HEALTH CONSULTATION

LAKE WORTH FISH SAMPLING

AIR FORCE PLANT #4 (GENERAL DYNAMICS)
CERCLIS NO. TX7572024605

FORT WORTH, TARRANT COUNTY, TEXAS

June 9, 2000

Prepared by

Texas Department of Health
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

BACKGROUND AND STATEMENT OF ISSUES

Lake Worth is a 3,560 acre body of water located north and northwest of the United States Air Force Plant 4 (AFP4) and the adjacent Naval Air Station, Joint Reserve Base, Carswell Field in Fort Worth, Texas. The lake, which has a maximum depth of about 22 feet, was constructed in 1914 by the City of Fort Worth to serve as a water reservoir for the city. Several small communities are within easy traveling distance of this reservoir and area residents use the lake for boating, swimming, and water skiing. There are four public boat ramps and several private marinas around the lake. The lake also is well known by recreational fishers for its abundance of crappie, catfish, largemouth bass and sunfish.

In August 1990, the U.S. Environmental Protection Agency (EPA) placed AFP4 on the National Priorities List (NPL) for Superfund sites. The site was listed primarily because past activities had resulted in the contamination of groundwater in the superficial and deeper aquifers [1].

In 1998, the Texas Department of Health (TDH) and the Agency for Toxic Substances and Disease Registry (ATSDR) released a public health assessment (PHA) for the AFP4 site. During the preparation of the PHA, TDH reviewed sampling data from small nonedible fish, known as mosquito fish, collected from five locations along Lake Worth and Meandering Road Creek. TDH noted that the mosquito fish collected adjacent to AFP4 had higher concentrations of polychlorinated biphenyls (PCBs), dieldrin, naphthalene, and PAHs (phenanthrene and benzo(b)fluoranthene) than those collected from the background locations. Although edible species of fish routinely consumed from Lake Worth were not available for the PHA, based on the mosquito fish findings, TDH and ATSDR recommended that the USAF collect edible fish from Lake Worth to determine whether eating fish from the reservoir poses a threat to public health.

In response to this recommendation, the United States Geological Survey (USGS) was asked to collect and analyze edible fish from Lake Worth and provide the data to the TDH Seafood Safety Division (SSD) for evaluation. In March and April 1999, the USGS collected 55 fish samples from several sites in Lake Worth. Samples consisted of ten largemouth bass, ten freshwater drum, ten common carp, ten channel catfish, ten white crappie and five smallmouth buffalo. Samples were analyzed for organic compounds (volatile and semi-volatile organic compounds, pesticides, and PCBs), and metals.

The organic compounds detected in samples from Lake Worth are summarized in Table 1. The contaminants of most concern to public health are PCBs, particularly Aroclor 1254. Chlordane, p,p'-DDE, hexachlorobenzene, and chlorpyrifos also were detected; however, the average concentrations of these contaminants were at or below detection limits and would not be expected to pose a public health hazard. None of the 22 metals were found at levels that would be expected to pose a threat to public health.

Table 1. ORGANIC CONTAMINANTS DETECTED IN FISH FROM LAKE WORTH				
CONTAMINANT	**Detection Limit (mg/kg)**	**Frequency of Detection**	**Range (mg/kg)**	**Average (mg/kg)**
Aroclor 1254	<0.05	34/55	nd-1.717	0.168
Aroclor 1260	<0.05	28/55	nd-0.415	0.0506
PCBs, total	<0.05	34/55	nd-2.132	0.2185
DDE	<0.05	26/55	nd-0.064	0.0056
Chlordane, total	<0.005	28/55	nd-0.0389	0.0034
Hexachlorobenzene	<0.005	13/55	nd-0.0063	0.00022
Chlorpyrifos	<0.005	3/55	nd-0.0016	0.00006

DISCUSSION

Polychlorinated Biphenyls (PCBs)

Background

PCBs are a group of synthetic organic chemicals that contain 209 individual chlorinated biphenyl compounds (known as congeners) with varying harmful effects. They are either oily liquids or solids and are colorless, odorless, and tasteless. There are seven common types of commercially available PCB mixtures, also known as "Aroclors," which constitute 98% of PCBs sold in the United States since 1970. The name Aroclor 1254 means that the molecule contains 12 carbon atoms (first two digits) and approximately 54% chlorine by weight (second two digits). The more highly chlorinated Aroclors have been found to have greater potential for adverse health effects in humans and animals. There are no known natural sources of PCBs in the environment [2].

