1.81E-07	2.43E-07	3.48E-07	4.50E-07	5.60E-07	6.87E-07	8.45E-07	1.06E-06	1.37E-06	1.98E-06	2.73E-06	5.03E-06
1,2-Dichloropropane Class I	1.01E-06	2.04E-08	4.53E-08	1.66E-07	3.26E-07	5.14E-07	7.31E-07	9.95E-07	1.32E-06	1.74E-06	2.39E-06	2.98E-06	4.17E-06
1,2-Dichloropropane Class III	1.01E-06	1.84E-07	2.47E-07	3.53E-07	4.59E-07	5.69E-07	7.00E-07	8.60E-07	1.07E-06	1.39E-06	2.03E-06	2.79E-06	5.20E-06
1,2-Diphenylhydrazine Class I	1.00E-06	8.54E-08	1.40E-07	2.64E-07	4.07E-07	5.73E-07	7.61E-07	9.88E-07	1.27E-06	1.64E-06	2.21E-06	2.72E-06	3.80E-06
1,2-Diphenylhydrazine Class III	1.00E-06	1.82E-07	2.44E-07	3.50E-07	4.54E-07	5.64E-07	6.94E-07	8.52E-07	1.07E-06	1.39E-06	2.02E-06	2.79E-06	5.18E-06
1,3-Dichloropropene Class I	1.01E-06	1.63E-08	3.81E-08	1.60E-07	3.19E-07	5.07E-07	7.24E-07	9.88E-07	1.31E-06	1.73E-06	2.38E-06	2.97E-06	4.16E-06
1,3-Dichloropropene Class III	1.02E-06	1.88E-07	2.52E-07	3.60E-07	4.67E-07	5.80E-07	7.12E-07	8.75E-07	1.09E-06	1.42E-06	2.06E-06	2.83E-06	5.27E-06
2,4,6-Trichlorophenol Class I	9.95E-07	1.95E-07	2.74E-07	4.11E-07	5.40E-07	6.72E-07	8.18E-07	9.86E-07	1.18E-06	1.46E-06	1.91E-06	2.35E-06	3.53E-06
2,4,6-Trichlorophenol Class III	9.98E-07	1.81E-07	2.44E-07	3.49E-07	4.53E-07	5.62E-07	6.92E-07	8.50E-07	1.06E-06	1.38E-06	2.01E-06	2.78E-06	5.20E-06
2,4-Dinitrotoluene Class I	1.03E-06	2.01E-08	4.50E-08	1.68E-07	3.31E-07	5.22E-07	7.44E-07	1.01E-06	1.34E-06	1.77E-06	2.44E-06	3.03E-06	4.25E-06
2,4-Dinitrotoluene Class III	9.97E-07	1.83E-07	2.45E-07	3.50E-07	4.55E-07	5.65E-07	6.94E-07	8.52E-07	1.07E-06	1.38E-06	2.01E-06	2.77E-06	5.15E-06
3,3'-Dichlorobenzidine Class I	9.98E-07	1.47E-07	2.18E-07	3.52E-07	4.88E-07	6.36E-07	8.00E-07	9.95E-07	1.23E-06	1.55E-06	2.04E-06	2.50E-06	3.52E-06
3,3'-Dichlorobenzidine Class III	9.97E-07	1.81E-07	2.43E-07	3.49E-07	4.52E-07	5.61E-07	6.91E-07	8.49E-07	1.06E-06	1.38E-06	2.01E-06	2.78E-06	5.18E-06
Acrylonitrile Class I	1.04E-06	8.28E-09	2.26E-08	1.53E-07	3.22E-07	5.18E-07	7.47E-07	1.02E-06	1.36E-06	1.81E-06	2.49E-06	3.10E-06	4.35E-06
Acrylonitrile Class III	9.70E-07	1.79E-07	2.41E-07	3.44E-07	4.45E-07	5.53E-07	6.79E-07	8.35E-07	1.04E-06	1.35E-06	1.96E-06	2.68E-06	4.95E-06
Aldrin Class I	1.01E-06	1.38E-07	1.88E-07	2.77E-07	3.67E-07	4.69E-07	5.90E-07	7.51E-07	9.66E-07	1.31E-06	2.06E-06	3.05E-06	6.88E-06
Aldrin Class III	1.01E-06	1.37E-07	1.87E-07	2.76E-07	3.66E-07	4.68E-07	5.90E-07	7.50E-07	9.66E-07	1.31E-06	2.06E-06	3.05E-06	6.88E-06
Benzene Class I	9.99E-7	2.16E-8	4.74E-8	1.52E-7	2.92E-7	4.60E-7	6.59E-7	9.09E-7	1.23E-6	1.66E-6	2.42E-6	3.15E-6	4.78E-6
Benzene Class III	1.01E-6	1.51E-7	2.09E-7	3.09E-7	4.10E-7	5.22E-7	6.52E-7	8.17E-7	1.04E-6	1.39E-6	2.09E-6	2.93E-6	5.71E-6
Benzidine Class I	1.02E-06	1.08E-08	2.78E-08	1.54E-07	3.18E-07	5.09E-07	7.31E-07	1.00E-06	1.33E-06	1.76E-06	2.43E-06	3.02E-06	4.24E-06
Benzidine Class III	1.02E-06	1.88E-07	2.52E-07	3.60E-07	4.67E-07	5.80E-07	7.12E-07	8.76E-07	1.09E-06	1.42E-06	2.06E-06	2.83E-06	5.23E-06
Benzo(a)anthracene Class I	9.78E-07	2.27E-07	2.95E-07	4.06E-07	5.06E-07	6.10E-07	7.28E-07	8.72E-07	1.06E-06	1.33E-06	1.87E-06	2.53E-06	4.52E-06

Parameter	Mean	5 %tile	10 %tile	20 %tile	30 %tile	40 %tile	50 %tile	60 %tile	70 %tile	80 %tile	90 %tile	95 %tile	99 %tile
Benzo(a)anthracene Class III	1.00E-06	1.85E-07	2.48E-07	3.55E-07	4.59E-07	5.71E-07	7.01E-07	8.62E-07	1.08E-06	1.39E-06	2.02E-06	2.77E-06	5.11E-06
Benzo(a)pyrene Class I	1.00E-06	2.33E-07	3.02E-07	4.16E-07	5.19E-07	6.26E-07	7.46E-07	8.94E-07	1.08E-06	1.37E-06	1.92E-06	2.59E-06	4.63E-06
Benzo(a)pyrene Class III	1.00E-06	1.85E-07	2.48E-07	3.55E-07	4.59E-07	5.71E-07	7.01E-07	8.62E-07	1.08E-06	1.39E-06	2.02E-06	2.77E-06	5.11E-06
Benzo(b)fluoranthene Class I	9.78E-07	2.27E-07	2.95E-07	4.06E-07	5.06E-07	6.10E-07	7.28E-07	8.72E-07	1.06E-06	1.33E-06	1.87E-06	2.53E-06	4.52E-06
Benzo(b)fluoranthene Class III	1.00E-06	1.85E-07	2.48E-07	3.55E-07	4.59E-07	5.71E-07	7.01E-07	8.62E-07	1.08E-06	1.39E-06	2.02E-06	2.77E-06	5.11E-06
Benzo(k)fluoranthene Class I	9.78E-07	2.27E-07	2.95E-07	4.06E-07	5.06E-07	6.10E-07	7.28E-07	8.72E-07	1.06E-06	1.33E-06	1.87E-06	2.53E-06	4.52E-06
