Health Consultation

Bayou Meto Watershed Fish Flesh Monitoring Report

VERTAC CHEMICAL CORPORATION SUPERFUND SITE
(a/k/a HERCULES INCORPORATED)
1600 MARSHALL ROAD
JACKSONVILLE, PULASKI COUNTY, ARKANSAS 72076

EPA FACILITY ID: ARD000023440
SITE ID: 0600023

OCTOBER 21, 2015

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Prepared By:

Arkansas Department of Health
Under a Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry
Atlanta, Georgia 30333

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SUMMARY

INTRODUCTION

Over the past thirty years, the Vertac Incorporated Superfund Site, a.k.a. Hercules Incorporated, has been a U.S. Environmental Protection Agency (EPA) Superfund site and as undergone remediation. Dioxins were one of the primary contaminants of concern (COC) that migrated off-site. Dioxins were identified in the Bayou Meto Watershed in close proximity to the site and have the potential to bioaccumulate in fish found in this water source. This health consultation serves to evaluate the most recent round of fish tissue data for human consumption as requested by EPA and ensure the accuracy of the fish advisory within the Bayou Meto Watershed surrounding the Vertac site.

CONCLUSION

There is a health concern for special populations (subsistence fishers), but not the general public. The Arkansas Department of Health (ADH)/Agency for Toxic Substances and Disease Registry (ATSDR) concludes current and past dioxin exposures from consumption of certain fish from the Bayou Meto Watershed are and were considered a potential *public health hazard* due to indications that dioxin contamination continues to persist in several fish species in this area, and since current estimates of dioxin exposure suggest elevated potential non-cancer and/or cancer risk levels for children and adults consuming a subsistence fish diet.

The need for continued enforcement of the existing fish consumption advisory in the Bayou Meto Watershed is supported by risk assessment results from the most recent round of fish sampling. Fish species evaluated in this review included buffalo, largemouth bass, white crappie, spotted bass, and bluegill. Results from risk calculations show that for the general population (children and adults), the daily exposure dose, HQ (non-cancer estimate), and LCR (cancer estimate) do not exceed public health risk levels for the fish species tested.

BASIS FOR DECISION

Based on results for the subsistence fisher population (children and adults), risk calculations of daily exposure dose, Hazard Quotient (HQ), and Lifetime Cancer Risks (LCR) ***do exceed*** public health risk levels for buffalo, largemouth bass, spotted bass, and bluegill. Also, the calculated HQ value was exceeded for the subsistence fisher - child scenario for the white crappie species.

The exposure dose calculations were examined for children and adults eating in the general population category (nationwide average) and children and adults eating in the subsistence fisher category (95th

	percentile nationwide). The estimated daily exposure dose for a child or adult in the general population (two or less fish meals eaten per month) is below the ATSDR Minimal Risk Level (MRL). However, the estimated daily exposure dose for a subsistence fisher (child or adult) is above the MRL when using maximum concentrations found in the buffalo, largemouth bass, spotted bass, and bluegill fish. Further theoretical calculations to determine acute and chronic potential risks were evaluated. The HQ was above one for the subsistence fisher (child or adult). The target HQ goal is less than one. The estimated LCR for the subsistence fisher (child or adult) was above the target LCR goal of 1.0E-06 and 1.0E-04.
NEXT STEPS	At this time, ADH recommends the current dioxin advisory for fish caught from the Bayou Meto Watershed remain in place pending future fish flesh data evaluation.
FOR MORE INFORMATION	If you have concerns about your health, you should contact your health care provider. You can also call ADH at 501-661-2936 and ask for information on the "Bayou Meto Watershed Fish Flesh Monitoring Report" near the Vertac Chemical Corporation Superfund Site (a.k.a. Hercules Incorporated) site.

Statement of Issues

Over the past thirty years, the Vertac Incorporated Superfund Site, a.k.a. Hercules Incorporated, has been a U.S. Environmental Protection Agency (EPA) Superfund site and has undergone remediation. This site is still in review status by the EPA. EPA issued a Record of Decision (ROD) to address the off-site areas related to the Vertac Superfund site in September 1990 [note: three other RODs were issued to address on-site soils and groundwater contamination] [1]. One requirement of this off-site ROD is to regularly test fish samples in the Bayou Meto Watershed near the Superfund site to monitor dioxin levels in fish tissue due to bioaccumulation. Bioaccumulation is the uptake of organic compounds by biota from either water or food. According to research, many toxic organic chemicals can reach concentrations in biota several orders of magnitude greater than their aqueous concentrations, and therefore, bioaccumulation poses a serious threat to both the biota of surface waters and the humans that feed on these surface-water species [2].

Dioxins were one of the primary contaminants of concern (COC) at the Vertac Superfund site that traveled off-site. When this ROD was issued, the Arkansas Department of Health (ADH) established a site-specific advisory level for dioxin in fish [3, 4]. Under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), ADH has prepared this health consultation to evaluate the most recent round (collected in 2011 and will be summarized in the fourth Five-Year Review by EPA) of fish tissue data for public health purposes and ensure the health-protectiveness of the fish advisory within the Bayou Meto Watershed surrounding the Vertac site.

Background and History

The federal government built the first industrial facilities at the former site during the 1940's as part of the expansive Arkansas Ordinance Plant munitions complex. Over the next forty years, chemical manufacturing facilities also produced insecticides and herbicides on site. Various companies operated on-site as an herbicide manufacturer between 1948 and 1987. Reasor-Hill Company began production, followed by Hercules Powder Company, Transvall, Inc., and eventually Vertac Chemical Corporation in 1978. Decades of improper waste disposal and production control practices from these manufacturers led to soil, surface water, and groundwater contamination at the site. Primary contaminants at the Vertac site consisted of insecticides, herbicides, chlorinated phenols, and dioxins [5].