Because they don't burn easily and are good insulating materials, PCBs have been used widely as coolants and lubricants in transformers, capacitors, and other electrical equipment. The manufacture of PCBs stopped in the United States in 1977 because of evidence that they build up in the environment and cause harmful health effects. Today, PCBs can be released into the environment from poorly maintained hazardous waste sites that process used electrical transformers or by burning of organic wastes in municipal and industrial incinerators [2].

Environmental Fate

PCBs released into the environment bind strongly to soil and sediments and may remain there for several years to many decades. The more highly chlorinated congeners, such as Aroclor 1260 do not typically travel deep into the soil with rainwater. Because of strong adherence to soil, migration of the highly chlorinated PCBs to groundwater and volatilization to air are negligible.

Currently, the major source of PCB release to the atmosphere is the redistribution of the compounds already present in soil and water. Aroclors are no longer produced in the U.S.; however, emissions may be discharged into the air from other sources including disposal sites

containing transformer and capacitor PCB wastes, incineration of waste, and improper disposal or spills of the compounds to open areas. PCB vapors remain in air for an average of more than ten days, and once in the air they can be carried for very long distances from where they were released into the environment. Vapors eventually return to the land and water by settling or washout with snow and rain. The higher chlorinated PCBs, such as Aroclor 1260, are more likely to be associated with the particulate adsorption phase in air than are the lower chlorinated PCBs [2].

In water, a small amount of PCBs may remain dissolved, but most tends to stick to organic particles and sediments. PCBs in water can build up in fish and marine animals at concentrations hundreds of thousands of times higher than the concentration in water. One of the most significant sources of PCB exposure by humans is through the ingestion of contaminated fish, shellfish, meat, or dairy products [2].

Health Effects

Non-Cancer

Once PCBs enter the body, they may be stored in body fat and the liver for months or years. They also can build up in milk fat and can be transferred to infants through breastfeeding. The most common health effect observed in persons exposed to high levels of PCBs is a form of skin irritation known as chloracne. Other health effects that have been reported in humans include general weakness, numbness of the limbs, respiratory symptoms, altered immune response, and damage to the liver. Gastrointestinal effects such as anorexia, weight loss, nausea, vomiting, and abdominal pain have been observed in workers exposed to PCBs. Ingestion of PCBs and/or swallowing inhaled PCB particles may have contributed to these effects [3].

It is not known whether PCBs can cause birth defects in humans; however, some studies indicate that consumption of PCB contaminated fish during pregnancy may be associated with decreased birth weight, gestational age, and head circumference of infants, as well as a decrease in learning abilities that continued later in life. In the majority of the developmental studies, co-exposure to chemicals other than PCBs and differences in lifestyle were not accounted for. Animal studies have conclusively shown PCBs to cause birth defects such as abortions, stillbirths, and underweight offspring. A number of studies have reported an association between consumption of PCB contaminated fish by women during and before pregnancy and subsequent neurodevelopmental effects in their infants. Limitations to these studies include comparability of exposed to control subjects and exposure assessment. In a group of 242 infants born to mothers who either ate fish from Lake Michigan that were contaminated with PCBs and those who did not, a weak correlation was found between PCB levels in the umbilical cord and altered behavioral responses which persisted until testing ended at age 11. Postnatal exposure from breastfeeding was not related to behavioral performance [3].

Other effects observed in animals include increased hepatic microsomal enzyme induction, liver enlargement, fat deposition, fibrosis, necrosis, increased cholesterol, thyroid enlargement with decreased production of thyroid hormones, increased adrenal gland production reported as an adaptive response to stress, facial edema, acne, fingernail loss, loss of hair in monkeys, weight

loss, and kidney damage. The levels necessary to produce those effects were very high and it is not known if the same effects would happen in people exposed chronically to lower levels [2].

Weak correlations between PCB exposure and depressed immunological function, specifically a reduction in natural killer (NK) cells, have been found in humans consuming PCB-contaminated fish; however, these studies are confounded by the coinciding presence of DDT, which also is capable of affecting the immune system [3].