Benzo(k)fluoranthene Class III	1.00E-06	1.85E-07	2.48E-07	3.55E-07	4.59E-07	5.71E-07	7.01E-07	8.62E-07	1.08E-06	1.39E-06	2.02E-06	2.77E-06	5.11E-06
beta-Hexachlorocyclohexane (HCH) Class I	9.93E-07	2.06E-07	2.86E-07	4.22E-07	5.48E-07	6.75E-07	8.14E-07	9.77E-07	1.17E-06	1.43E-06	1.87E-06	2.33E-06	3.63E-06
beta-Hexachlorocyclohexane (HCH) Class III	1.01E-06	1.84E-07	2.46E-07	3.53E-07	4.58E-07	5.69E-07	7.00E-07	8.59E-07	1.08E-06	1.40E-06	2.03E-06	2.81E-06	5.25E-06
Bis(2-Chloroethyl) Ether Class I	1.01E-06	1.07E-08	2.74E-08	1.52E-07	3.14E-07	5.02E-07	7.21E-07	9.87E-07	1.31E-06	1.74E-06	2.39E-06	2.98E-06	4.18E-06
Bis(2-Chloroethyl) Ether Class III	1.00E-06	1.84E-07	2.47E-07	3.53E-07	4.58E-07	5.69E-07	6.99E-07	8.58E-07	1.07E-06	1.39E-06	2.02E-06	2.77E-06	5.13E-06
Bis(2-Ethylhexyl) Phthalate Class I	1.01E-06	2.35E-07	3.15E-07	4.46E-07	5.62E-07	6.80E-07	8.07E-07	9.53E-07	1.14E-06	1.39E-06	1.86E-06	2.41E-06	4.06E-06
Bis(2-Ethylhexyl) Phthalate Class III	1.01E-06	1.86E-07	2.50E-07	3.57E-07	4.63E-07	5.75E-07	7.06E-07	8.68E-07	1.08E-06	1.40E-06	2.03E-06	2.79E-06	5.15E-06
Bromoform Class I	9.80E-07	3.55E-08	6.95E-08	1.84E-07	3.33E-07	5.11E-07	7.15E-07	9.63E-07	1.27E-06	1.66E-06	2.27E-06	2.83E-06	3.96E-06
Bromoform Class III	1.01E-06	1.85E-07	2.49E-07	3.56E-07	4.62E-07	5.73E-07	7.05E-07	8.65E-07	1.08E-06	1.41E-06	2.05E-06	2.82E-06	5.27E-06
Butylbenzyl Phthalate Class I	9.97E-07	1.90E-07	2.52E-07	3.58E-07	4.61E-07	5.72E-07	7.00E-07	8.60E-07	1.07E-06	1.39E-06	2.01E-06	2.75E-06	5.06E-06
Butylbenzyl Phthalate Class III	9.90E-07	1.83E-07	2.46E-07	3.51E-07	4.54E-07	5.64E-07	6.93E-07	8.52E-07	1.06E-06	1.38E-06	2.00E-06	2.74E-06	5.05E-06
Carbon Tetrachloride Class I	1.00E-06	5.32E-08	9.67E-08	2.14E-07	3.62E-07	5.39E-07	7.38E-07	9.84E-07	1.28E-06	1.68E-06	2.28E-06	2.83E-06	3.95E-06
Carbon Tetrachloride Class III	9.69E-07	1.76E-07	2.37E-07	3.39E-07	4.40E-07	5.46E-07	6.73E-07	8.26E-07	1.03E-06	1.34E-06	1.95E-06	2.70E-06	5.03E-06
Chlordane Class I	9.76E-07	1.59E-07	2.13E-07	3.08E-07	4.00E-07	5.05E-07	6.28E-07	7.80E-07	9.91E-07	1.32E-06	1.99E-06	2.81E-06	5.76E-06
Chlordane Class III	9.71E-07	1.55E-07	2.09E-07	3.03E-07	3.96E-07	5.00E-07	6.23E-07	7.75E-07	9.86E-07	1.31E-06	1.98E-06	2.81E-06	5.75E-06
Chlorodibromomethane Class I	1.02E-06	2.58E-08	5.45E-08	1.76E-07	3.35E-07	5.23E-07	7.40E-07	1.00E-06	1.33E-06	1.75E-06	2.40E-06	2.99E-06	4.19E-06
Chlorodibromomethane Class III	1.00E-06	1.84E-07	2.47E-07	3.53E-07	4.58E-07	5.68E-07	6.98E-07	8.58E-07	1.07E-06	1.39E-06	2.03E-06	2.79E-06	5.19E-06
Chrysene Class I	9.78E-07	2.27E-07	2.95E-07	4.06E-07	5.06E-07	6.10E-07	7.28E-07	8.72E-07	1.06E-06	1.33E-06	1.87E-06	2.53E-06	4.52E-06
Chrysene Class III	1.00E-06	1.85E-07	2.48E-07	3.55E-07	4.59E-07	5.71E-07	7.01E-07	8.62E-07	1.08E-06	1.39E-06	2.02E-06	2.77E-06	5.11E-06
Dibenzo(a,h)anthracene Class I	9.78E-07	2.27E-07	2.95E-07	4.06E-07	5.06E-07	6.10E-07	7.28E-07	8.72E-07	1.06E-06	1.33E-06	1.87E-06	2.53E-06	4.52E-06
Dibenzo(a,h)anthracene Class III	1.00E-06	1.85E-07	2.48E-07	3.55E-07	4.59E-07	5.71E-07	7.01E-07	8.62E-07	1.08E-06	1.39E-06	2.02E-06	2.77E-06	5.11E-06

Parameter	Mean	5 %tile	10 %tile	20 %tile	30 %tile	40 %tile	50 %tile	60 %tile	70 %tile	80 %tile	90 %tile	95 %tile	99 %tile
Dichlorobromomethane Class I	1.01E-06	2.34E-08	5.04E-08	1.70E-07	3.29E-07	5.15E-07	7.30E-07	9.92E-07	1.31E-06	1.73E-06	2.38E-06	2.96E-06	4.15E-06
Dichlorobromomethane Class III	1.00E-06	1.84E-07	2.47E-07	3.53E-07	4.58E-07	5.68E-07	6.99E-07	8.59E-07	1.07E-06	1.39E-06	2.02E-06	2.79E-06	5.19E-06
Dieldrin Class I	9.99E-07	1.41E-07	1.92E-07	2.81E-07	3.71E-07	4.74E-07	5.95E-07	7.54E-07	9.68E-07	1.31E-06	2.04E-06	3.01E-06	6.60E-06
Dieldrin Class III	9.98E-07	1.40E-07	1.91E-07	2.80E-07	3.70E-07	4.72E-07	5.94E-07	7.52E-07	9.67E-07	1.31E-06	2.04E-06	3.00E-06	6.60E-06
Heptachlor Class I	1.01E-06	1.44E-07	1.96E-07	2.88E-07	3.79E-07	4.83E-07	6.06E-07	7.66E-07	9.82E-07	1.33E-06	2.05E-06	3.01E-06	6.52E-06
Heptachlor Class III	1.01E-06	1.43E-07	1.95E-07	2.87E-07	3.77E-07	4.82E-07	6.04E-07	7.65E-07	9.80E-07	1.32E-06	2.05E-06	3.01E-06	6.52E-06