The Vertac site is approximately 193 acres in size, and is located on Marshall Road in Jacksonville, Pulaski County, Arkansas (Appendix A). Jacksonville is about 15 miles northwest of Little Rock, the state's capital. Approximately 1,000 of Jacksonville's 30,000 residents live within one mile of the Superfund site, with residential areas bordering the entire east and south

sides. The west and northern sides of the site are bounded by an industrial area and the Little Rock Air Force Base, respectively.

The Vertac site is divided into two parcels of land (Parcel 1 and Parcel 2) that were acquired at different times when the plant was operating. Parcel 1 (the southern acreage), which contained the central process area, is approximately 93 acres and was in nearly continuous use since 1948 (prior to remedial action activities). Parcel 2, which is approximately 100 acres to the north, was purchased by Vertac Chemical Corporation in 1978, but was never used in the herbicides formulations operation [6]. EPA listed the site on the National Priorities List (NPL) in 1983 [1]. For further historical background of the Superfund listing and information, see Appendix B.

Historical fish tissue samples related to this site have been recorded since 1979. Since 1994, fish sampling has been conducted in the Bayou Meto Watershed near the Vertac site to determine dioxin concentrations. The most recently collected round of fish samples occurred in 2011 [4].

Discussion

As part of the provision laid out in the off-site ROD, fish tissue (which has the possibility of becoming contaminated with dioxins) must be collected and sampled while a fish advisory remains in place near this site along the Bayou Meto Watershed. Since fish living in contaminated water bodies can accumulate significant amounts of dioxins, a complete exposure pathway exists for individuals that eat any potentially contaminated fish caught from the Bayou Meto Watershed until such time that data prove there is no longer a future exposure to past contaminants from the Vertac site.

Dioxins

Chlorinated dibenzo-*p*-dioxins (CDDs) are a family of 75 different compounds with similar properties. The CDD family is divided into eight groups of chemicals based on the number of chlorine atoms in the compound. The collective group is often referred to as polychlorinated dioxins. The primary sources of dioxin releases to the environment are the combustion of fossil fuels and wood; the incineration of municipal, medical, and hazardous waste; and certain pulp and paper processes [7].

Dioxins are found everywhere in the environment; they degrade slowly and can persist and accumulate in soils, sediments, and organisms for a long time. Dioxins are found at very low levels in the environment and are often measured in soil, sediment, or biota in the parts per trillion (ppt). Most people are exposed to very small background levels of dioxins when they breathe air, consume food or milk, have skin contact with materials contaminated with dioxins, or have contact with cigarette smoke. The actual intake of dioxins from food for any one person will depend on the amount and type of food consumed and the level of contamination. For the

general population, more than 90% of the daily intake of dioxins and other dioxin-like compounds comes primarily from meat, dairy products, and fish [7].

When a site is contaminated with dioxins, the effects of all dioxin-like compounds are assumed to be additive due to a similar mode of action. A mathematical method called Toxicity Equivalence (TEQ) is used to assess the risk of exposure to this mixture of dioxin-like compounds. A Toxicity Equivalence Factor (TEF) for each dioxin has been developed to compare its individual relative toxicity to that of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD). To assist with the standardized evaluation of potential toxicity, TEFs have been assigned to dioxin compounds by the World Health Organization (WHO) in 2005 and the EPA in 2010 (see Appendix C) [8, 9]. The TEF for 2,3,7,8-TCDD is defined as one, whereas TEF values for other TCDD-like compounds of equal or lesser toxicity are assigned values ranging between 1.0 and 0.00003 [8, 9]. TEFs are unitless. Based on these assigned relative weights, a summary value for a sample representing all dioxins combined is derived and expressed as the TEQ to 2,3,7,8-TCDD.

The most toxic chemical in the dioxin group is 2,3,7,8-TCDD. The EPA Integrated Risk Information System (IRIS) carcinogenic classification of 2,3,7,8- TCDD is currently under review [10]. The U.S. Department Health and Human Services (DHHS) has determined that it is reasonable to expect that 2,3,7,8-TCDD may cause cancer, and the International Agency for Research on Cancer (IARC) has determined it is carcinogenic to humans. 2,3,7,8-TCDD is not intentionally produced by industry. It can be inadvertently produced in very small amounts as an impurity during the incineration of municipal and industrial wastes and during the manufacture of certain chemicals. 2,3,7,8-TCDD serves as a prototype for the CDDs. CDDs with toxic properties similar to 2,3,7,8-TCDD are called “dioxin-like” compounds [7].

intermediate- (15 – 364 days), and chronic- (365 days or more) duration oral exposure to 2,3,7,8-

Fish Samples

The 2011 Bayou Meto Watershed fish flesh report includes a total of 15 composite fish samples. Seven different areas, or reaches, from the Bayou Meto Watershed were designated as collection points. Two categories of composite fish, "bottom feeders" and "target predators", were collected from each reach location (for example, five smallmouth Buffalo fish comprise one composite sample). The reaches (from order of downstream to upstream), along with the type and number of fish per composite in each category, are listed in Table 1. Seven reach areas with two composite samples from each reach totaled 14 fish samples. For quality control purposes, one additional duplicate fish sample was collected from reach BM-6, Bayou Meto at Arkansas Highway 15 (the higher of the two samples from reach BM-6 is reported in this health consultation) [4].