Neither the EPA nor the Agency for Toxic Substances and Disease Registry (ATSDR) have developed health-based comparison values for Aroclor 1260; however, ATSDR has established a chronic oral minimal risk level (MRL) of 0.00002 mg/kg/day for Aroclor 1254, a structurally similar compound. The MRL is an estimate of a daily human exposure to a contaminant that is unlikely to cause adverse non-cancer health effects over a lifetime. The MRL for Aroclor 1254 is based on a study in which decreased immune system functioning was observed in rhesus monkeys fed Aroclor 1254 in a mixture of corn oil for a period of 55 months. At 55 months, there was a significant dose-related decrease in IgM titers in response to challenges with sheep red blood cell antigens. The lowest dose level tested, 0.005 mg/kg/day, was considered the lowest observable adverse effect level (LOAEL) for decreased antibody response. Uncertainty factors used in deriving the MRL include a factor of 10 for use of a LOAEL, a factor of 3 for extrapolation from animals to humans, and a factor of 10 to account for variability in the human population [3]. Studies in species other than monkeys have given inconclusive immunologic findings in that changes in some immune parameters were sporadic, generally not dose-related, or occurred at much higher levels.

Cancer

Studies in animals show that PCBs containing 60% chlorine by weight are clearly carcinogenic and indicate differences in the carcinogenic potential of other PCB mixtures, based on the degree of chlorination. Available data suggest that the carcinogenic potency decreases with the percent chlorination. Hepatocellular (liver) carcinomas developed in rats fed an estimated dose of 5 mg/kg/day Aroclor 1260 for 21 months [2].

Animals treated intermediately or chronically with Aroclors 1254 or 1260 showed statistically increased incidences of liver adenomas and carcinomas. To investigate hepatic tumor progression after exposure has stopped, groups of rats were exposed for 52 weeks, then exposure was discontinued for an additional 52 weeks. For Aroclor 1260, the “stop-study” tumor incidences were greater than those of the lifetime study, indicating persistent biological activity after exposure stops for the more highly chlorinated Aroclors. Other cancers observed in animals include thyroid gland carcinomas, adenocarcinoma of the stomach, leukemia and lymphoma [2].

A human study analyzing cancer mortality among 2,100 workers at a capacitor manufacturing plant in Italy found statistically significant increases in death from cancers of the gastrointestinal tract and blood system compared with national and local rates [3]. Another human study involving 2,588 workers at two capacitor plants in the U.S. has found significant increases in death from cancer of the liver, gall bladder, and bilary tract [4]. Studies of associations between

serum PCBs and hepatic indices in environmentally exposed populations are generally inconclusive due to the elimination of other contributing factors such as lifestyle, occupational exposures, or consumption of PCB contaminated foods.

Although studies of workers do not provide enough information to determine if PCBs cause cancer in humans, based on the animal studies, the Department of Health and Human Services (DHHS) has determined that PCBs may reasonably be anticipated to be carcinogens. The International Agency for Research on Cancer (IARC) and the EPA each have determined that PCBs are probable human carcinogens. The EPA has estimated an oral cancer slope factor (potency factor) of 2.0 $(mg/kg/day)^{-1}$ for PCB mixtures [2].

Evaluation of Potential Non-cancer Effects

To assess the possibility of health effects associated with exposure to PCBs from eating fish from Lake Worth, we used the average concentration of PCBs and the 95th percentile of the arithmetic average[1] of the contaminant concentrations in the fish to estimate the number of fish meals that a person would have to eat to exceed ATSDR's MRL (Table 2). The MRL for PCBs is 300 times lower than the lowest level at which adverse immune system effects were observed in primates. Using either estimate of the average level of PCBs in fish from Lake Worth we determined that adults and children would have to limit their consumption of fish from Lake Worth to less than one meal each week (8 ounce meal size for adults and 4 ounce meal size for children) to avoid exceeding the MRL for PCBs.

Evaluation of Potential Carcinogenic Effects

TDH has established criteria for issuance of fish consumption advisories [5]. If analyses show that eating less than one meal per week (eight ounces for adults or four ounces for children) results in a theoretical excess lifetime cancer risk of one in ten-thousand persons ($1x10^{-4}$), a risk level qualitatively interpreted as a low increased risk, an advisory is indicated. We used EPA's cancer unit risk factor for PCBs to estimate the number of meals that it would take for individuals of different weights to exceed the 1×10^{-4} risk level necessary for the issuance of an advisory (Table 3). The criteria were exceeded under several of the different body weight specific exposure scenarios.