Heptachlor Epoxide Class I	9.95E-07	1.67E-07	2.25E-07	3.22E-07	4.17E-07	5.25E-07	6.50E-07	8.06E-07	1.02E-06	1.35E-06	2.02E-06	2.84E-06	5.74E-06
Heptachlor Epoxide Class III	9.98E-07	1.63E-07	2.21E-07	3.18E-07	4.14E-07	5.23E-07	6.49E-07	8.06E-07	1.02E-06	1.35E-06	2.03E-06	2.86E-06	5.79E-06
Hexachlorobutadiene Class I	1.02E-06	1.21E-07	1.67E-07	2.48E-07	3.36E-07	4.38E-07	5.64E-07	7.29E-07	9.66E-07	1.35E-06	2.22E-06	3.36E-06	7.28E-06
Hexachlorobutadiene Class III	1.01E-06	1.12E-07	1.58E-07	2.39E-07	3.26E-07	4.28E-07	5.53E-07	7.19E-07	9.55E-07	1.34E-06	2.21E-06	3.35E-06	7.27E-06
Hexachloroethane Class I	1.01E-06	1.96E-07	2.61E-07	3.65E-07	4.63E-07	5.67E-07	6.83E-07	8.30E-07	1.03E-06	1.34E-06	2.00E-06	2.84E-06	5.70E-06
Hexachloroethane Class III	9.88E-07	1.44E-07	1.96E-07	2.87E-07	3.81E-07	4.87E-07	6.10E-07	7.67E-07	9.87E-07	1.34E-06	2.07E-06	3.01E-06	6.27E-06
Indeno(1,2,3-cd)pyrene Class I	9.78E-07	2.27E-07	2.95E-07	4.06E-07	5.06E-07	6.10E-07	7.28E-07	8.72E-07	1.06E-06	1.33E-06	1.87E-06	2.53E-06	4.52E-06
Indeno(1,2,3-cd)pyrene Class III	1.00E-06	1.85E-07	2.48E-07	3.55E-07	4.59E-07	5.71E-07	7.01E-07	8.62E-07	1.08E-06	1.39E-06	2.02E-06	2.77E-06	5.11E-06
Isophorone Class I	1.01E-06	1.37E-08	3.33E-08	1.56E-07	3.16E-07	5.04E-07	7.22E-07	9.86E-07	1.31E-06	1.73E-06	2.39E-06	2.97E-06	4.16E-06
Isophorone Class III	9.93E-07	1.83E-07	2.45E-07	3.51E-07	4.54E-07	5.64E-07	6.93E-07	8.52E-07	1.06E-06	1.38E-06	2.00E-06	2.75E-06	5.12E-06
Methylene Chloride Class I	9.99E-07	1.06E-08	2.72E-08	1.50E-07	3.11E-07	4.98E-07	7.15E-07	9.79E-07	1.30E-06	1.72E-06	2.37E-06	2.96E-06	4.15E-06
Methylene Chloride Class III	1.02E-06	1.88E-07	2.52E-07	3.60E-07	4.67E-07	5.80E-07	7.12E-07	8.76E-07	1.09E-06	1.42E-06	2.06E-06	2.83E-06	5.23E-06
p,p'-Dichlorodiphenyltrichloroethane (DDT) Class I	9.74E-07	1.15E-07	1.56E-07	2.30E-07	3.07E-07	3.94E-07	5.00E-07	6.40E-07	8.42E-07	1.17E-06	1.96E-06	3.09E-06	8.05E-06
p,p'-Dichlorodiphenyltrichloroethane (DDT) Class III	9.73E-07	1.14E-07	1.56E-07	2.29E-07	3.06E-07	3.93E-07	5.00E-07	6.39E-07	8.41E-07	1.17E-06	1.96E-06	3.09E-06	8.05E-06
PCBs Class I	1.00E-06	1.87E-07	2.50E-07	3.57E-07	4.61E-07	5.72E-07	7.01E-07	8.63E-07	1.08E-06	1.39E-06	2.02E-06	2.77E-06	5.10E-06
PCBs Class III	9.98E-07	1.85E-07	2.48E-07	3.54E-07	4.58E-07	5.69E-07	6.99E-07	8.60E-07	1.07E-06	1.39E-06	2.01E-06	2.76E-06	5.10E-06
Pentachlorophenol Class I	9.94E-07	1.97E-07	2.72E-07	3.97E-07	5.17E-07	6.37E-07	7.70E-07	9.23E-07	1.11E-06	1.37E-06	1.84E-06	2.41E-06	4.43E-06
Pentachlorophenol Class III	1.03E-06	1.59E-07	2.15E-07	3.13E-07	4.08E-07	5.16E-07	6.41E-07	8.03E-07	1.02E-06	1.36E-06	2.08E-06	3.01E-06	6.45E-06
Tetrachloroethylene (Perchloroethylene) Class I	1.01E-06	1.56E-07	2.29E-07	3.65E-07	5.01E-07	6.49E-07	8.12E-07	1.00E-06	1.24E-06	1.55E-06	2.04E-06	2.49E-06	3.53E-06

Parameter	Mean	5 %tile	10 %tile	20 %tile	30 %tile	40 %tile	50 %tile	60 %tile	70 %tile	80 %tile	90 %tile	95 %tile	99 %tile
Tetrachloroethylene (Perchloroethylene) Class III	9.98E-07	1.82E-07	2.44E-07	3.49E-07	4.53E-07	5.62E-07	6.92E-07	8.50E-07	1.06E-06	1.38E-06	2.01E-06	2.78E-06	5.20E-06
Toxaphene Class I	9.97E-07	1.95E-07	2.57E-07	3.59E-07	4.58E-07	5.67E-07	6.90E-07	8.46E-07	1.05E-06	1.37E-06	1.99E-06	2.74E-06	5.18E-06
Toxaphene Class III	1.02E-06	1.82E-07	2.44E-07	3.51E-07	4.53E-07	5.68E-07	6.96E-07	8.59E-07	1.08E-06	1.41E-06	2.06E-06	2.85E-06	5.43E-06
Trichloroethylene (TCE) Class I	9.72E-07	4.92E-08	9.03E-08	2.04E-07	3.48E-07	5.21E-07	7.16E-07	9.57E-07	1.25E-06	1.63E-06	2.22E-06	2.76E-06	3.85E-06
Trichloroethylene (TCE) Class III	9.75E-07	1.78E-07	2.39E-07	3.42E-07	4.43E-07	5.50E-07	6.77E-07	8.32E-07	1.04E-06	1.35E-06	1.97E-06	2.71E-06	5.06E-06
Vinyl Chloride Class I	9.99E-07	1.07E-08	2.75E-08	1.51E-07	3.11E-07	4.98E-07	7.16E-07	9.79E-07	1.30E-06	1.72E-06	2.37E-06	2.96E-06	4.15E-06
Vinyl Chloride Class III	1.01E-06	1.86E-07	2.50E-07	3.57E-07	4.63E-07	5.75E-07	7.06E-07	8.68E-07	1.08E-06	1.41E-06	2.04E-06	2.81E-06	5.23E-06