Table 1. Summary of Composite Sample Fish Collection for 2011 Bayou Meto Watershed Fish Flesh Report

Reach Location (ID)	Number & Type of Bottom Feeder	Number & Type of Target Predator
Bayou Meto at Hwy. 13 (Reach BM-8)	5 Smallmouth Buffalo	5 Largemouth Bass
Bayou Meto at Arkansas Hwy. 15 (Reach BM-6)*	5 Bigmouth Buffalo	5 Largemouth Bass
Bayou Meto at I-40** (Reach BM-5.5)	5 Smallmouth Buffalo	8 White Crappie
Bayou Meto at Arkansas Hwy. 161 (Reach BM-5)	5 Bigmouth Buffalo	5 Spotted Bass
Bayou Meto at US Hwy. 67/167 (Reach BM-3)	5 Bigmouth Buffalo	5 Largemouth Bass
Rocky Branch Creek (RBC) from confluence with Bayou Meto upstream to US Hwy. 67/167 (RBC)	None	7 Largemouth Bass; 28 Bluegill***
Lake Dupree (LD)	5 Bigmouth Buffalo	5 Largemouth Bass

*Reach BM-6 also had one additional duplicate composite sample collected at this location for quality control purposes.
** This reach was referred to as Pulaski Country Road 67/724 in the original Standard Operating Procedures (SOP).
***This group of 7 largemouth bass and 28 bluegill at Reach RBC was separated into two composite samples.

According to the report, the fish samples were collected and processed in accordance with the Standard Operating Procedures (SOP) dated July 18, 1996. During the 2011 sampling event, all of the fish were collected using electroshocking equipment. The collections from Bayou Meto and Lake Dupree were collected using a Smith-Root Model GPP pulsator combined with a 5000 watt generator fitted with hand held electrodes. Collection efforts in Rocky Branch Creek (RBC) utilized a Smith-Root Model 15-D back pack electroshocker. All fish collections were completed during the concentrated field effort from July 19 through July 27, 2011 [4].

Once collected, fish were segregated by species, placed in species-specific designated plastic bags in decontaminated ice chests with bagged crushed ice. Target species were not mixed at any point during the collection process. Fish were filleted to produce two skinless filets (left and right) according to the methods prescribed in the SOP. Each fillet was individually wrapped in decontaminated aluminum foil and over wrapped in brown paper. The samples were shipped to VISTA Analytical Laboratories in El Dorado Hills, California. Upon receipt at the analytical facility, samples were logged and ascribed a case number. Samples were prepared (i.e., composited) at the analytical facility for analyses using EPA method 1613 [4].

When ADH became involved with the fish tissue data evaluation related to this site, a dioxin advisory level of 25 ppt TEQ fish flesh (any species) was established [2, 3]. All samples reviewed for this evaluation were found to contain less than the 25 ppt 2,3,7,8-TCDD target advisory level. 2,3,7,8-TCDD concentrations ranged from 0.39 – 21.6 ppt. The highest concentration (21.6 ppt) was found in the RBC largemouth bass fish composite.

The RBC composite and Bayou Meto at I-40 (BM-5.5) composite samples displayed the highest TEQ concentrations with 21.8 ppt (largemouth bass) and 23.0 ppt (smallmouth buffalo), respectively. All other samples, including both predator and bottom feeders, were less than 11.5 ppt TEQ and less than 11.0 ppt for 2,3,7,8-TCDD. Total dioxin concentrations among all reaches ranged from 0.49 – 23.0 ppt, the highest being displayed from the Bayou Meto at I-40 reach smallmouth buffalo fish composite. All other reaches recorded total dioxin less than 11.5 ppt. Total TEQ values were similar to 2,3,7,8-TCDD, indicating minimal variability in TEQ calculations compared to the 2,3,7,8-TCDD concentrations alone [4]. See Table 2 for results.

Since there is a “no consumption” advisory set for all buffalo fish (which is issued by ADH) all fish species in this data set were evaluated to determine if possible human ingestion exposure exists from eating the dioxin-contaminated fish from this area. The following fish samples (with the corresponding maximum TEQ value) were used to calculate exposure dose values in order to determine potential health risks to children and adults for each species:

- Smallmouth Buffalo (23.04 ppt TEQ from the Bayou Meto at I-40)
- Largemouth Bass (21.8 ppt TEQ from Rocky Branch Creek)

- White Crappie (3.5 ppt TEQ from Bayou Meto at I-40)
- Spotted Bass (8.5 ppt TEQ from Bayou Meto at AR Hwy. 161)
- Bluegill (9.1 ppt TEQ from Rocky Branch Creek)

Table 2. Summary of Maximum Dioxin Concentrations for 2011 Bayou Meto Watershed Fish Flesh Report

Reach Location	Species of Fish	Sample ID	2,3,7,8-TCDD (ppt)	TEQ (ppt)
Bayou Meto at Hwy. 13 (Reach BM-8)	Smallmouth Buffalo	BM-8-SMBF-1-5-L	0.39	0.50
	Largemouth Bass	BM-8-LMB-1-5-L	0.56	0.66
Bayou Meto at Arkansas Hwy. 15 (Reach BM-6)	Bigmouth Buffalo	BM-6-BMBF-1-5-L	5.69	6.40
	Largemouth Bass	BM-6-LMB-1-5-L	2.53	2.75
Bayou Meto at I-40 (Reach BM-5.5)	Smallmouth Buffalo	BM-5.5-SMBF-1-5-L	21.30	23.04
	White Crappie	BM-5.5-WC-1-8-L	3.26	3.48
Bayou Meto at Arkansas Hwy. 161 (Reach BM-5)	Bigmouth Buffalo	BM-5-BMBF-1-5-L	10.50	11.41
	Spotted Bass	BM-5-SPB-1-5-L	8.19	8.50
Bayou Meto at US Hwy. 67/167 (Reach BM-3)	Bigmouth Buffalo	BM-3-BMBF-1-5-L	7.16	7.76
	Largemouth Bass	BM-3-LMB-1-5-L	2.47	2.72
Rocky Branch Creek (RBC) from confluence with Bayou Meto upstream to US Hwy. 67/167 (RBC)	Largemouth Bass	RBC-LMB-1-7-L	21.6	21.83
	Bluegill	RBC-BLG-1-28-L	8.96	9.11
Lake Dupree (LD)	Bigmouth Buffalo	LD-BMBF-1-5-L	4.78	5.03
	Largemouth Bass	LD-LMB-1-5-L	8.90	9.18

2,3,7,8-TCDD = 2,3,7,8-tetrachlorodibenzo-*p*-dioxin; TEQ = Toxicity Equivalence; ppt = parts per trillion
*For comparison to Toxicity Equivalency Factors, see table in Appendix C [8, 9].