CHILD HEALTH INITIATIVE

ATSDR's Child Health Initiative recognizes that the unique vulnerabilities of infants and

[1] The 95th percentile of the arithmetic average is a value that, when calculated repeatedly for randomly-drawn subsets of the data, equals or exceeds the true average 95 percent of the time and constitutes the 95% upper confidence limit (UCL) on the arithmetic average. TDH estimated the 95th percentile of the average by defining the distribution of each of the contaminants and then calculating the 95 percent upper confidence limit on the mean. The 95 percent upper confidence limit provides a conservative estimate of the average concentration to which a person might be exposed.

children demand special emphasis in communities faced with contamination of their water, soil, air, or food [6]. Children are at greater risk than adults from certain kinds of exposures to hazardous substances emitted from waste sites and emergency events. They are more likely to be exposed because they play outdoors and they often bring food into contaminated areas. They are shorter than adults, which means they breathe dust, soil, and heavy vapors close to the ground. Children also are smaller, resulting in higher doses of chemical exposure per body weight. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Most importantly, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care.

The TDH evaluated the potential public health hazards associated with children eating fish from Lake Worth and determined that young children who eat fish from Lake Worth could be exposed to PCBs at levels that pose an unnecessary health risk.

Table 2. Number of meals required to exceed the MRL for non-cancer health effects in Lake Worth fish

Estimates based on average PCB concentration of 0.218 mg/kg or the 95th percentile on the arithmetic average of 0.316 mg/kg in the 55 fish samples collected from Lake Worth

Chemical Name: Aroclors 1254 and 1260
Population: Adults and children
Minimal Risk Level: 0.00002 mg/kg body weight/day
Detection Limit: 50 mg/kg of tissue

Risk-Based Consumption Limit (meals/week)			
Body Weight (kg)	Age Range (years)	Number of meals per week that may be consumed without exceeding the Minimum Risk Level for non-cancer effects	
		Arithmetic Average 0.218 mg/kg	95th percentile on Arithmetic Average 0.316 mg/kg
Child: Average meal size = 4 ounces			
15	3 to 6	0.08	0.06
35	10 to 11	0.2	0.14
Adult : Average meal size = 8 ounces			
50		0.14	0.1
60		0.17	0.12
70		0.2	0.14
80		0.23	0.16
90		0.25	0.18

Table 3. Number of meals required to exceed the 1x10-4 risk level for persons consuming Lake Worth fish over a lifetime

Estimates based on average PCB concentration of 0.218 mg/kg or the 95th percentile on the arithmetic average of 0.316 mg/kg in the 55 fish samples collected from Lake Worth

Chemical Name:	**Aroclors 1254 and 1260**
Population:	**Adults and children**
Cancer slope factor	**2 (mg/kg/day)-1**
Detection Limit:	**50 mg/kg of tissue**

Risk-Based Consumption Limit (meals/week)			
		Number of meals per week that may be consumed without exceeding the 1x10-4 risk level	
Body Weight (kg)	**Age Range (years)**	**Arithmetic Average 0.218 mg/kg**	**95th percentile of Arithmetic Average 0.316 mg/kg**
Child: Average meal size = 4 ounces			
15	**3 to 6**	**0.5**	**0.34**
35	**10 to 11**	**1.2**	**0.79**
Adult : Average meal size = 8 ounces			
50		**0.83**	**0.57**
60		**0.99**	**0.68**
70		**1.16**	**0.80**
80		**1.32**	**0.91**
90		**1.49**	**1.02**

CONCLUSIONS

Based on the average levels of PCBs found in fish from Lake Worth, we have concluded that chronic ingestion of the fish poses a public health hazard. This conclusion is primarily based upon the potential for immunologic effects associated with chronic exposure to PCBs; however, there also is a low increased lifetime risk for cancer associated with long-term ingestion of PCB-contaminated fish from the lake.

RECOMMENDATIONS AND PUBLIC HEALTH ACTIONS

1. In April 2000, the Commissioner of Health issued a fish consumption advisory for Lake Worth indicating that fish from Lake Worth are unsafe for human consumption due to PCB contamination. The advisory recommended that fish from Lake Worth should not be eaten.

2. TDH/ATSDR have provided this information to EPA/AFP4 for consideration in their ongoing investigation and remediation of the AFP4 NPL site.

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CERTIFICATION

This Lake Worth Fish Sampling Health Consultation was prepared by the Texas Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was initiated.

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The Division of Health Assessment and Consultation, ATSDR, has reviewed this Health Consultation and concurs with its findings.

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