Table F-3. Human health risks for Cyanide (Class III only), Endosulfan alpha, Endosulfan beta, Endosulfan sulfate , Endrin, Selenium, gamma-Hexachlorocyclohexane (HCH), Toxaphene, and phenol (Cancer or HQ) for adult consumers of freshwater and estuarine fish and Florida drinking water, based on exposures at the more sensitive aquatic life or organoleptic-based criteria. Class III risks include Class II and Class III-Limited waters. Risks for Class I includes Class I-Treated waters. The “Risk Metric” column provides the basis of the risk assessment. Cyanide, Endosulfan alpha, Endosulfan beta, Endosulfan sulfate, Selenium, gamma-Hexachlorocyclohexane (HCH), and Toxaphene have different criteria for Class III Fresh (F) and Class III Marine (M) and II waters. The risk assessments were run separately using both the marine and freshwater criteria conservatively assuming that all fish consumption came from the given waterbody type.

Parameter	Risk Metric	Mean	5 %tile	10 %tile	20 %tile	30 %tile	40 %tile	50 %tile	60 %tile	70 %tile	80 %tile	90 %tile	95 %tile	99 %tile
Toxaphene Class I	**Cancer Risk**	1.1E-07	2.1E-08	2.7E-08	3.8E-08	4.8E-08	5.9E-08	7.3E-08	8.9E-08	1.1E-07	1.4E-07	2.1E-07	2.9E-07	5.6E-07
Toxaphene Class III	**Cancer Risk**	1.0E-07	1.8E-08	2.5E-08	3.5E-08	4.5E-08	5.7E-08	7.0E-08	8.6E-08	1.1E-07	1.4E-07	2.1E-07	2.9E-07	5.6E-07
alpha-Endosulfan Class I	**HQ**	1.5E-03	3.2E-04	4.4E-04	6.4E-04	8.3E-04	1.0E-03	1.2E-03	1.5E-03	1.8E-03	2.2E-03	2.8E-03	3.5E-03	5.7E-03
alpha-Endosulfan Class IIIF	**HQ**	8.7E-04	1.6E-04	2.1E-04	3.0E-04	3.9E-04	4.9E-04	6.0E-04	7.4E-04	9.3E-04	1.2E-03	1.8E-03	2.4E-03	4.6E-03
alpha-Endosulfan Class IIIM/II	**HQ**	1.4E-04	2.5E-05	3.3E-05	4.7E-05	6.1E-05	7.6E-05	9.3E-05	1.1E-04	1.4E-04	1.9E-04	2.7E-04	3.7E-04	7.2E-04
beta-Endosulfan Class I	**HQ**	1.2E-03	2.2E-04	3.2E-04	4.8E-04	6.3E-04	7.9E-04	9.7E-04	1.2E-03	1.4E-03	1.8E-03	2.3E-03	2.8E-03	4.3E-03
beta-Endosulfan Class IIIF	**HQ**	5.6E-04	1.0E-04	1.3E-04	1.9E-04	2.5E-04	3.1E-04	3.8E-04	4.7E-04	5.9E-04	7.7E-04	1.1E-03	1.5E-03	3.0E-03
beta-Endosulfan Class IIIM/II	**HQ**	8.6E-05	1.6E-05	2.1E-05	3.0E-05	3.9E-05	4.8E-05	5.9E-05	7.3E-05	9.1E-05	1.2E-04	1.7E-04	2.4E-04	4.6E-04
Cyanide Class IIIF	HQ	7.1E-03	1.3E-03	1.8E-03	2.5E-03	3.2E-03	4.0E-03	5.0E-03	6.1E-03	7.6E-03	9.9E-03	1.4E-02	2.0E-02	3.6E-02
Cyanide Class IIIM/II	HQ	1.4E-03	2.5E-04	3.4E-04	4.8E-04	6.2E-04	7.8E-04	9.5E-04	1.2E-03	1.5E-03	1.9E-03	2.7E-03	3.8E-03	7.0E-03
Endosulfan Sulfate Class I	**HQ**	1.2E-03	2.4E-04	3.4E-04	5.0E-04	6.7E-04	8.3E-04	1.0E-03	1.2E-03	1.5E-03	1.8E-03	2.4E-03	2.9E-03	4.5E-03
Endosulfan Sulfate Class IIIF	**HQ**	6.1E-04	1.1E-04	1.5E-04	2.1E-04	2.7E-04	3.4E-04	4.2E-04	5.1E-04	6.4E-04	8.4E-04	1.2E-03	1.7E-03	3.2E-03

Parameter	Risk Metric	Mean	5 %tile	10 %tile	20 %tile	30 %tile	40 %tile	50 %tile	60 %tile	70 %tile	80 %tile	90 %tile	95 %tile	99 %tile
Endosulfan Sulfate Class IIIM/II	**HQ**	9.4E-05	1.7E-05	2.3E-05	3.3E-05	4.2E-05	5.3E-05	6.5E-05	8.0E-05	1.0E-04	1.3E-04	1.9E-04	2.6E-04	5.0E-04
Endrin Class I	**HQ**	0.02	3.6E-03	4.8E-03	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.06	0.13
Endrin Class III	**HQ**	0.02	3.5E-03	4.7E-03	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.06	0.13
gamma- Hexachlorocyclohexane (HCH) Class I	**HQ**	0.10	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.10	0.13	0.19	0.26	0.49
gamma- Hexachlorocyclohexane (HCH) Class IIIF	**HQ**	0.09	0.02	0.02	0.03	0.04	0.05	0.06	0.08	0.10	0.13	0.18	0.26	0.49
gamma- Hexachlorocyclohexane (HCH) Class IIIM/II	**HQ**	0.02	2.8E-03	3.8E-03	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.08
Phenol Class I	**HQ**	0.03	3.9E-04	1.0E-03	0.01	0.01	0.02	0.03	0.03	0.05	0.06	0.08	0.10	0.14
Phenol Classs III	**HQ**	6.1E-04	1.1E-04	1.5E-04	2.1E-04	2.7E-04	3.4E-04	4.2E-04	5.2E-04	6.5E-04	8.4E-04	1.2E-03	1.7E-03	3.2E-03
Selenium Class I	**HQ**	0.07	2.4E-03	4.7E-03	0.01	0.02	0.04	0.05	0.07	0.09	0.12	0.17	0.21	0.29
Selenium Class IIIF	**HQ**	3.9E-03	7.3E-04	9.8E-04	1.4E-03	1.8E-03	2.2E-03	2.8E-03	3.4E-03	4.2E-03	0.01	0.01	0.01	0.02
Selenium Class IIIM/II	**HQ**	0.06	0.01	0.01	0.02	0.03	0.03	0.04	0.05	0.06	0.08	0.11	0.15	0.29

Appendix G. Summary of Probabilistic Risk Analyses of Proposed Carcinogen Criteria for Subsistence Fishers.