The exposure dose calculations were examined for children and adults eating in the general population category (nationwide average) and children and adults eating in the subsistence fisher category (95th percentile nationwide). To find the daily exposure dose for each of these groups, the amount of fish consumed and individual body weight was used. For a child fish meal consumption value, the general population category considered approximately two 2.25-ounce fish meals per month, and the subsistence fisher category considered approximately 22 2.25-ounce fish meals per month. For an adult fish meal consumption value, the general population category considered approximately two 8-ounce fish meals per month, and the subsistence fisher category considered approximately 22 8-ounce fish meals per month. A body weight of 13.8 kilograms (kg) or 80 kg was attributed to the child and adult exposure dose calculations, respectively [11].

The daily exposure dose for all child and adult fish consumption scenarios is listed in Table 3. Total dioxin TEQs do not have assigned health comparison values; the values for 2,3,7,8-TCDD were used as the surrogate values for comparison purposes. As listed in the toxicological profile, the ATSDR chronic MRL for 2,3,7,8-TCDD is 1.0E-09 mg/kg/day [7]. In addition, as listed in the EPA IRIS database the RfD for 2,3,7,8-TCDD is 7.0E-10 (mg/kg-day). The estimated exposure dose for the general population consumption rate is below the MRL and RfD, while the estimated exposure dose for a child or adult on a subsistence fish diet is slightly above the MRL.

The Hazard Quotient (HQ) was calculated for each potentially exposed child or adult (equations shown in Appendix D). An HQ is the average daily intake divided by a chemical specific guidance value, such as the ATSDR MRL or EPA RfD to further evaluate the potential for non-cancer health effects. If the HQ for a chemical is equal to or less than one, it is believed that there is no appreciable risk that non-cancer health effects will occur. If the HQ exceeds one, there is some possibility that non-cancer effects may occur, although an HQ above one does not indicate an effect will definitely occur. This is because of the margin of safety inherent in the derivation of all RfD values. The larger the HQ value, the more likely it is that an adverse effect may possibly occur. For this evaluation, the HQs were calculated using the EPA RfD, as it has been recently updated and represents the best available science for dioxin [11]. Refer to Table 3 for HQ values.

Because 2,3,7,8-TCDD is reasonably anticipated to be carcinogen, a cancer risk was calculated using the exposure dose from the maximum concentration for TEQ for each fish species. These values are based on a daily exposure dose of 33 years over a 70-year lifespan. The 33-year exposure dose was based on 12 years as a child plus 21 years as an adult reasonably anticipated to be spent in the community. See Appendix D for all individual variables and equations. Table 3 represents a summary of the estimated risk-based calculated values derived using the maximum TEQ concentration of each fish species for this health consultation.

Table 3. Summary of Estimated Risk-based Values Based on the 2011 Bayou Meto Watershed Fish Flesh Report

Fish Species	Community Member	Daily Exposure Dose; mg/kg/day	Hazard Quotient (HQ)*; unitless	Lifetime Cancer Risk (LCR)** ; unitless
Buffalo	General Population: Child	5.98E-11	0.09	3.66E-06
Buffalo	General Population: Adult	4.88E-11	0.07	2.99E-06
Buffalo	Subsistence Fisher: Child	**6.10E-09**	**8.71**	**3.74E-04**
Buffalo	Subsistence Fisher: Adult	**3.72E-09**	**5.31**	**2.28E-04**
Largemouth Bass	General Population: Child	5.66E-11	0.08	3.47E-06
Largemouth Bass	General Population: Adult	4.62E-11	0.07	2.83E-06
Largemouth Bass	Subsistence Fisher: Child	**5.77E-09**	**8.24**	**3.54E-4**
Largemouth Bass	Subsistence Fisher: Adult	**3.52E-09**	**5.03**	**2.16E-04**
White Crappie	General Population: Child	9.09E-12	0.01	5.57E-07
White Crappie	General Population: Adult	7.41E-12	0.01	4.54E-07
White Crappie	Subsistence Fisher: Child	9.27E-10	**1.41**	5.68E-05
White Crappie	Subsistence Fisher: Adult	5.64E-10	0.81	3.46E-05
Spotted Bass	General Population: Child	2.21E-11	0.03	1.35E-06
Spotted Bass	General Population: Adult	1.80E-11	0.03	1.11E-06
Spotted Bass	Subsistence Fisher: Child	**2.25E-09**	**3.21**	**1.38E-04**
Spotted Bass	Subsistence Fisher: Adult	**1.37E-09**	**1.86**	8.40E-05
Bluegill	General Population: Child	2.36E-11	0.03	1.45E-06
Bluegill	General Population: Adult	1.930E-11	0.03	1.18E-06
Bluegill	Subsistence Fisher: Child	**2.41E-09**	**3.44**	**1.48E-04**
Bluegill	Subsistence Fisher: Adult	**1.47E-09**	**2.10**	9.01E-05

mg/kg/day = milligrams per kilogram per day

*Reference dose for 2,3,7,8-tetrachlorodibenzo-p-dioxin is 7E-10 mg/kg/day. Based on Environmental Protection Agency Regional Screening Level Table; January 2015.

** Oral Cancer Slope Factor for 2,3,7,8-tetrachlorodibenzo-p-dioxin is 1.3E5 $(mg/kg/day)^{-1}$. Based on Environmental Protection Agency Regional Screening Level Table; January 2015.

Public Health Implications

A number of effects have been observed in people exposed to 2,3,7,8-TCDD levels which are at least 10 times higher than normal background levels. The most noted health effect in people exposed to large amounts of 2,3,7,8-TCDD is chloracne. Chloracne is a severe skin disease with acne-like lesions that occur mainly on the face and upper body. Other skin effects noted in people exposed to high doses of 2,3,7,8-TCDD include skin rashes, discoloration, and excessive body hair. Changes in blood and urine that may indicate liver damage also are seen in people. Exposure to high concentrations of dioxins may induce long-term alterations in glucose metabolism and subtle changes in hormonal levels [7].

One way to see if a chemical will hurt people is to learn how the chemical is absorbed, used, and released by the body. For some chemicals, animal testing may be necessary. Animal testing may also be used to identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method to get information needed to make wise decisions to protect public health. The results of the oral animal studies of 2,3,7,8-TCDD suggest that the most sensitive effects (effects that will occur at the lowest doses) are immune, endocrine, and developmental effects. The EPA RfD is derived from the No-Observed-Adverse-Effect Level (NOAEL) from animal and human studies with applied uncertainty factors. Based on the ATSDR Toxicological Profile for dioxins, the acute MRL for 2,3,7,8-TCDD is based on immunological endpoints, the intermediate MRL is based on lymphatic endpoints, and the chronic MRL is based on developmental endpoints, all from specific animal studies. It is reasonable to assume that these will also be the most sensitive effects in humans [7].

Community Health Concerns

Because of past remediation events at the nearby Vertac Superfund site, there was a high interest from the community. The EPA set up a Community Relations Office in Jacksonville in 1990. ADH, along with federal and state partners, worked in the community to establish a health registry for community members to voluntarily sign-up in order to track their medical history as it pertained to environmental exposures. An active campaign to notify local residents and receive input prior to the site excavation and transportation was conducted. Landowners adjacent to the site were visited, and transportation was coordinated with local authorities. A community open house meeting was held on August 22, 1994, to discuss the remedial action and receive citizen input. A site close-out open house and ribbon-cutting ceremony were held on September 25, 1995 [13]. Since remedial activity completion in 1998, ADH has received few community concerns regarding this site. ADH continues to work with EPA and the Arkansas Department of Environmental Quality (ADEQ) regarding public health education activities in the community, as needed or requested.

The Bayou Meto community may be exposed to dioxins by eating certain types of fish caught in certain locations of the Bayou Meto watershed. Currently, the state has an advisory issued for Bayou Meto (upstream from Highway 13). The advisory states not to eat buffalo fish (any size) due to dioxin contamination. Fish advisories are often stricter for pregnant women, nursing mothers, and young children. To reduce a child's exposure to dioxins, obey all fish advisories within the state guidelines.

Another current Arkansas Game and Fish Commission (AGFC) fishing guideline for this site (unrelated to the dioxin contamination) states that from Highway 11 to the Arkansas River largemouth bass shorter than 14 inches must be immediately released. This advisory for Bayou Meto can be found in AGFC guidelines [14].

Child Health Considerations

In communities with environmental contamination, children can be at greater risk than adults for exposure to hazardous substances. Children drink more fluids, eat more food, breathe more air per unit of bodyweight, and have a larger skin surface area in proportion to their bodyweight. In addition to physical and behavioral differences, children's metabolic pathways, especially in the first few months after birth, are less developed than those of adults. In some instances, children are less susceptible to environmental toxicants, but in others, they are more vulnerable. Children are rapidly growing and developing during the first months and years of life. Some organ systems, especially the nervous and respiratory systems, may experience permanent damage if exposed to high concentrations of certain contaminants during this period. In addition, children are less able to avoid hazards because of their lack of knowledge of potential dangers and their dependence on adults for protection.

Very few human studies have looked at the effects of dioxins on children. Chloracne has been seen in children exposed to high levels of dioxins. It is unknown if dioxins affect the ability of people to have children or if it causes birth defects, but given the effects observed in animal studies, this cannot be ruled out [7].

Experimental studies in animals have demonstrated that exposure to dioxins can cause neurodevelopmental, neurobehavioral, and immunological effects in new born and young animals. In humans, some studies, but not all, have reported similar effects in neonates and infants, although overall, the evidence for these effects in humans is inconclusive [15].

It is prudent public health policy to minimize dioxin exposures in children. During this health consultation evaluation, the individual child ingestion exposure from fish caught in the Bayou Meto Watershed was examined due to the factors listed above. Potential health risks for children were evaluated based on the calculated HQ and LCR values.

Neonates and infants are not likely to eat large (if any) quantities of fish. The most significant source of dioxin exposure in neonates and young children is likely from breast feeding. Breast feeding provides many nutritional, immunological, social, and other benefits that make it the preferred source of nutrition for infants. Although dioxins can be transferred from breast milk to an infant, the American Academy of Pediatrics recommends that women do not stop breast feeding on the basis of exposure to low-level environmental chemical agents [16].

Conclusions

There is a health concern for special populations (subsistence fishers), but not the general public. ADH concludes current and past dioxin exposures from consumption of certain fish from the Bayou Meto Watershed are and were considered a potential *public health hazard* due to indications that dioxin contamination continues to persist in several fish species in this area, and since current estimates of dioxin exposure suggest elevated potential non-cancer and/or cancer risk levels for children and adults consuming a subsistence fish diet.

Results from risk calculations show that for the general population (children and adults), the daily exposure dose, HQ (non-cancer estimate), and LCR (cancer estimate) do not exceed public health risk levels for the fish species tested.

The need for continued enforcement of the existing fish consumption advisory in the Bayou Meto Watershed is supported by risk assessment results from the most recent round of fish sampling. Fish species evaluated in this review included buffalo, largemouth bass, white crappie, spotted bass, and bluegill.