Table G-1. Parameter specific percentiles of carcinogen health risks for subsistence fishers. Class III risks include Class II and Class III-Limited waters. Risks for Class I include Class I-Treated waters. Criteria inputs used in the risk assessment were rounded to two significant figures, consistent with the proposed final values. Risk analysis for subsistence fishers was conducted by holding the total fish consumption rate constant at 142.4 g/day (randomly apportioned across trophic levels 2, 3, and 4) while allowing all other model distributions to vary. The analysis assumes that general population statistics such as weight and drinking water intake are also representative of the population of subsistence fishers. Risk is expressed as the incremental risk in the lifetime likelihood of a cancer event based on the proposed human health criteria. Risk analyses for toxaphene were run using criteria derived from the more aquatic life endpoint.

Parameter	Mean	5 %tile	10 %tile	20 %tile	30 %tile	40 %tile	50 %tile	60 %tile	70 %tile	80 %tile	90 %tile	95 %tile	99 %tile
1,1,2,2-Tetrachloroethane Class I	1.65E-06	5.68E-07	6.56E-07	8.06E-07	9.64E-07	1.15E-06	1.36E-06	1.62E-06	1.94E-06	2.38E-06	3.05E-06	3.66E-06	4.96E-06
1,1,2,2-Tetrachloroethane Class III	1.16E-05	7.33E-06	8.05E-06	9.02E-06	9.80E-06	1.05E-05	1.12E-05	1.20E-05	1.29E-05	1.40E-05	1.57E-05	1.72E-05	2.06E-05
1,1,2-Trichloroethane Class I	1.64E-06	5.81E-07	6.71E-07	8.21E-07	9.77E-07	1.15E-06	1.36E-06	1.62E-06	1.94E-06	2.36E-06	3.02E-06	3.62E-06	4.90E-06
1,1,2-Trichloroethane Class III	1.18E-05	7.44E-06	8.18E-06	9.17E-06	9.97E-06	1.07E-05	1.14E-05	1.22E-05	1.31E-05	1.43E-05	1.60E-05	1.75E-05	2.10E-05
1,2,4-Trichlorobenzene Class I	1.08E-05	4.39E-06	5.36E-06	6.67E-06	7.77E-06	8.83E-06	9.96E-06	1.12E-05	1.27E-05	1.46E-05	1.75E-05	2.01E-05	2.54E-05
1,2,4-Trichlorobenzene Class III	1.15E-05	4.66E-06	5.70E-06	7.09E-06	8.26E-06	9.40E-06	1.06E-05	1.20E-05	1.36E-05	1.56E-05	1.87E-05	2.15E-05	2.71E-05
1,2-Dichloroethane Class I	1.20E-06	1.87E-07	2.28E-07	3.38E-07	4.98E-07	6.89E-07	9.12E-07	1.18E-06	1.50E-06	1.94E-06	2.61E-06	3.21E-06	4.45E-06
1,2-Dichloroethane Class III	1.14E-05	7.27E-06	7.97E-06	8.92E-06	9.68E-06	1.04E-05	1.11E-05	1.18E-05	1.27E-05	1.38E-05	1.54E-05	1.68E-05	2.01E-05
1,2-Dichloropropane Class I	1.35E-06	3.19E-07	3.78E-07	5.00E-07	6.54E-07	8.41E-07	1.06E-06	1.33E-06	1.65E-06	2.09E-06	2.76E-06	3.37E-06	4.64E-06
1,2-Dichloropropane Class III	1.17E-05	7.38E-06	8.10E-06	9.07E-06	9.85E-06	1.06E-05	1.13E-05	1.20E-05	1.29E-05	1.40E-05	1.57E-05	1.72E-05	2.06E-05
1,2-Diphenylhydrazine Class I	2.70E-06	1.40E-06	1.57E-06	1.81E-06	2.03E-06	2.24E-06	2.47E-06	2.73E-06	3.04E-06	3.46E-06	4.14E-06	4.76E-06	6.15E-06
1,2-Diphenylhydrazine Class III	1.16E-05	7.27E-06	7.99E-06	8.96E-06	9.75E-06	1.05E-05	1.12E-05	1.20E-05	1.28E-05	1.40E-05	1.57E-05	1.72E-05	2.06E-05
1,3-Dichloropropene Class I	1.27E-06	2.55E-07	3.06E-07	4.21E-07	5.76E-07	7.64E-07	9.86E-07	1.25E-06	1.57E-06	2.01E-06	2.67E-06	3.28E-06	4.53E-06
1,3-Dichloropropene Class III	1.19E-05	7.52E-06	8.25E-06	9.23E-06	1.00E-05	1.07E-05	1.15E-05	1.22E-05	1.31E-05	1.43E-05	1.60E-05	1.75E-05	2.09E-05
2,4,6-Trichlorophenol Class I	6.27E-06	3.88E-06	4.27E-06	4.80E-06	5.24E-06	5.64E-06	6.04E-06	6.47E-06	6.97E-06	7.60E-06	8.55E-06	9.43E-06	1.14E-05
2,4,6-Trichlorophenol Class III	1.15E-05	7.25E-06	7.97E-06	8.94E-06	9.72E-06	1.04E-05	1.11E-05	1.19E-05	1.28E-05	1.39E-05	1.56E-05	1.72E-05	2.05E-05
2,4-Dinitrotoluene Class I	1.36E-06	3.14E-07	3.73E-07	4.95E-07	6.53E-07	8.43E-07	1.07E-06	1.34E-06	1.67E-06	2.12E-06	2.80E-06	3.42E-06	4.71E-06
2,4-Dinitrotoluene Class III	1.16E-05	7.31E-06	8.02E-06	8.98E-06	9.76E-06	1.05E-05	1.12E-05	1.19E-05	1.28E-05	1.39E-05	1.56E-05	1.71E-05	2.04E-05
3,3'-Dichlorobenzidine Class I	4.41E-06	2.62E-06	2.90E-06	3.29E-06	3.60E-06	3.90E-06	4.20E-06	4.53E-06	4.91E-06	5.40E-06	6.16E-06	6.88E-06	8.50E-06

Parameter	Mean	5 %tile	10 %tile	20 %tile	30 %tile	40 %tile	50 %tile	60 %tile	70 %tile	80 %tile	90 %tile	95 %tile	99 %tile
3,3'-Dichlorobenzidine Class III	1.15E-05	7.24E-06	7.96E-06	8.93E-06	9.71E-06	1.04E-05	1.11E-05	1.19E-05	1.28E-05	1.39E-05	1.56E-05	1.71E-05	2.05E-05
Acrylonitrile Class I	1.18E-06	1.31E-07	1.63E-07	2.78E-07	4.48E-07	6.45E-07	8.76E-07	1.15E-06	1.49E-06	1.94E-06	2.63E-06	3.25E-06	4.54E-06
Acrylonitrile Class III	1.13E-05	7.18E-06	7.88E-06	8.81E-06	9.56E-06	1.02E-05	1.09E-05	1.17E-05	1.25E-05	1.36E-05	1.52E-05	1.66E-05	1.98E-05
Aldrin Class I	1.14E-05	3.24E-06	4.41E-06	6.21E-06	7.67E-06	8.99E-06	1.03E-05	1.17E-05	1.35E-05	1.58E-05	1.97E-05	2.37E-05	3.19E-05
Aldrin Class III	1.14E-05	3.24E-06	4.41E-06	6.20E-06	7.67E-06	8.99E-06	1.03E-05	1.17E-05	1.34E-05	1.58E-05	1.97E-05	2.37E-05	3.19E-05
Benzene Class I	2.12E-06	4.46E-07	5.76E-07	7.95E-07	1.02E-06	1.27E-06	1.58E-06	1.97E-06	2.48E-06	3.19E-06	4.41E-06	5.59E-06	8.16E-06
Benzene Class III	2.09E-05	8.86E-06	1.04E-05	1.28E-05	1.51E-05	1.74E-05	1.97E-05	2.21E-05	2.49E-05	2.82E-05	3.30E-05	3.73E-05	4.63E-05
Benzidine Class I	1.19E-06	1.70E-07	2.09E-07	3.20E-07	4.83E-07	6.76E-07	9.02E-07	1.17E-06	1.50E-06	1.94E-06	2.62E-06	3.23E-06	4.49E-06
Benzidine Class III	1.19E-05	7.53E-06	8.26E-06	9.24E-06	1.00E-05	1.07E-05	1.15E-05	1.22E-05	1.31E-05	1.43E-05	1.59E-05	1.75E-05	2.09E-05
Benzo(a)anthracene Class I	1.01E-05	6.43E-06	7.05E-06	7.89E-06	8.56E-06	9.17E-06	9.79E-06	1.04E-05	1.12E-05	1.22E-05	1.36E-05	1.49E-05	1.78E-05
Benzo(a)anthracene Class III	1.17E-05	7.41E-06	8.13E-06	9.10E-06	9.87E-06	1.06E-05	1.13E-05	1.20E-05	1.29E-05	1.40E-05	1.57E-05	1.71E-05	2.05E-05
Benzo(a)pyrene Class I	1.04E-05	6.59E-06	7.22E-06	8.09E-06	8.78E-06	9.40E-06	1.00E-05	1.07E-05	1.15E-05	1.25E-05	1.39E-05	1.53E-05	1.82E-05
Benzo(a)pyrene Class III	1.17E-05	7.41E-06	8.13E-06	9.10E-06	9.87E-06	1.06E-05	1.13E-05	1.20E-05	1.29E-05	1.40E-05	1.57E-05	1.71E-05	2.05E-05
Benzo(b)fluoranthene Class I	1.01E-05	6.43E-06	7.05E-06	7.89E-06	8.56E-06	9.17E-06	9.79E-06	1.04E-05	1.12E-05	1.22E-05	1.36E-05	1.49E-05	1.78E-05
Benzo(b)fluoranthene Class III	1.17E-05	7.41E-06	8.13E-06	9.10E-06	9.87E-06	1.06E-05	1.13E-05	1.20E-05	1.29E-05	1.40E-05	1.57E-05	1.71E-05	2.05E-05
Benzo(k)fluoranthene Class I	1.01E-05	6.43E-06	7.05E-06	7.89E-06	8.56E-06	9.17E-06	9.79E-06	1.04E-05	1.12E-05	1.22E-05	1.36E-05	1.49E-05	1.78E-05
Benzo(k)fluoranthene Class III	1.17E-05	7.41E-06	8.13E-06	9.10E-06	9.87E-06	1.06E-05	1.13E-05	1.20E-05	1.29E-05	1.40E-05	1.57E-05	1.71E-05	2.05E-05
beta-Hexachlorocyclohexane (HCH) Class I	6.81E-06	4.23E-06	4.66E-06	5.24E-06	5.71E-06	6.14E-06	6.57E-06	7.04E-06	7.57E-06	8.25E-06	9.27E-06	1.02E-05	1.23E-05
beta-Hexachlorocyclohexane (HCH) Class III	1.17E-05	7.33E-06	8.06E-06	9.04E-06	9.83E-06	1.06E-05	1.13E-05	1.21E-05	1.30E-05	1.41E-05	1.58E-05	1.74E-05	2.08E-05
Bis(2-Chloroethyl) Ether Class I	1.18E-06	1.68E-07	2.06E-07	3.15E-07	4.76E-07	6.67E-07	8.89E-07	1.15E-06	1.48E-06	1.91E-06	2.58E-06	3.18E-06	4.42E-06
Bis(2-Chloroethyl) Ether Class III	1.16E-05	7.38E-06	8.10E-06	9.06E-06	9.84E-06	1.05E-05	1.12E-05	1.20E-05	1.29E-05	1.40E-05	1.56E-05	1.71E-05	2.04E-05
Bis(2-Ethylhexyl) Phthalate Class I	8.68E-06	5.50E-06	6.03E-06	6.75E-06	7.33E-06	7.86E-06	8.39E-06	8.95E-06	9.62E-06	1.04E-05	1.17E-05	1.28E-05	1.53E-05