Recommendations

Currently, the state has an advisory in place for fish caught in the Bayou Meto Watershed. ADH has issued a dioxin fish consumption concentration level advisory on Bayou Meto Watershed fish since the 1990s based on significant exposure dose estimates. Fish consumption advisories are necessary to minimize dioxin exposures and associated potential risks for people who eat fish caught from the Bayou Meto Watershed. At this time, ADH recommends the current dioxin advisory for fish caught from the Bayou Meto Watershed remain in place pending future fish flesh data evaluation. Also, ADH recommends that the AGFC change the language in its fishing guidelines to include a ‘do not eat’ advisory for **all** fish species (any size) caught from the Bayou Meto Watershed (upstream from Highway 13), rather than for buffalo fish only [14].

Public Health Action Plan

The purpose of the Public Health Action Plan (PHAP) is to ensure that this health consultation not only identifies any public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. The PHAP implemented by ADH with regards to the Bayou Meto Watershed fish study near the Vertac Superfund site is as follows:

Completed Actions

- Corresponded with EPA and ADEQ regarding information and data relevant to the Bayou Meto Watershed fish study near the Vertac Superfund site.
- Evaluated potential exposure pathways within the surrounding community.
- Conducted a site visit to the former Vertac Superfund site and surrounding areas.

Future Activities

- Continue to issue the dioxin consumption advisory in the Bayou Meto Watershed.
- Continue to analyze future data, as available.
- Continue to educate the public and address community requests or concerns in regards to this site, as needed.

Report Preparation

This Health Consultation for the Bayou Meto Watershed Fish Flesh Monitoring Report near the Vertac Chemical Corporation Superfund Site, a.k.a. Hercules Incorporated Site, was prepared by the Arkansas Department of Health (ADH) under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved agency methods, policies, procedures existing at the date of publication.

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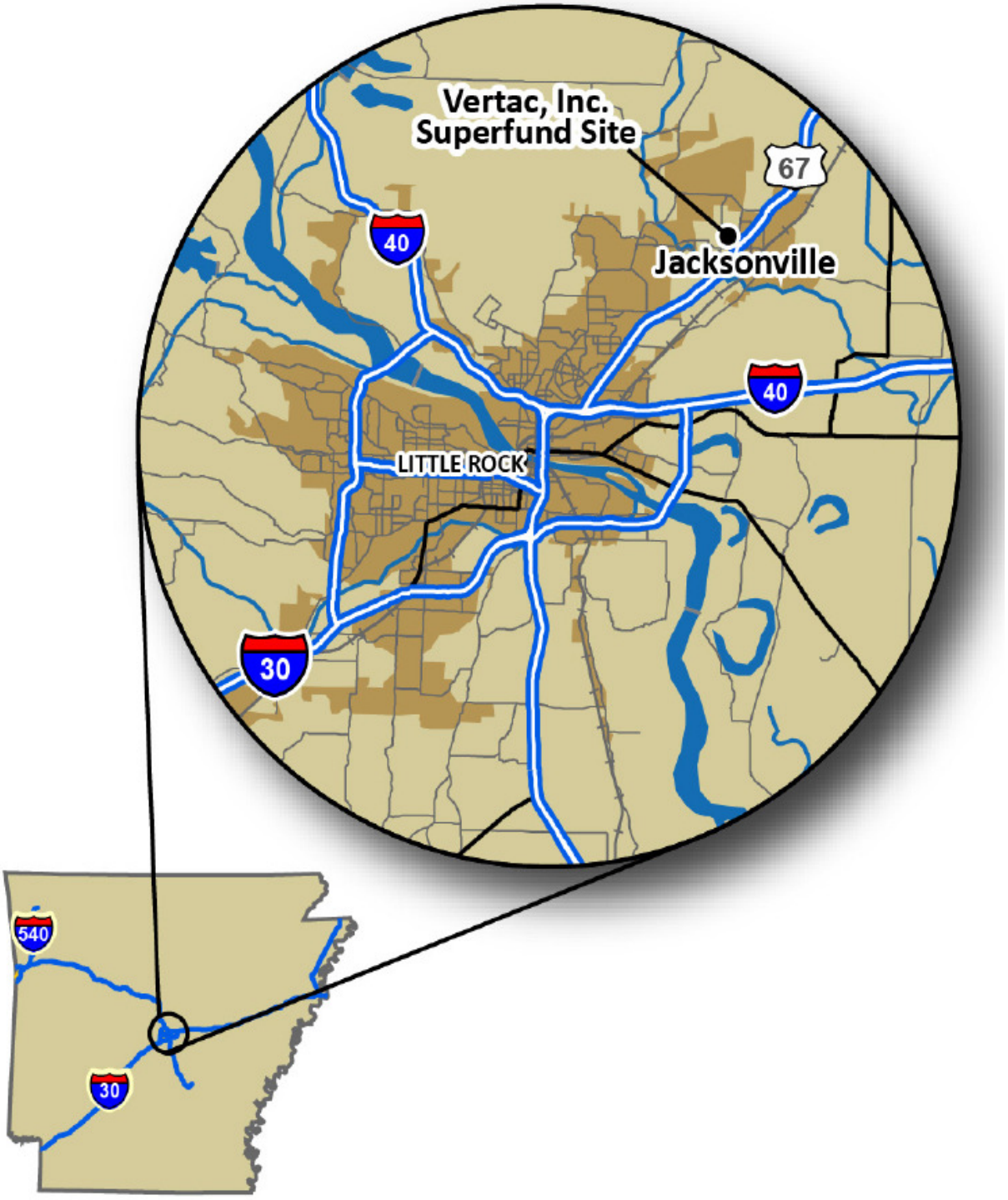
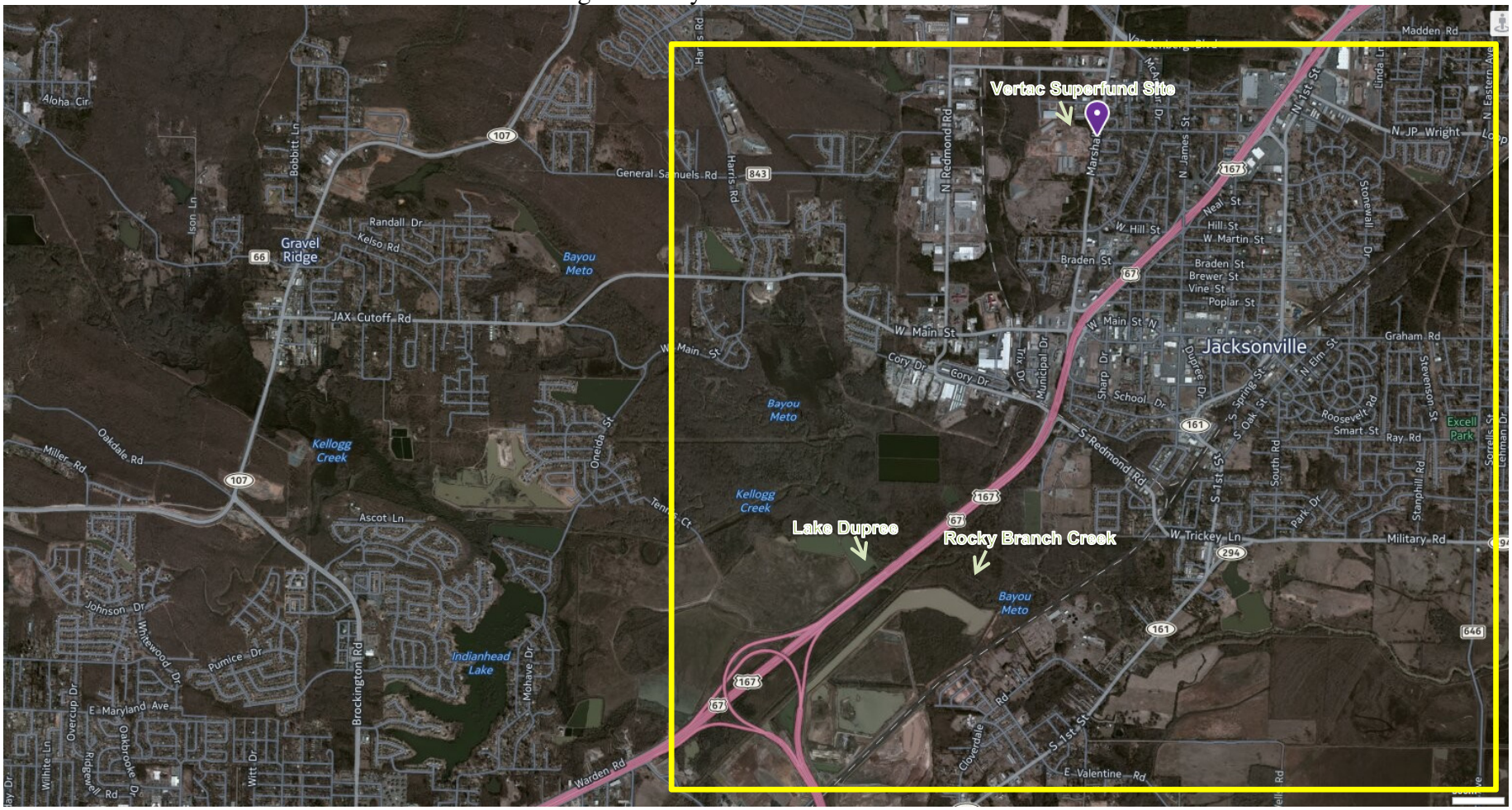
Appendix A: Site Figures