Bis(2-Ethylhexyl) Phthalate Class III	1.17E-05	7.47E-06	8.19E-06	9.16E-06	9.94E-06	1.06E-05	1.14E-05	1.21E-05	1.30E-05	1.41E-05	1.58E-05	1.73E-05	2.06E-05
Bromoform Class I	1.60E-06	5.57E-07	6.44E-07	7.90E-07	9.42E-07	1.12E-06	1.32E-06	1.58E-06	1.89E-06	2.31E-06	2.95E-06	3.55E-06	4.80E-06
Bromoform Class III	1.18E-05	7.41E-06	8.14E-06	9.12E-06	9.91E-06	1.06E-05	1.14E-05	1.21E-05	1.30E-05	1.42E-05	1.59E-05	1.74E-05	2.08E-05
Butylbenzyl Phthalate Class I	1.15E-05	7.33E-06	8.04E-06	9.00E-06	9.77E-06	1.05E-05	1.12E-05	1.19E-05	1.28E-05	1.39E-05	1.55E-05	1.70E-05	2.03E-05
Butylbenzyl Phthalate Class III	1.15E-05	7.33E-06	8.04E-06	8.99E-06	9.76E-06	1.05E-05	1.12E-05	1.19E-05	1.28E-05	1.39E-05	1.55E-05	1.70E-05	2.02E-05
Carbon Tetrachloride Class I	1.97E-06	8.44E-07	9.61E-07	1.14E-06	1.31E-06	1.50E-06	1.71E-06	1.96E-06	2.27E-06	2.70E-06	3.36E-06	3.97E-06	5.28E-06

Parameter	Mean	5 %tile	10 %tile	20 %tile	30 %tile	40 %tile	50 %tile	60 %tile	70 %tile	80 %tile	90 %tile	95 %tile	99 %tile
Carbon Tetrachloride Class III	1.12E-05	7.05E-06	7.75E-06	8.69E-06	9.45E-06	1.01E-05	1.08E-05	1.16E-05	1.25E-05	1.35E-05	1.52E-05	1.66E-05	1.99E-05
Chlordane Class I	1.12E-05	4.33E-06	5.40E-06	7.00E-06	8.35E-06	9.54E-06	1.07E-05	1.19E-05	1.33E-05	1.50E-05	1.76E-05	2.00E-05	2.53E-05
Chlordane Class III	1.12E-05	4.33E-06	5.40E-06	7.00E-06	8.35E-06	9.53E-06	1.07E-05	1.19E-05	1.33E-05	1.50E-05	1.76E-05	2.00E-05	2.53E-05
Chlorodibromomethane Class I	1.46E-06	4.04E-07	4.73E-07	6.05E-07	7.59E-07	9.45E-07	1.17E-06	1.43E-06	1.76E-06	2.20E-06	2.88E-06	3.49E-06	4.78E-06
Chlorodibromomethane Class III	1.16E-05	7.36E-06	8.08E-06	9.04E-06	9.83E-06	1.05E-05	1.13E-05	1.20E-05	1.29E-05	1.40E-05	1.57E-05	1.72E-05	2.06E-05
Chrysene Class I	1.01E-05	6.43E-06	7.05E-06	7.89E-06	8.56E-06	9.17E-06	9.79E-06	1.04E-05	1.12E-05	1.22E-05	1.36E-05	1.49E-05	1.78E-05
Chrysene Class III	1.17E-05	7.41E-06	8.13E-06	9.10E-06	9.87E-06	1.06E-05	1.13E-05	1.20E-05	1.29E-05	1.40E-05	1.57E-05	1.71E-05	2.05E-05
Dibenzo(a,h)anthracene Class I	1.01E-05	6.43E-06	7.05E-06	7.89E-06	8.56E-06	9.17E-06	9.79E-06	1.04E-05	1.12E-05	1.22E-05	1.36E-05	1.49E-05	1.78E-05
Dibenzo(a,h)anthracene Class III	1.17E-05	7.41E-06	8.13E-06	9.10E-06	9.87E-06	1.06E-05	1.13E-05	1.20E-05	1.29E-05	1.40E-05	1.57E-05	1.71E-05	2.05E-05
Dichlorobromomethane Class I	1.40E-06	3.66E-07	4.31E-07	5.57E-07	7.10E-07	8.94E-07	1.11E-06	1.38E-06	1.70E-06	2.14E-06	2.81E-06	3.42E-06	4.68E-06
Dichlorobromomethane Class III	1.16E-05	7.36E-06	8.08E-06	9.05E-06	9.83E-06	1.05E-05	1.13E-05	1.20E-05	1.29E-05	1.40E-05	1.57E-05	1.72E-05	2.06E-05
Dieldrin Class I	1.14E-05	3.37E-06	4.54E-06	6.32E-06	7.78E-06	9.09E-06	1.04E-05	1.18E-05	1.34E-05	1.56E-05	1.93E-05	2.29E-05	3.05E-05
Dieldrin Class III	1.14E-05	3.37E-06	4.54E-06	6.32E-06	7.78E-06	9.09E-06	1.04E-05	1.18E-05	1.34E-05	1.56E-05	1.93E-05	2.29E-05	3.05E-05
Heptachlor Class I	1.15E-05	3.51E-06	4.68E-06	6.47E-06	7.96E-06	9.27E-06	1.06E-05	1.20E-05	1.36E-05	1.57E-05	1.92E-05	2.27E-05	3.01E-05
Heptachlor Class III	1.15E-05	3.51E-06	4.67E-06	6.47E-06	7.96E-06	9.27E-06	1.06E-05	1.20E-05	1.36E-05	1.57E-05	1.92E-05	2.27E-05	3.01E-05
Heptachlor Epoxide Class I	1.14E-05	4.74E-06	5.78E-06	7.35E-06	8.64E-06	9.80E-06	1.09E-05	1.21E-05	1.34E-05	1.51E-05	1.77E-05	2.00E-05	2.50E-05
Heptachlor Epoxide Class III	1.16E-05	4.77E-06	5.83E-06	7.42E-06	8.73E-06	9.89E-06	1.10E-05	1.22E-05	1.36E-05	1.53E-05	1.78E-05	2.02E-05	2.53E-05
Hexachlorobutadiene Class I	1.17E-05	2.51E-06	3.27E-06	4.70E-06	6.22E-06	7.97E-06	9.94E-06	1.22E-05	1.48E-05	1.80E-05	2.26E-05	2.66E-05	3.42E-05