Source: EPA Reuse and the Benefit to the Community: Vertac, Inc. Superfund Site; 2012.
http://www.epa.gov/oerrpage/superfund/programs/recycle/pdf/vertac-success.pdf

Figure of Bayou Meto Watershed



Existing Bayou Meto Watershed Fish Consumption Advisory Area (highlighted yellow area begins at Vertac site at the mouth of the discharge from the now-closed wastewater treatment ponds, encompasses Rocky Branch Creek beyond Highway 67/167, and extends downstream to Arkansas Highway 13.) Source: https://maps.yahoo.com/#/place/?lat=34.85050896372591&lon=-92.15838432312012&q=1600%20marshall%20road%2C%2072076&t=h&bb=34.87966455%2C-92.22383022%2C34.82141351%2C-92.09293842&addr=1600%20marshall%20road%2C%2072076.

Appendix B: Historical Superfund Site Information

Following initial environmental investigations of the Vertac plant, the Environmental Protection Agency (EPA) listed the site on the National Priorities List (NPL) in 1983. The first cleanup actions were initiated in 1984. Cleanup actions included the consolidation of contaminated debris, the excavation and disposal of tons of dioxin-contaminated soil in an on-site landfill, and the incineration of drummed wastes. Several structures were constructed in the early 1990's by the EPA. The southern portion of the site is a secure, fenced area comprised of the landfill, a wastewater treatment facility and the operating ground water pump-and-treat system. Deed restrictions are also in place for this area of the property [1]. A final remedy for this Superfund site was selected in 1996, and on-site remediation construction began. After remedial action was completed in late 1998, the City of Jacksonville acquired Parcel 2, and is currently using some of the structures constructed by EPA to house the City's re-cycling center. The City also has plans to use this property for police and fire department training facilities.

On July 26, 2001, EPA signed the first Five-Year Review report for the site following a thirty day public comment period. The report is available on the EPA website along with the public comments and the responsiveness summary. The second Five-Year Review report was completed on November 20, 2003. The third Five-Year Review was completed on November 20, 2008. The result of the third Five-Year Review concluded that the site remedy remains protective of human health and the environment. The EPA is presently finalizing the fourth Five-Year Review, and the final report should be available in 2014 [2].