Hexachlorobutadiene Class III	1.17E-05	2.50E-06	3.26E-06	4.69E-06	6.22E-06	7.96E-06	9.93E-06	1.22E-05	1.48E-05	1.80E-05	2.26E-05	2.65E-05	3.42E-05
Hexachloroethane Class I	1.02E-05	3.88E-06	4.64E-06	5.83E-06	6.92E-06	8.02E-06	9.20E-06	1.05E-05	1.21E-05	1.41E-05	1.71E-05	1.97E-05	2.50E-05
Hexachloroethane Class III	1.13E-05	4.25E-06	5.10E-06	6.42E-06	7.64E-06	8.89E-06	1.02E-05	1.17E-05	1.35E-05	1.57E-05	1.90E-05	2.20E-05	2.79E-05
Indeno(1,2,3-cd)pyrene Class I	1.01E-05	6.43E-06	7.05E-06	7.89E-06	8.56E-06	9.17E-06	9.79E-06	1.04E-05	1.12E-05	1.22E-05	1.36E-05	1.49E-05	1.78E-05
Indeno(1,2,3-cd)pyrene Class III	1.17E-05	7.41E-06	8.13E-06	9.10E-06	9.87E-06	1.06E-05	1.13E-05	1.20E-05	1.29E-05	1.40E-05	1.57E-05	1.71E-05	2.05E-05
Isophorone Class I	1.23E-06	2.16E-07	2.60E-07	3.72E-07	5.30E-07	7.19E-07	9.40E-07	1.20E-06	1.53E-06	1.96E-06	2.63E-06	3.23E-06	4.47E-06
Isophorone Class III	1.15E-05	7.33E-06	8.04E-06	8.99E-06	9.76E-06	1.05E-05	1.12E-05	1.19E-05	1.28E-05	1.39E-05	1.55E-05	1.70E-05	2.03E-05
Methylene Chloride Class I	1.17E-06	1.67E-07	2.04E-07	3.13E-07	4.72E-07	6.61E-07	8.82E-07	1.14E-06	1.47E-06	1.90E-06	2.56E-06	3.16E-06	4.39E-06
Methylene Chloride Class III	1.19E-05	7.53E-06	8.26E-06	9.24E-06	1.00E-05	1.07E-05	1.15E-05	1.22E-05	1.31E-05	1.43E-05	1.59E-05	1.75E-05	2.09E-05

Parameter	Mean	5 %tile	10 %tile	20 %tile	30 %tile	40 %tile	50 %tile	60 %tile	70 %tile	80 %tile	90 %tile	95 %tile	99 %tile
p,p'- Dichlorodiphenyltrichloroethane (DDT) Class I	1.07E-05	2.94E-06	3.70E-06	4.84E-06	5.83E-06	6.85E-06	8.05E-06	9.60E-06	1.19E-05	1.55E-05	2.18E-05	2.75E-05	3.87E-05
p,p'- Dichlorodiphenyltrichloroethane (DDT) Class III	1.07E-05	2.94E-06	3.69E-06	4.84E-06	5.83E-06	6.85E-06	8.05E-06	9.60E-06	1.19E-05	1.55E-05	2.18E-05	2.75E-05	3.86E-05
PCBs Class I	1.16E-05	7.40E-06	8.11E-06	9.08E-06	9.85E-06	1.05E-05	1.13E-05	1.20E-05	1.29E-05	1.40E-05	1.56E-05	1.71E-05	2.04E-05
PCBs Class III	1.16E-05	7.39E-06	8.11E-06	9.07E-06	9.85E-06	1.05E-05	1.13E-05	1.20E-05	1.29E-05	1.40E-05	1.56E-05	1.71E-05	2.04E-05
Pentachlorophenol Class I	7.53E-06	3.08E-06	3.72E-06	4.67E-06	5.44E-06	6.18E-06	6.91E-06	7.73E-06	8.70E-06	9.98E-06	1.21E-05	1.42E-05	1.86E-05
Pentachlorophenol Class III	1.18E-05	4.61E-06	5.62E-06	7.15E-06	8.41E-06	9.58E-06	1.08E-05	1.21E-05	1.36E-05	1.57E-05	1.91E-05	2.24E-05	2.97E-05
Tetrachloroethylene (Perchloroethylene) Class I	4.68E-06	2.81E-06	3.11E-06	3.52E-06	3.85E-06	4.16E-06	4.48E-06	4.82E-06	5.22E-06	5.73E-06	6.52E-06	7.26E-06	8.92E-06
Tetrachloroethylene (Perchloroethylene) Class III	1.16E-05	7.26E-06	7.98E-06	8.94E-06	9.72E-06	1.04E-05	1.12E-05	1.19E-05	1.28E-05	1.39E-05	1.56E-05	1.71E-05	2.05E-05
Toxaphene Class I	1.19E-06	6.44E-07	7.33E-07	8.59E-07	9.60E-07	1.05E-06	1.15E-06	1.24E-06	1.35E-06	1.49E-06	1.71E-06	1.90E-06	2.31E-06
Toxaphene Class III	1.19E-06	6.41E-07	7.30E-07	8.56E-07	9.58E-07	1.05E-06	1.14E-06	1.24E-06	1.35E-06	1.49E-06	1.71E-06	1.90E-06	2.30E-06
Trichloroethylene (TCE) Class I	1.87E-06	7.79E-07	8.89E-07	1.06E-06	1.22E-06	1.40E-06	1.61E-06	1.85E-06	2.16E-06	2.57E-06	3.21E-06	3.80E-06	5.07E-06
Trichloroethylene (TCE) Class III	1.13E-05	7.11E-06	7.81E-06	8.75E-06	9.51E-06	1.02E-05	1.09E-05	1.17E-05	1.25E-05	1.36E-05	1.53E-05	1.67E-05	2.01E-05
Vinyl Chloride Class I	1.17E-06	1.69E-07	2.06E-07	3.15E-07	4.75E-07	6.64E-07	8.85E-07	1.15E-06	1.47E-06	1.90E-06	2.56E-06	3.16E-06	4.39E-06
Vinyl Chloride Class III	1.18E-05	7.46E-06	8.18E-06	9.15E-06	9.94E-06	1.07E-05	1.14E-05	1.21E-05	1.30E-05	1.42E-05	1.58E-05	1.73E-05	2.07E-05