Remediation of on-site contamination at the Vertac site reduced the environmental risks for the citizens of Jacksonville. About 10,000 cubic yards of highly contaminated waste were treated by incineration. Approximately 25,000 cubic yards of debris resulting from demolition of buildings and equipment have been disposed in the on-site Resource Conservation and Recovery Act (RCRA) Subtitle C landfill (consolidation/containment unit). Approximately 20,000 cubic yards of contaminated soil have been disposed (contained) in the on-site RCRA landfill. According to EPA, the numerous cleanup actions performed to date have reduced the further spread of contaminants and the threat of exposure to dioxin wastes from the tanks and drums on-site, as well as the threat of dioxin exposure from contaminated buildings and debris, soil and groundwater [1].

References

1. U.S. Environmental Protection Agency Region 6, "Vertac Superfund Site Jacksonville, Arkansas, EPA ID# ARD000023440, Site ID: 0600023" Fact Sheet; December 2013.

2. "Hercules Incorporated 2011 Bayou Meto Fish Flesh Monitoring Report", GBMc & Associates; October 23, 2012.

Example of land re-use by the city of Jacksonville of part of the former Vertac Parcel 2 superfund site. Source: EPA Reuse and the Benefit to the Community: Vertac, Inc. Superfund Site; 2012. http://www.epa.gov/oerrpage/superfund/programs/recycle/pdf/vertac-success.pdf

Appendix C: Toxicity Equivalence Factors of Dioxins and Dioxin-like Compounds

Recommended toxicity equivalence factors (TEFs) for human health risk assessment of polychlorinated dibenzo-*p*-dioxins, dibenzofurans, and dioxin-like polychlorinated biphenyls.

Compound	**TEF**
Polychlorinated dibenzo-*p*-dioxins (*PCDDs)*	
2,3,7,8-TCDD	1
1,2,3,7,8-PeCDD	1
1,2,3,4,7,8-HxCDD	0.1
1,2,3,6,7,8-HxCDD	0.1
1,2,3,7,8,9-HxCDD	0.1
1,2,3,4,6,7,8-HpCDD	0.01
OCDD	0.0003
Polychlorinated dibenzofurans (*PCDFs)*	
2,3,7,8-TCDF	0.1
1,2,3,7,8-PeCDF	0.03
2,3,4,7,8-PeCDF	0.3
1,2,3,4,7,8-HxCDF	0.1
1,2,3,6,7,8-HxCDF	0.1
1,2,3,7,8,9-HxCDF	0.1
2,3,4,6,7,8-HxCDF	0.1
1,2,3,4,6,7,8-HpCDF	0.01
1,2,3,4,7,8,9-HpCDF	0.01
OCDF	0.0003
Polychlorinated biphenyls* (*PCBs)*	
3,3',4,4'-TCB (77)	0.0001
3,4,4',5-TCB (81)	0.0003
3,3',4,4',5-PeCB (126)	0.1
3,3',4,4',5,5'-HxCB (169)	0.03
2,3,3',4,4'-PeCB (105)	0.00003
2,3,4,4',5-PeCB (114)	0.00003
2,3',4,4',5-PeCB (118)	0.00003
2',3,4,4',5-PeCB (123)	0.00003

Sources:

U.S. Environmental Protection Agency, "Recommended Toxicity Equivalence Factors (TEFs) for Human Health Risk Assessments of 2,3,7,8-Tetrachlorodibenzo-*p*-dioxin and Dioxin-Like Compounds," Office of the Science Advisor, Risk Assessment Forum; December 2010.

Van den Berg M., Birnbaum L.S., Denison M., De Vito M., Farland W., et al. "The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-like Compounds," Toxicological Sciences; 93(2):223–241; 2006

Appendix D: Exposure Dose Calculations

Exposure Dose Equation for Ingestion of Fish from Bayou Meto Watershed

ED = (C x IR x AF x EF x CF) / BW

ED = Exposure Dose (milligrams per kilogram per day, mg/kg/day)
C = Contaminant Concentration
IR = Intake Rate of Contaminated Fish
AF = Bioavailability Factor (unitless)
EF = Exposure Factor (unitless)
CF = Conversion Factor
BW = Body Weight (kilograms, kg)

Receptor Scenario Variables*:
C = 23.04, 21.8, 3.5, 8.5, or 9.1 parts per trillion TEQ
IR = general population-adult (.709 oz/day) 2 days per month for 1 year
IR = general population-child (.15 oz/day) 2 days per month for 1 year
IR = subsistence fisher-adult (6.0 oz/day) 22 days per month for 1 year
IR = subsistence fisher-child (1.7 oz/day) 22 days per month for 1 year
EF = 1; AF = 1E-1; CF = 1E-12
BW = 16 kg (child) or 70 kg (adult)

*Reference: Agency for Toxic Substances and Disease Registry (ATSDR). Public Health Assessment Guidance Manual (Update), Appendix G: Calculating Exposure Doses; January 2005.

Hazard Quotient Equation for Estimating Short-Term Health Effects

HQ = ED / RfD

HQ = Hazard Quotient (unitless)
ED = Exposure Dose (milligrams per kilogram per day, mg/kg/day)
RfD = Reference Dose (milligrams per kilogram per day, mg/kg/day)

RfD for 2,3,7,8-TCDD = 7.0E-10 $(mg/kg/day)^{-1}$

Lifetime Cancer Risk Equation for Estimating Possible Carcinogen Effects

LCR = ED x CSF x (estimated exposure years / 70 years lifetime)

LCR = Lifetime Cancer Risk (unitless)
ED = Exposure Dose (milligrams per kilogram per day, mg/kg/day)
CSF = Cancer Slope Factor (1 / milligrams per kilogram per day, $mg/kg/day^{-1}$)
Estimated exposure years = 70 years (lifetime)

CSF^{φ} for 2,3,7,8-TCDD = 1.3E05

$^{\varphi}$California Environmental Protection Agency (Cal/EPA). Technical Support Document for Cancer Potency Factors. Office of Environmental Health Hazard Assessment, Air Toxicology and Epidemiology Branch. Berkeley, CA. 2009

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